

UM-HSRI-80-12

INVESTIGATION OF THE PERFORMANCE OF
CHILD RESTRAINTS IN SERIOUS CRASHES

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Final Report
to the
Insurance Institute for Highway Safety

May 1980

Technical Report Documentation Page

1. Report No. UM-HSRI-80-12	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Investigation of the Performance of Child Restraints in Serious Crashes		5. Report Date May 1980	
		6. Performing Organization Code UM-HSRI-80-12	
		8. Performing Organization Report No.	
7. Author(s) John W. Melvin, Kathleen Weber, Paula Lux		10. Work Unit No. (TRAIS)	
9. Performing Organization Name and Address Highway Safety Research Institute The University of Michigan Ann Arbor, Michigan 48109		11. Contract or Grant No. Project No. 6697	
		13. Type of Report and Period Covered Final Report 5/78 - 1/80	
		14. Sponsoring Agency Code	
12. Sponsoring Agency Name and Address Insurance Institute for Highway Safety Watergate Six Hundred Washington, D.C. 20037		15. Supplementary Notes	
16. Abstract The purpose of the project was to investigate the performance of child restraints in actual crashes. Timely notification of crashes in which a child restraint was used was solicited from state and national agencies and other organizations concerned with vehicle occupant protection. Notifications of 214 crashes were received, and 16 cases of interest were investigated in depth at the crash locale. These cases are described in detail, and evaluations of the effectiveness of specific child restraints, used in specific ways in these crashes, are made. Two of the crashes were judged to be close in crash configuration and severity to laboratory dynamic test conditions. Conclusions of the study are as follows: (1) severe frontal crashes in which a child is properly harnessed in a properly secured child restraint are rare events; (2) child restraints that only meet static test criteria provide some injury protection in less severe crashes; (3) child restraints that meet dynamic test criteria provide excellent injury protection when used properly and still provide adequate protection in some misuse modes; and (4) further work is needed with respect to both vehicle structures and child restraint design to provide better side impact protection for children.			
17. Key Words Child Restraint Devices Injury Protection Accident Investigation		18. Distribution Statement	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages 64	22. Price

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1.0 Introduction and Scope

Restraints specially designed to provide protection for children in crashes have been available for about ten years. In the last eight years, many manufacturers have voluntarily subjected their products to dynamic tests, simulating usually a 30 mph crash into a rigid barrier. With the promulgation of the new Federal Motor Vehicle Safety Standard 213, Child Restraint Systems¹⁻², all child restraints manufactured after January 1, 1981, will have to meet dynamic test requirements. The primary criterion for acceptable performance has been a limit on forward head excursion, or the distance the test dummy's head is allowed to move in a frontal impact. This project was initiated to investigate the performance of child restraints in actual crashes and, when possible, to relate this performance to the dynamic test criteria above.

The results of an earlier study, limited geographically to two counties in Michigan, have been reported³. It was found that unrestrained children often received injuries from contact with the vehicle interior, while there was a notable lack of injury among properly restrained children in similar crashes. However, the extremely low use rate of child restraints in vehicles involved in crashes (4.7% in the earlier study) and the likelihood that these restraints would be installed incorrectly (67% in the earlier study) resulted in no cases that could indicate the upper limits of child restraint performance. A nationwide attempt to identify severe crashes in which child restraints were properly used was therefore launched.

2.0 Methodology

2.1 Notification Procedures

The present study was expanded geographically to include the continental United States and Canada. To effect timely notification of accident cases, letters (see Appendix A) were sent to state police and traffic safety agencies, national traffic safety agencies, safety research centers, consumer groups, and manufacturers of child restraints asking for their cooperation in notifying us, by collect telephone call, of any crash in which a child restraint was used. A determination would

then be made whether the case warranted on-scene investigation.

Notifications of cases were contributed by various governmental units and by several organizations in the public and private sectors. (See Case Log, Appendix B.) Notifications from all sources were received at the rate of about seven per month for the first nine months after contacts were established. At this point, state agency notifications dropped off abruptly, but other organizations continued to provide information.

Also, at about this time, new contacts were made with the Ontario Ministry of Transportation and Communications (OMTC), who in turn enlisted the cooperation of the Ontario Provincial Police. The result was a new and valuable influx of cases from a jurisdiction in which adult restraint use is mandatory, and, although children under 5 are exempt from the law, child restraint use is estimated by OMTC to be between 20% and 30%. The arrangement included (1) immediate telephone notification by the investigating officer of "serious" crashes involving child restraints and (2) automatic provision by OMTC of a copy of the accident report. During the last two months of the project, copies were provided of all accident reports coded to include child restraint usage, regardless of crash severity or selection by an investigating officer. A comparison of the frequency of these cases vs. those judged to warrant investigation emphasizes the rarity of the type of crash event simulated by dynamic child restraint tests. Of the 134 reports received for crashes occurring in November and December (reports of cases received after December are counted here but do not appear on the Case Log, Appendix B), only two were investigated. Five other cases that appeared to be potentially interesting from the reports proved to be minor impacts with minor bruises or bit lips and one case of non-use.

2.2 Case Selection Criteria

The criteria for selecting crashes to be investigated were based on the general goal of acquiring information on the performance of child restraint systems in severe crashes. Because of the importance of investigating these crashes soon after their occurrence and before the

evidence disappeared, individual cases were judged on the information immediately available from telephone contacts and, in some cases, from police reports. Frontal crashes apparently severe enough to approach laboratory test conditions were selected as well as lateral impacts with occupant compartment intrusion. All cases with significant injuries and fatalities to restrained young children were investigated, including a case involving fire, regardless of impact direction or severity.

2.3 Investigation Procedures

A trained HSRI accident investigator located the case vehicle and other involved vehicles if available, measured deformations, identified interior contact points, checked vehicle belts for evidence of stretching, child restraint marking or wear, and took photographs of the exterior and interior of the vehicle. If the child restraint was still in the vehicle, it was inspected for webbing marks, contact points, deformation or cracking, and harness stretching or wear. Top tether attachment, if applicable, was also noted. Photographs were taken of the child restraint positioned in the vehicle, and the restraint was retrieved by the investigator.

Parents of the child were also routinely contacted, unless death or serious injury made this impossible. The child restraint was usually located at the parents' home and inspected there. If possible, arrangements were made to replace the used restraint with a new one, and the crash-involved restraint was taken by the investigator. However, due to litigation, some restraints could only be inspected and photographed. In one case, the investigator was not even allowed to see the restraint. In addition, in spite of our best efforts to convince parents that once a restraint is placed under crash loads it may fail the next time, some still held to the misguided belief that "if it worked once, it will work again" and refused to give it up.

Parents were also interviewed by the investigator regarding restraint attachment, harness use, and injuries to the child and other occupants. This information was always checked against the physical evidence. Medical diagnoses were obtained for injured restrained children and for other occupants as appropriate.

The information gathered by the investigator was then analyzed by project staff, and a description of each case was developed from the investigator's observations, parental comments, police reports, medical records, photographs, and the restraint itself.

3.0 Case Descriptions

Twenty cases were investigated in all, but only 16 proved to be of sufficient interest to report in detail here. Among these crashes, eight were frontal, six lateral, and two of multiple direction. Excluding the fire case, nine were considered to be severe tests of the child restraint systems, and the remaining six were moderately severe crashes. Of the 17 young children in child restraint devices, two sustained fatal impact injuries, but seven children escaped with no injury whatsoever. Twelve children were in forward-facing child restraints, and five were in rear-facing infant or convertible child restraints. Only six of these restraint systems were used correctly, only one being a forward-facing child restraint in a severe frontal crash.

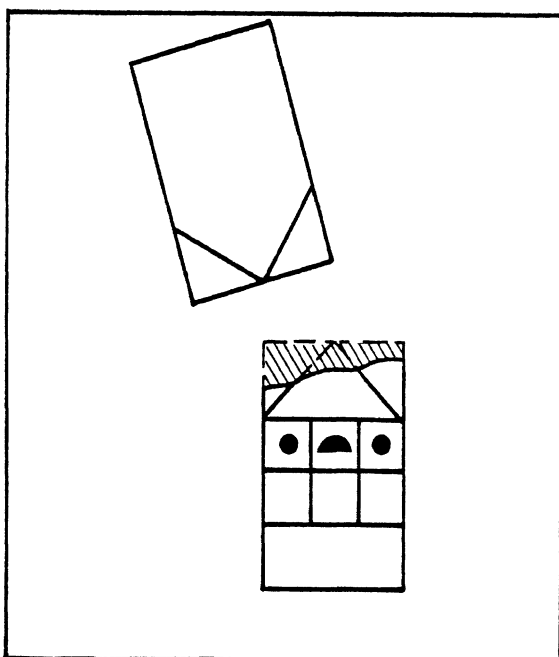
The descriptions of investigated cases include the following information:

- (1) a diagram showing impact direction, vehicle damage, occupant locations in the case vehicle (indicated by dots) and child restraint location and orientation (indicated by a half circle, with its flat side facing rearward or forward as appropriate);
- (2) a general description of the crash event and the vehicles involved;
- (3) identification of the child restraint by manufacturer and brand name, with additional description if old or uncommon.
- (4) details about usage, including age of the child, restraint position and orientation in the vehicle, harness use, and means of securing the restraint to the vehicle, as well as details about the physical effect of the impact on the restraint itself;

(5) a description of injuries received by the child, if any,
and by other occupants as an indication of crash severity;
and

(6) comments related to the performance of the child restraint
and the significance of the investigated crash.

The cases are numbered according to the Case Log included as Appendix B.



A '68 Chevrolet II Nova was traveling north at 55 mph, when a '73 Chevrolet Camaro going south slid sideways into the northbound lane.

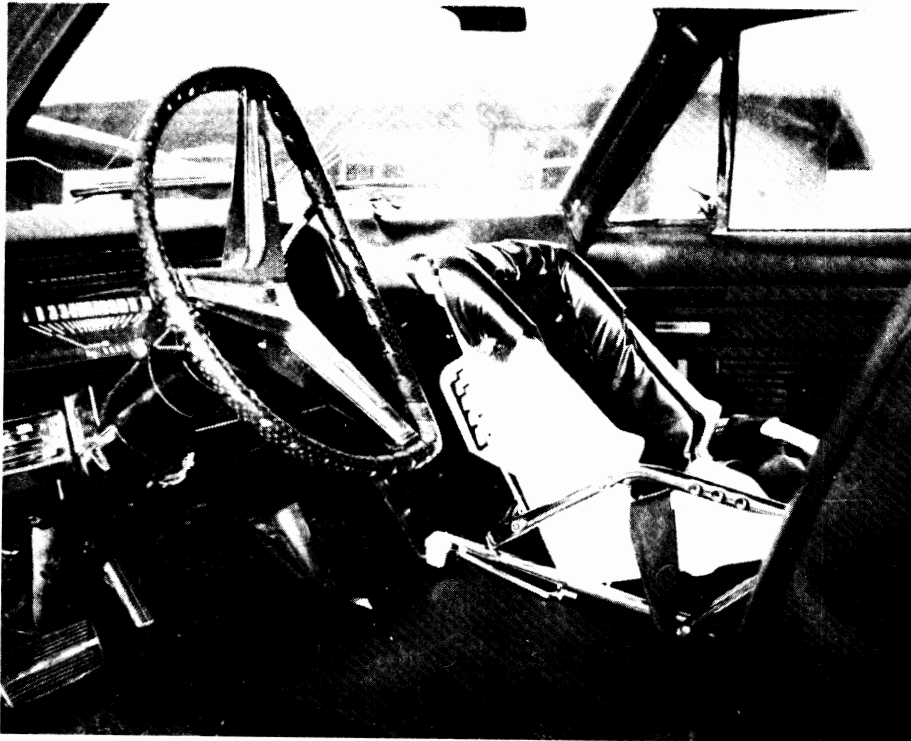
Child restraint: Bobby Mac 2-in-1.

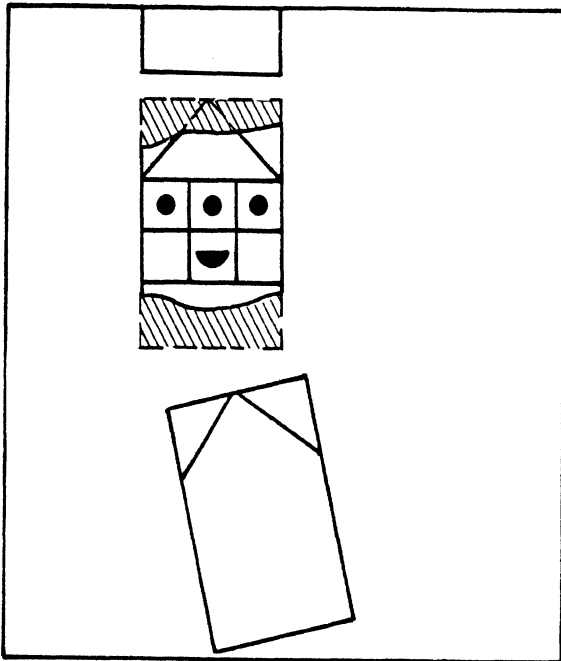
Child restraint usage and performance: A 7-week-old child was harnessed in a convertible child restraint used in the rear-facing infant mode in the center front position. The restraint was secured with the vehicle lap belt. The restraint functioned as intended.

Injuries: There was no injury to the child despite multiple injuries to the two lap-belted adults flanking the child. Upon impact the two adults moved forward and to the left. The driver contacted the steering wheel rim, the steering column, and the left side door suffering a fractured nose and bruises. The adult in the right front position contacted the instrument panel and ashtray suffering various fractures and a lacerated lower lip. Both adult passengers suffered lap belt injuries.

Comments: This case represents a good example of the effectiveness of rear-facing child restraint systems. Examination of the child restraint revealed no significant contacts with the vehicle interior, and thus the restraint received no support from the dashboard, a condition similar to the laboratory test configuration. The lack of injury to the child from

contact with other occupants, from contact with interior surfaces, or from loading of the restraint harnesses themselves, demonstrates the effectiveness of the restraint system. This was a moderately severe oblique frontal crash, not quite as severe as the laboratory test conditions.





A '71 Oldsmobile Cutlass was stopped at a red light when it was rear-ended by a drunken driver in a '70 Pontiac Catalina, who was swerving out of control after having just side-swiped another vehicle. The case vehicle was then pushed into the back of a stopped vehicle also waiting at the red light. On impact the case vehicle went up in flames. The three unrestrained passengers in the front seat escaped. A witness attempted to remove

the child from the child restraint but failed. He then attempted to remove the entire child restraint but again failed. Intense heat caused him to abandon further attempts.

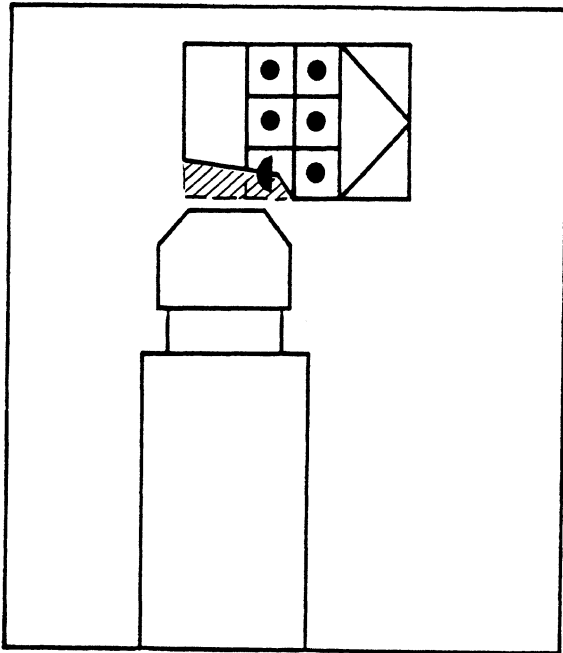
Child restraint: Strolee Wee Care

Child restraint usage and performance: A 14-month-old child was harnessed in a forward-facing child restraint in the center rear position. The restraint was secured with the lap belt, but the tether strap was not anchored.

Injuries: Although the child died in the fire, according to the morgue report, she had no apparent crash injuries. Minor bruises were sustained by the two unrestrained adults in the front. The unrestrained 16-month-old child in the center front position was not injured.

Comments: This was a very severe rear-end collision. After the crash, the child restraint system was apparently close to the backs of the front seats, because of forward intrusion of the rear seat and rearward deformation of the front seatbacks. In this position access to the child restraint would have been difficult and the buckle of the lap belt and harness would not even have been visible. In addition, the would-be

rescuer was most likely unfamiliar with child restraint systems. Because of these circumstances in combination with the fire, it is not surprising that he was unable to free the child.



The driver of a '68 Ford LTD, attempting to cross a major highway, failed to yield the right-of-way to a semitrailer truck carrying bulk cement and traveling about 50 mph. The case vehicle was struck in the right rear and spun off the road.

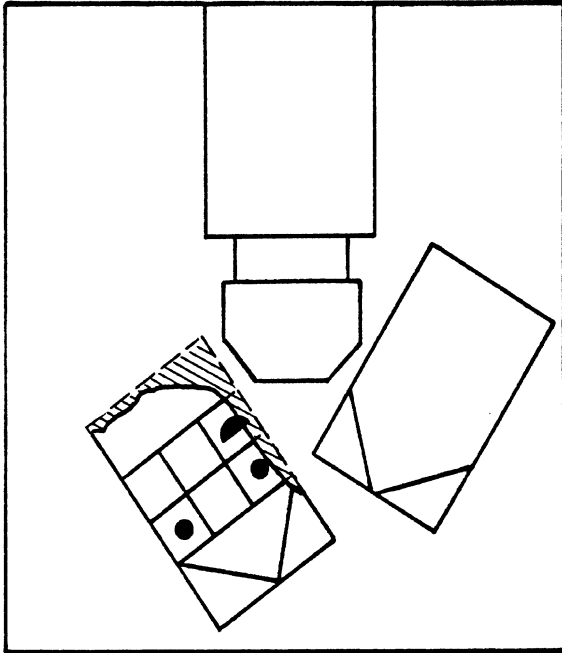
Child restraint: Peterson (c.1975) with top tether and 5-point harness.

Child restraint usage and performance: A 15-month-old child was harnessed in a forward-facing child restraint in the right rear position. The tether was bolted permanently to the car, and the lap belt was also used to secure the child restraint. After the accident there was a four-inch bend in the upper right portion of the frame. Also, the padded back was loosened, possibly from the impact. Despite the severe impact, the child restraint did remain attached to the car and the child stayed in it.

Injuries: The child suffered a right side depressed skull fracture with severe brain contusion and lacerations. The child died from these injuries in surgery a few hours after the crash. An unrestrained 16-month-old child in the center front position sustained a forehead laceration. An unrestrained 3-year-old child in the left rear position suffered a concussion and left forehead laceration. Another 3-year-old in the center rear suffered a concussion and two black eyes.

Comments: Although this restraint system has a good harness design, it lacks adequate lateral impact protective structure. Because of this, the restraint could not prevent the child from impacting the side of the ve-

hicle interior and quite probably the striking vehicle. However, considering the severity of the impact and the child's position at the point of maximum intrusion by the striking vehicle, it is unlikely that a more "wrap-around" design would have saved the child's life.



On a snowy evening a '75 Toyota stopped on a slippery stretch of pavement after colliding with another car sliding out of control. Before the passengers could get out of the cars, a tractor semitrailer going 45 mph approached the same slippery stretch of pavement and, unable to stop, plowed its way through the two cars.

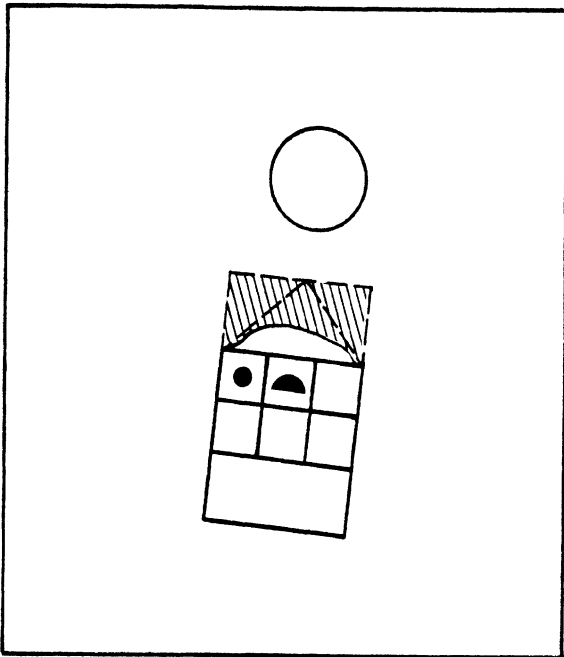
Child restraint: Jamy (c. 1971) with frame extension at rear base to fit between seat cushions.

Child restraint usage and performance: A 2-year-old child was in a forward-facing child restraint in the left rear position. The vehicle lap belt was used to secure the child and the restraint in the car, but the shoulder straps attached to the child restraint were not used. The restraint, which had been purchased used, lacked padding on the arm rest. Upon impact with the intruding vehicle interior, the tubular frame was severely distorted and the head restraint broken off.

Injuries: The child received only a few facial scratches. The unrestrained front seat passengers sustained major injuries.

Comments: The performance of the restraint, which meets only the static test criteria of FMVSS 213, was not truly tested in this severe rear and near-side crash. Although the use of the lap belt to anchor both child and restraint prevented the child from impacting the interior, the position of the restraint relative to the point of impact was more responsible for preventing injuries. A lap belt would have been as effective.





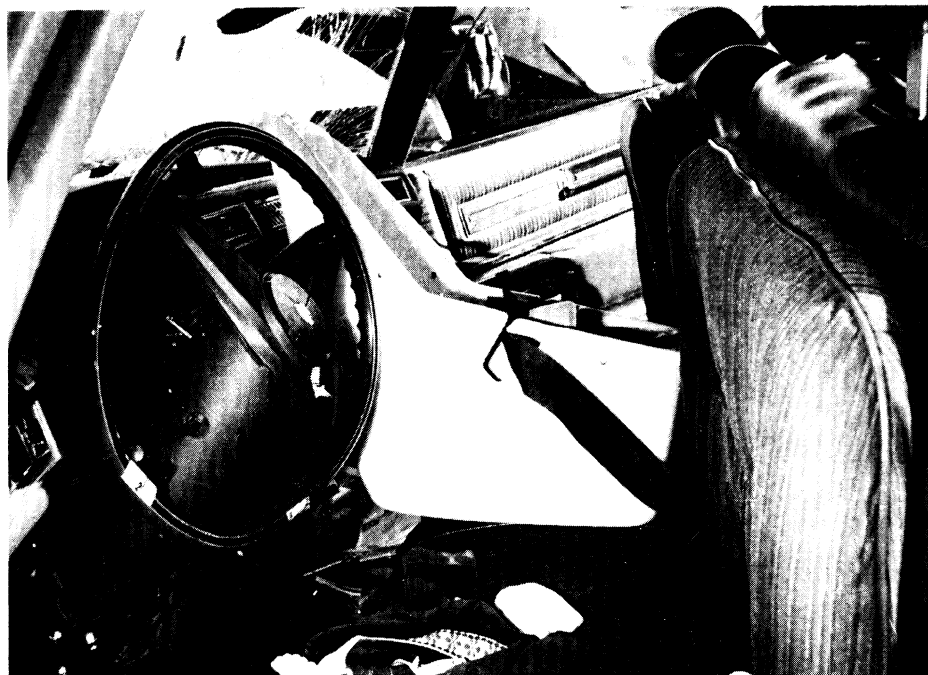
For reasons unknown, the driver of a '76 Cadillac left the roadway. Traveling on the soft shoulder she struck a mailbox, speed limit sign, and finally crashed head-on into a large elm tree.

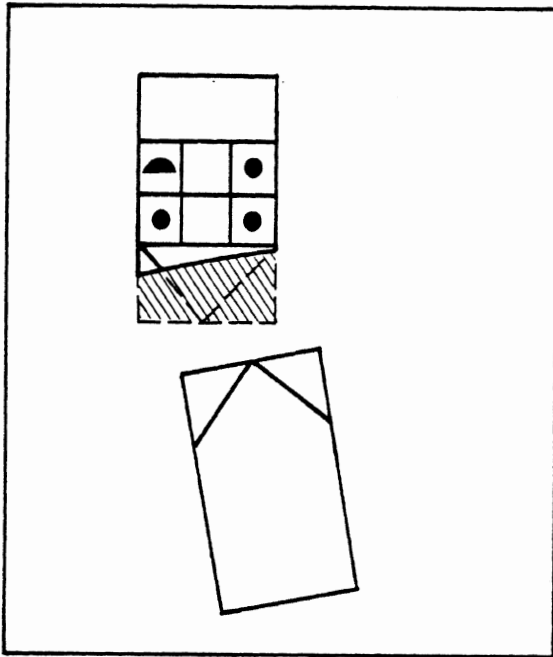
Child restraint: General Motors Infant Love Seat.

Child restraint usage and performance: A 2-month-old child was in a rear-facing infant restraint in the center front position. The child was not harnessed in the restraint, but the latter was secured in the car with the lap belt. Upon impact the front seatbacks deformed forward, and the infant restraint was squeezed between the seatback and the intruding dash. The restraint also showed evidence of having contacted the steering wheel. The infant restraint functioned properly.

Injuries: The child was uninjured. The unrestrained driver received fatal chest and abdominal injuries.

Comments: In this very severe frontal crash, the restraint demonstrated the effectiveness of the rear-facing position even without the use of the harness. The restraint's impact with the dashboard prevented it from rotating forward, thus minimizing the need for the harness in this case.





A '76 Peugeot was traveling on a roadway with a designated speed of 45 mph, when a '71 Mustang crossed the center line and crashed head-on into the Peugeot.

Child restraint: General Motors Child Love Seat

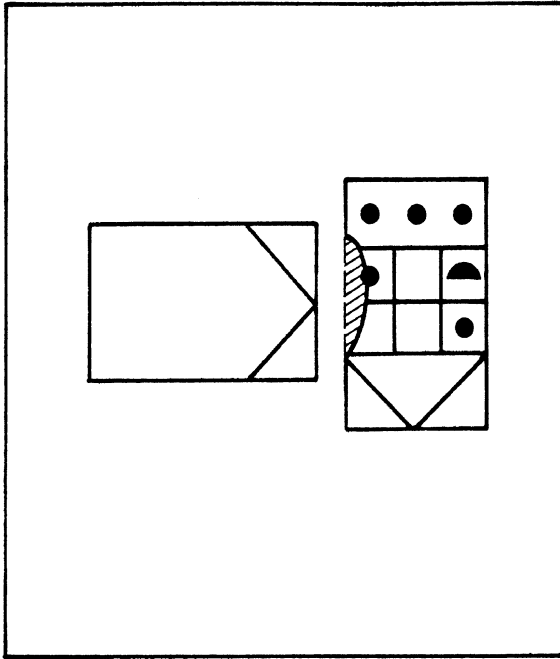
Child restraint usage and performance: A 2-year-old child was harnessed in a forward-facing child restraint in the right rear position. The restraint was secured to the car with the lap belt, and the top tether was threaded behind the rear seatback and anchored to the right rear wheel well. Impact forces cracked the plastic shell in several places, but the child was well protected by the restraint.

Injuries: The 2-year-old in the child restraint was uninjured. The restrained adults in the front seat suffered various fractures requiring hospitalization. A 4-year-old child, restrained by a lap belt in the left rear, sustained a fractured pelvis.

Comments: This very severe frontal crash is comparable to simulated laboratory test conditions. The top tether was anchored atypically, allowing more strap length and resulting in more forward motion than usual upon impact. The restraint performed effectively although the shell was cracked. The cracking could have been due to the unusual tether strap routing and/or the possible aging (4 years) of the plastic. In addition, in preventing a serious head injury to the four-year-old, the lap belt demonstrated its effectiveness as a restraint system for young children. The pelvic injury could

probably have been avoided had an upper torso harness or a child restraint been used.





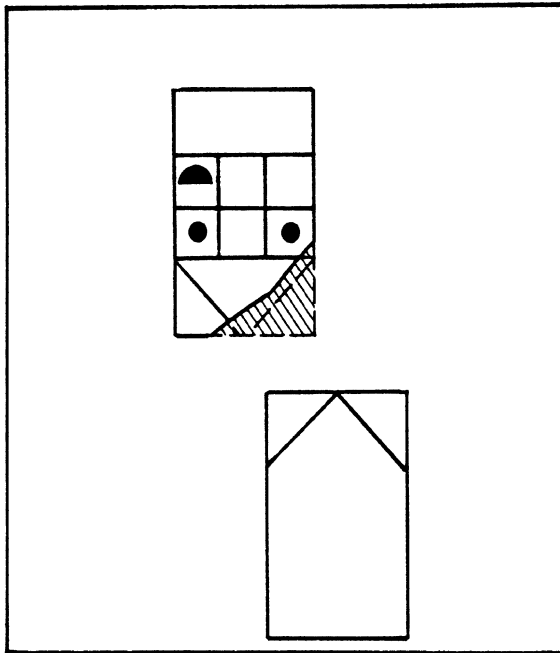
A '78 Chevrolet Impala station wagon was struck on the right side at an intersection by a '73 Chevrolet Monte Carlo traveling 40-45 mph.

Child restraint: Peterson (c. 1973) with 3-point harness.

Child restraint usage and performance: A 2-year-old child was harnessed in a forward-facing child restraint in the left rear position. The restraint was properly secured with the lap belt through the frame. Upon impact the child's body struck the right side of the padded arm rest with sufficient force to dislodge it from its anchor pin, but not enough to cause injury.

Injuries: The child was not injured. The restrained driver, a 3-year-old child wearing an adult lap belt in the right rear, and three unrestrained children riding in the cargo area all received minor injuries.

Comments: This was a moderate-to-severe far-side impact. The restraint system protected the child by preventing impact with the other children. In controlling the child's motion as a far-side occupant, this restraint was effective, despite the fact that this model only meets the static test criteria of FMVSS 213. But if the restraint had been positioned on the near-side of impact, it may not have been as effective. The child in the near-side position did suffer minor injuries.



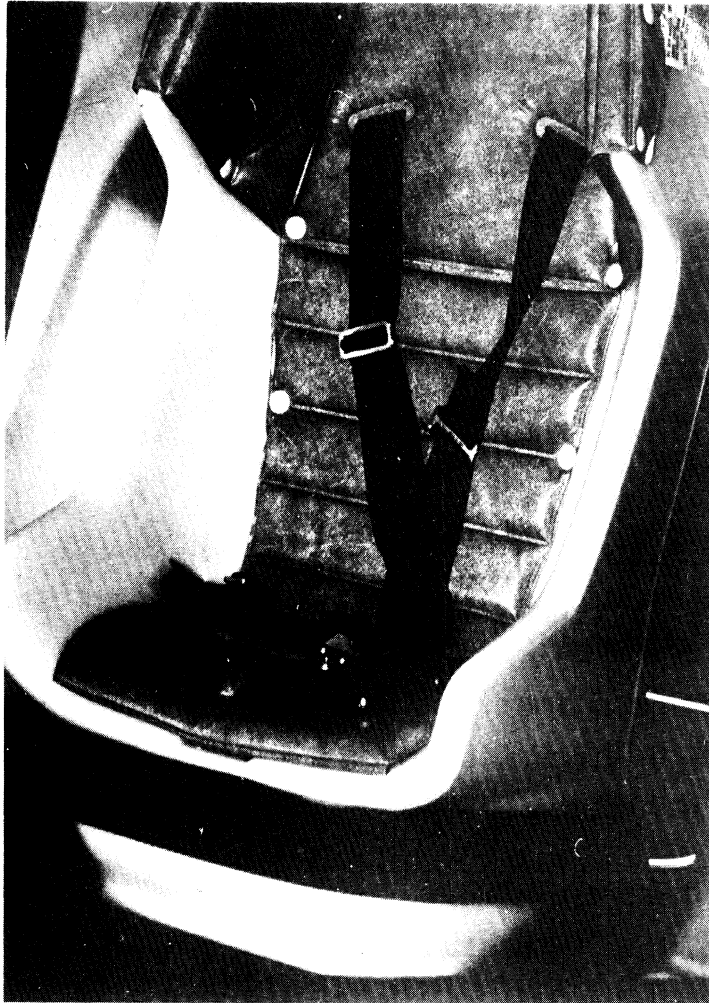
A '72 Pinto hatchback crossed the center line amid blowing snow and struck an oncoming '76 Ford Torino with its left front end.

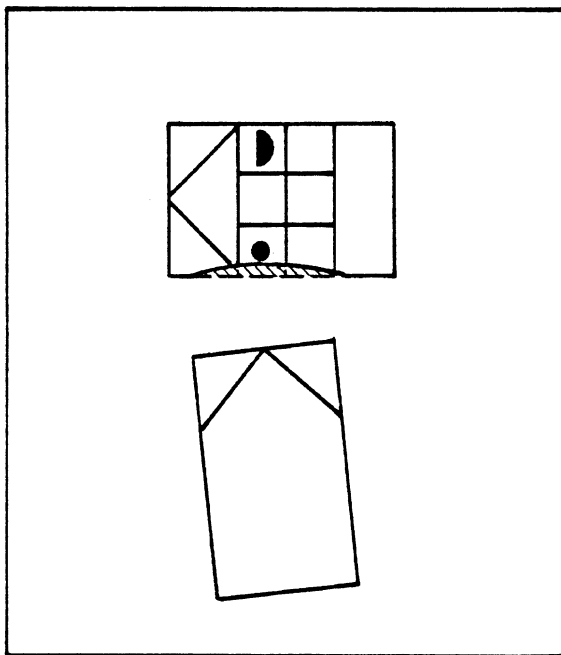
Child restraint: General Motors Child Love Seat.

Child restraint usage and performance: An 11-month-old, 21 lb. child was harnessed in a forward-facing child restraint in the right rear position. The restraint was secured only by the lap belt around the molded plastic base, the tether not being anchored. Despite the method of attachment to the vehicle, the child restraint functioned well, and no occupant-to-vehicle contact was observed.

Injuries: The child was not injured. The unrestrained front seat occupants sustained major injuries.

Comments: Even though the restraint was secured at its base, allowing for greater forward rotation than usual with an untethered child restraint, it provided adequate protection in this moderately severe crash.





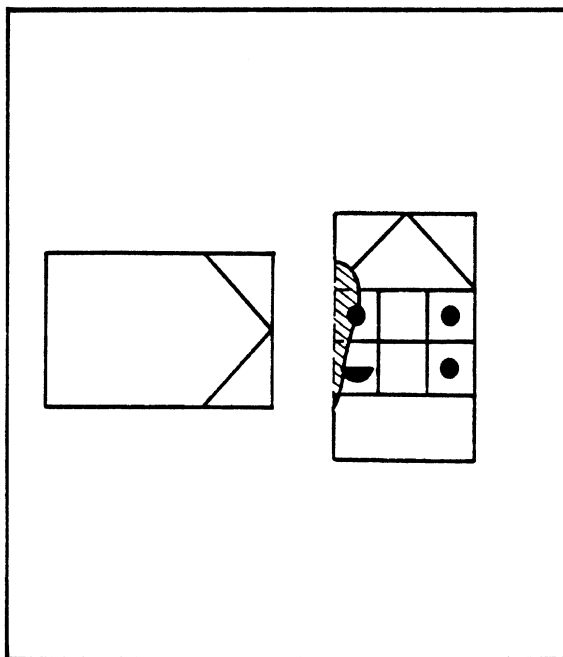
A '76 Chevrolet Monte Carlo was struck on the left side by a '72 Ford pick-up truck, which had failed to stop at a stop sign.

Child restraint: General Motors Child Love Seat.

Child restraint usage and performance: A 4-year-old child, whose height exceeded that recommended by the restraint manufacturer, was riding unharnessed in a forward-facing child restraint in the right front position. The restraint was properly secured, however, with the lap belt (the shoulder harness being behind the child restraint), and the tether was attached to the rear lap belt. The child sat tall enough that her head extended above the top of the side wings. Because of her size and bulky clothing, the child seemed to be adequately restrained by the adult lap belt over the child restraint.

Injuries: Because of her height, the child's head contacted the window on the right side causing minor swelling. The restrained driver received fractured ribs and multiple lacerations.

Comments: The restraint, even used improperly, did hold the child in place in this moderate side impact. If the harness had been fastened, the restraint might even have prevented the head impact with the window.



A '74 Toyota was struck on the left side by a '78 GM pick-up truck, which was traveling about 50 mph and had entered the intersection against a red light.

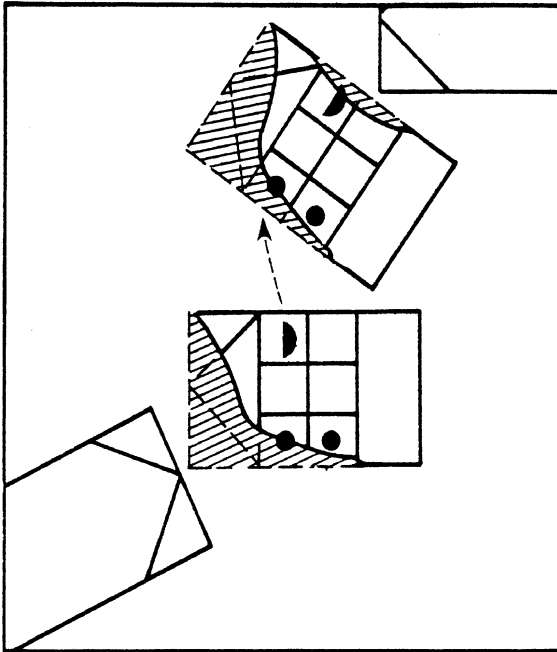
Child restraint: Dorel (Canadian manufacturer) with top tether.

Child restraint usage and performance: A 16-month-old child was harnessed in a forward-facing child restraint in the left rear position. The restraint was secured by wrapping the lap belt twice around the lower rear portion of the tubular frame. Threading the belt once through a higher slot is recommended by the manufacturer. The child was being transported in a vehicle other than his parents', and no anchorage was available for the top tether. The vehicle side panel impacted the child restraint at the front left, bending the tubular base and crushing the left front corner of the plastic shell. Considering the level of intrusion, the child restraint functioned well, although the child's arm was trapped between the restraint and the vehicle interior. The unorthodox method of securing the child restraint was probably due to the driver's unfamiliarity with the system but was not likely to have affected its performance in this crash.

Injuries: The child was unconscious after the accident and received a broken left arm and facial lacerations from broken glass. The restrained driver received fatal internal injuries, and the other occupants sustained various minor injuries.

Comments: This was a severe near-side impact in which the position of the restraint just behind the central point of contact was critical. The child suffered injuries from interior intrusion, but probably not from direct impact with the striking vehicle. Although the tether was not anchored, the restraint was effective in preventing possibly fatal interactions between the child and the intruding interior and striking vehicle. It appears that the lower side wings protected the child against leg and pelvic injury.





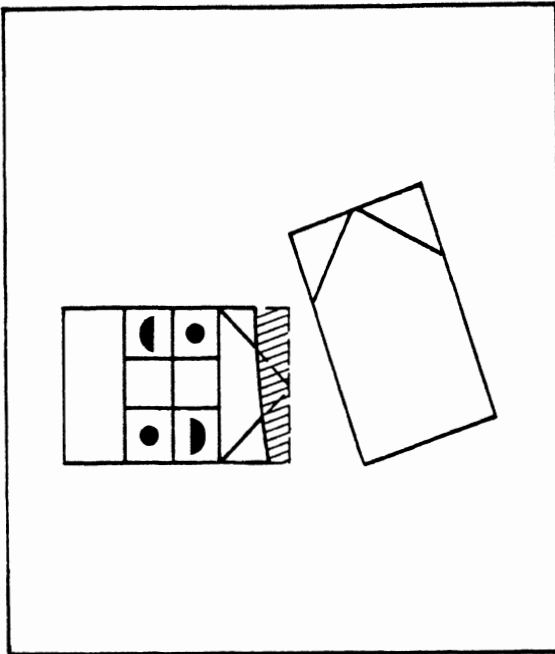
A '78 Volkswagen Dasher station wagon was struck in the left front by a '74 Ford Torino station wagon, which had crossed the center line to avoid another vehicle. The case vehicle (Dasher) then rotated and was hit on the right side by another vehicle.

Child restraint: Bobby-Mac Deluxe.

Child restraint usage and performance: A 21-month-old child was harnessed in a forward-facing child restraint in the right front position. The shield, a critical component of this restraint system, was not in use. The restraint was secured with the lap belt through the slots normally used for the rear-facing position. Upon the initial left-forward impact, the restraint allowed the child's head to contact the dash. At the second impact, the tubular frame distorted downward on its right side. Considering the improper mode of use, the child restraint functioned well.

Injuries: The child received facial abrasions and contusions and a swollen right eye but remained conscious and alert. The unrestrained driver sustained fatal head and neck injuries, and the unrestrained rear seat occupant received facial bone fractures and brain concussion.

Comments: This was a very severe crash comparable in severity to laboratory test conditions. Even though the restraint was used improperly without the shield, it did minimize the child's injuries. The facial injuries sustained from dashboard contact could have been avoided had the shield been used. This case is a good illustration of forward head excursion in the absence of a shield.



A '77 Toyota Corolla was proceeding at 35 mph when a '79 Chevrolet Corvette was approaching in the opposite lane at high speed. After sliding out of control at a curve, the Corvette crossed over the case vehicle's lane and, braking hard, slid onto the shoulder. It then immediately returned to the road impacting the case vehicle in the front with its left side.

Child restraints: General Motors Infant Love Seat

Teddy Tot Model 6600 (c. 1971), with tubular steel frame and shoulder straps that attach to the adult lap belt.

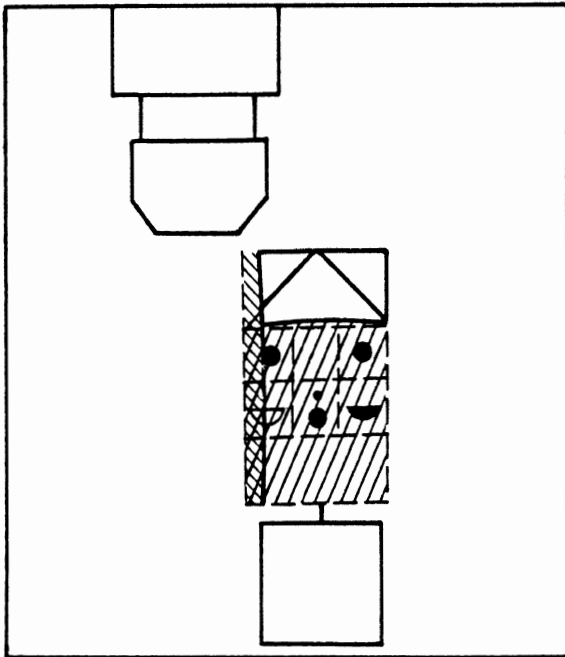
Child restraint usage and performance: A 1-year-old child was harnessed in a rear-facing infant restraint in the right front position. The restraint functioned effectively in protecting the child. A 2-year-old child was in a forward-facing child restraint in the left rear position. The child and restraint were anchored to the car with the lap belt only. The shoulder straps were not fastened.

Injuries: The 1-year-old child in the rear-facing infant restraint sustained a facial cut possibly due to flying glass. The 2-year-old child received a cut on the face, possibly from glass, and a sprained right arm. The restrained driver struck the windshield with his head, while the unrestrained right rear adult passenger moved forward between the two front seats and struck the windshield and dashboard.

Comments: This was a severe frontal crash. The infant restraint performed very effectively. Its performance was aided by the back of the restraint being supported against the instrument panel. The child restraint in the back seat, a model that only meets the static test criteria of FMVSS 213, was being used essentially as a booster chair

with the adult lap belt being the restraint system. The child in this restraint probably contacted the back of the driver's seat with his head and chest, but no significant injury was sustained. An upper torso restraint for this child might have prevented the arm injury he sustained.





A '78 Plymouth Volare station wagon, towing a camper trailer, was hit by a tractor-trailer traveling left of the center line. The left side and roof of the case vehicle were sheared off, and the camper trailer became detached.

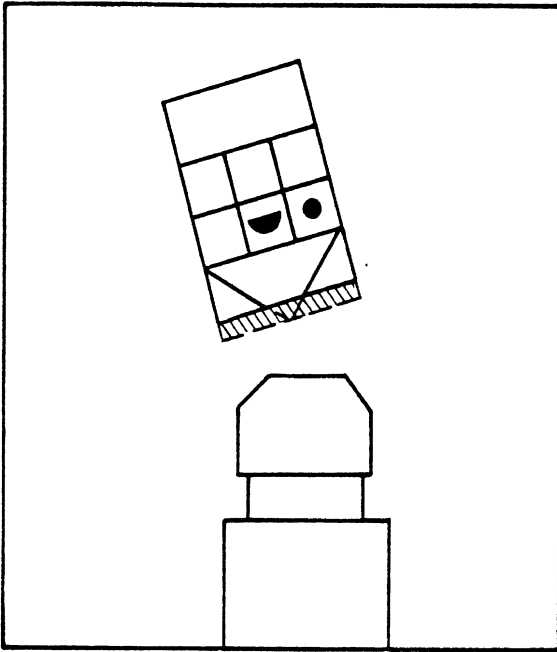
Child restraints: General Motors Child Love Seats.

Child restraint usage and performance: One child restraint was unoccupied in the left rear position. It was possibly secured by the lap belt, but the top tether was not anchored. A 1-year-old child was being held by the mother in the center rear position. A 4-year-old child was in an unsecured child restraint in the right rear. Harness use could not be determined, because an interview with the father and access to this latter child restraint were denied.

Injuries: The lap-held younger child received head injuries, and the older child a possible fractured collarbone. Details were not available. The adult holding the child was decapitated by the intruding structure, while the unrestrained front seat occupants sustained minor injuries.

Comments: Although the case vehicle underwent extensive destruction of the occupant compartment, it may not have involved a severe impact in terms of vehicle deceleration. There were two child restraints in the rear outboard seat positions, but only one was occupied. The occupied child restraint was not properly secured, but the lack of information on its use precludes judgement of its performance. The unoccupied restraint was next to the side of the car that was ripped off. The re-

straint was broken slightly, but its condition does not guarantee that injury might not have occurred to a child sitting in that restraint. The addition of the child's weight might have had an effect on the rotational motion of the combined child and restraint during the crash.



The driver of a '71 Buick Skylark had an epileptic seizure, crossed the center line, and ran head-on into a tractor semi-trailer. Each vehicle had been traveling about 40 mph.

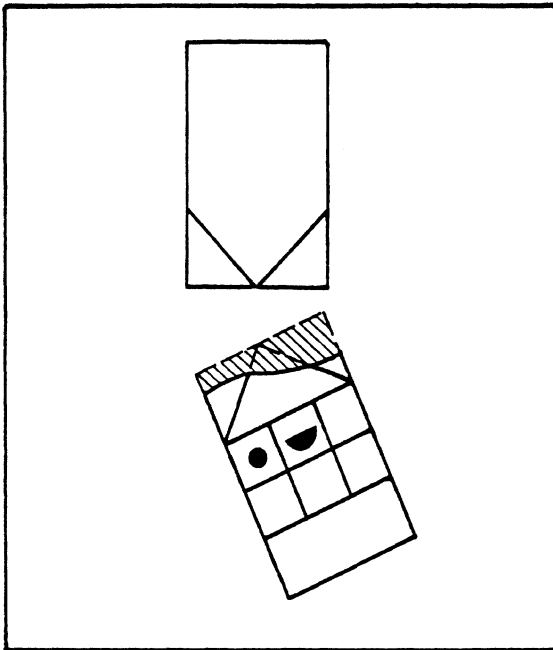
Child restraint: General Motors Infant Love Seat

Child restraint usage and performance: A 4-month-old child was in a rear-facing infant restraint in the center front position. The restraint was properly secured by the vehicle lap belt, although the belt may have been somewhat loose. (Extensive stretching of the belt occurred.) The harness had been dismantled and was underneath the child. Upon impact the top of the restraint rotated forward and contacted the dash. In addition, the plastic welds between the inner and outer shells broke, but the shells remained in place during the crash. The restraint functioned properly despite improper usage.

Injuries: The child was not injured. Minor injuries were sustained by the lap-belted driver.

Comments: In this moderately severe frontal crash, the effectiveness of the rear-facing position, even without the use of the harness, was demonstrated. The forward rotation of the infant restraint was limited by the dashboard, thus minimizing the need for the harness.





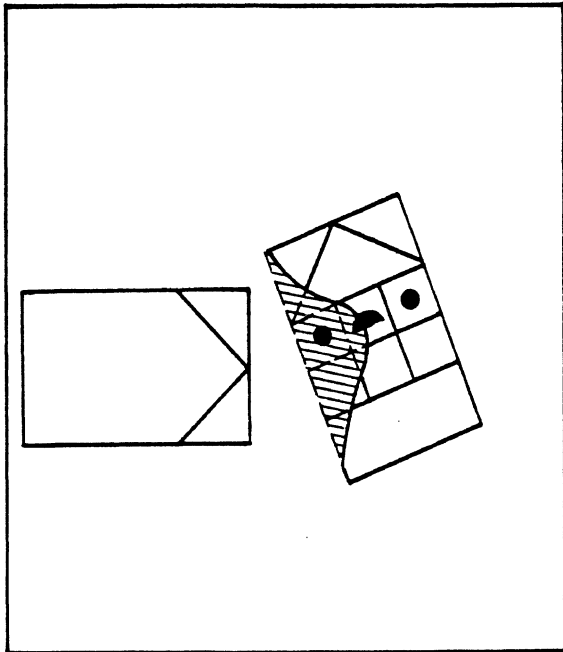
A '75 Ford Torino, slowing from 50 mph, turned left into the path of a '78 Dodge pick-up truck traveling at 50 mph.

Child restraint: Strolee Wee Care

Child restraint usage and performance: An 8-month-old child was harnessed in a forward-facing child restraint in the center front position. The restraint was secured with the vehicle lap belt, and the tether was wrapped tightly around the right front seat head restraint. Due to the tether attachment, the child restraint rotated forward during the crash but returned to the upright position. Otherwise the restraint functioned properly.

Injuries: The child was not injured.

Comments: In spite of the inadequate tether anchorage, the restraint prevented the child from contacting the vehicle interior and thus performed adequately in this moderately severe crash.



A '78 Chevrolet Malibu station wagon went out of control on a divided highway, crossed the median, rotated, and skidded sideways into an oncoming '79 Chrysler traveling at 50 mph.

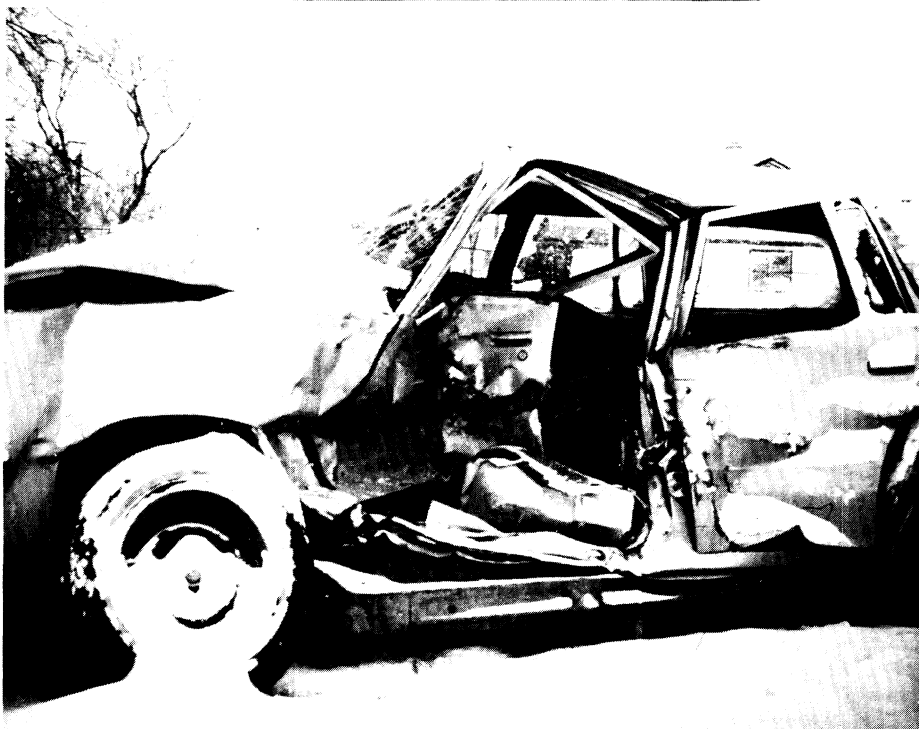
Child restraint: Dyn-O-Mite Carrier Car Seat.

Child restraint usage and performance: A 7-month-old child was harnessed in a properly secured rear-facing infant restraint in the center front position. Fully restrained adults occupied seats on either side. Impact forces resulted in a maximum crush of 38 inches at the B pillar, and the child restraint and its occupant were crushed between the two adult occupants. The child restraint was flattened and the shell partially broken.

Injuries: The child received fatal head injuries. Major injuries were sustained by the restrained adult occupants.

Comments: This was a very severe lateral impact that involved extensive intrusion into the front seat. The three front seat passengers were forced into the space normally occupied by the right front passenger. The fatal injuries to the child were due primarily to contact with the adult occupants. Although the structure of this particular restraint system is fairly flexible, the forces acting on the system were so great that it is doubtful that any conventional infant restraint system would have prevented the direct loading of the child by the vehicle occupants. The rear-facing, open nature of infant restraints also leaves the child

vulnerable to occupant contact in oblique impacts. It was not possible to discern whether or not the infant's head contacted the steering or shift controls early in the impact, because of the final severity of the intrusion in that area.



4.0 Discussion of Child Restraint Performance

A wide variety of child restraint systems was represented among the 16 cases described, including eleven different designs from eight different manufacturers. Among the 17 restraints in use, the most common child restraint was the GM Child Love Seat (4) and the most common infant restraint was the GM Infant Love Seat (3). Nine of the twelve child restraints required top tethers, but only three of those were installed correctly. Three of the restraints were of the type generally considered not to be dynamically crashworthy, although they met the static test criteria of FMVSS 213.

There were three cases in which the same restraint system, the GM Infant Love Seat, was used in the same manner in each crash (2-8, 2-68, and 2-99). In these cases, the instrument panel served as additional support for the restraint and minimized its forward rotation. A similar case (2-2) involved a rear-facing Bobby-Mac 2-in-1 convertible child restraint. This restraint did not contact the instrument panel, apparently due to the vehicle seat position and the interior configuration of the compartment, but retained the infant effectively with no injury. The remainder of the cases represented such a wide variety of crash conditions, restraint system use or misuse, and seating positions that direct comparisons or combining of data is not reasonable. Thus, further generalizations on the performance of a particular type or brand of restraint system are not possible. Only the performance of an individual restraint system in a particular crash can be judged from the investigations in this study.

It is possible, however, to discuss the general combined performance of child restraint systems in terms of crash type. In the eight frontal crashes, the restraint systems investigated provided effective protection for their child occupants. Even in five severe frontal crashes, in which some of the adult occupants were either killed or seriously injured, the restrained children were only slightly injured, if at all. In contrast, the lateral crash performance of the restraint systems varied greatly, with two fatalities and one serious injury being produced in the six side impact cases. This situation is similar to that with adults:

near-side occupants positioned close to the area of impact are very likely to suffer serious or fatal injury, even if they are restrained. The local nature of side impacts is demonstrated by the following three cases. In Case 2-4, the child was killed by head contact with the impacting object, a truck, that intruded along the rear half of the vehicle where the child was seated. In Case 2-57 the intruding vehicle struck just in front of the seated position of the child, but contact occurred to the extent that the child suffered a fractured arm and facial lacerations. Finally, in Case 2-6, which was similar in some aspects of the major intrusion to that of Case 2-57, the intrusion of the striking object, a truck, was just far enough forward of the seated child that the child was uninjured.

Fatal injuries occurred in three cases. Two of these cases were side impacts. In addition to Case 2-4 discussed above, severe intrusion and occupant-to-occupant contact resulted in the death of an infant in Case 2-103. The third fatality case (2-3) was in a severe rear-end collision with ensuing fire. No attempt was made to remove the child from the restraint until after the fire had developed, and the rescuer was not familiar with the restraint system. In addition, the restraint harness hardware and the vehicle lap belt were obscured from view because of intrusion of the rear seat toward the back of the front seat. The role of the child restraint in this case could only be conjectural, but the case does emphasize the concern over emergency egress from restraint systems.

Two of the crashes involving forward-facing child restraints (2-10 and 2-59) were close in impact direction and severity to child restraint dynamic test conditions. The first was an almost direct head-on collision, in which a GM Child Love Seat was fully secured in the back seat. Impact forces were sufficient to crack the plastic shell. The only unusual aspect was the tether anchorage point and thus the extra-long tether strap. This may have allowed further head excursion than would otherwise have occurred, but the child was not injured. The second case was a left-front impact in which a Bobby-Mac Deluxe was used forward-facing without the shield. Although this child restraint normally allows excessive head excursion in a dynamic test without the shield, the

child's contact with the dash resulted in fairly minor facial injuries, while the driver in this case was killed. It would be interesting to simulate these crashes on an impact sled to compare head excursion levels allowed by the child restraints in actual vehicles with those allowed by child restraints secured to a standard laboratory test seat.

Lateral impact tests have not traditionally been used to evaluate the performance of child restraints in the United States, and no lateral test criteria are included in the revision of FMVSS-213. It is clear from even these few cases that current child restraint designs provide better frontal than side impact protection. In Canada, child restraints are required to limit lateral head excursion to 15 inches from the dummy centerline when impacted from the side. Tests observed at HSRI indicate that side wings provided on most restraints are not particularly effective in restraining the head but instead bend outward during impact with the head. For near-side occupants, intrusion of the striking object poses a greater danger than does excessive excursion of the child's head. Although improvements could certainly be made in the lateral protection offered by child restraints themselves, it may be that the increased strength and energy-absorbing capabilities of vehicle side structures, planned for an upgraded FMVSS-214 on side impact protection, will be an even more effective solution to the problem.

5.0 Conclusions

1. Severe frontal crashes in which a child is properly harnessed in a properly secured child restraint are rare events.
2. Child restraints that only meet the static test criteria of FMVSS 213 were found to provide some injury protection in less severe crashes, these types of crashes also being the most common.
3. Child restraints that meet dynamic test criteria similar to those of the revised FMVSS-213 provide excellent injury protection when properly used and still provide adequate protection, even in severe crashes, in some misuse modes.
4. Protection from side impact, particularly when intrusion is involved, is as difficult a problem for children as it is for other occupants. Current child restraint designs provide better frontal

than lateral crash protection, and the revision of FMVSS-213 does not yet address the latter situation. Further work needs to be done with respect to both vehicle structures and child restraint designs to provide an effective means of protecting children from this source of serious injury and death.

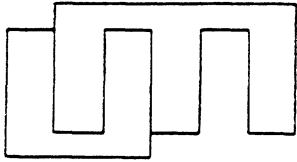
6.0 Acknowledgements

The authors would like to acknowledge the assistance of Peter Cooley and his staff of dedicated accident investigators, including Catherine Bell, Mark Huber, Lissa Hurwitz, Greg Iverson, Susan Rundle, Daniel Stein, Ronald Wakefield, and Carol Whitney, without whom this study would not have been possible.

7.0 References

1. Federal Register, vol. 44, no. 421, Dec. 13, 1979, pp. 72147-72159.
2. Federal Register, vol. 45, no. 86, May 1, 1980, pp. 29045-29048.
3. Melvin, J.W., Stalnaker, R. L., and Mohan, D. "Protection of child occupants in automobile crashes." Stapp Car Crash Conference, 22nd, 1978, Proceedings. Warrendale, Pa., Society of Automotive Engineers, 1978, pp. 671-695.

Appendix A



HIGHWAY SAFETY RESEARCH INSTITUTE

Institute of Science and Technology

Harsh Parkway and Dexter Road

Ann Arbor, Michigan 48106

UNIVERSITY OF MICHIGAN

The Highway Safety Research Institute at the University of Michigan is presently conducting a nationwide study of car crashes involving children. We are particularly concerned with severe accidents in which child restraints were present and being used. The major objectives of such a study are:

- 1) Determination of injury patterns of restrained children.
- 2) Assessment of the effectiveness of child restraint systems presently in use.

We will be handling the detailed investigations ourselves. However, we seek your assistance in alerting us to those accidents which could be of possible interest to us. We would like notification on any accident in which any child in a child restraint was an occupant in a passenger car, van, or station wagon of any make or model. Because timing is a critical factor, we would appreciate on-scene notification whenever possible.

If you need to notify us about an accident which may meet our requirements please call collect to Brenda Robinson (313) 763-3582 or Dr. John Melvin (313) 763-3462.

Thank you for your cooperation.

Sincerely,

John W. Melvin, Ph.D.
Research Scientist

JWM:bjc

Appendix B

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C. R. Obtained or Inspected
2-1	New York	9/25/78	9/26/78	New York State Police	Police report.	Pre-213 GM seat w/chest strap. Minor injury.	10/10/78	Insp.
2-2	Iowa	10/1/78	10/1/78	Iowa State Patrol	Police report. Medical records.	7 wk infant in rear-facing Bobby-Mac 2-in-1. No injury.	10/4/78	Obt.
2-3	Arizona	9/16/78	10/19/78	Clipping from IIHS	Police report.	Fatal fire. 16 mo. trapped in CR in rear seat.	11/14/78	Obt.
2-4	Utah	9/27/78	10/19/78	Clipping from IIHS	Police report.	Fatal head injury. Child in secured CR on side of impact. Peterson with top tether.	1/26/79	Obt.
2-5	Louisiana	1/77	9/25/78	Mother called	Unable to recontact.	Peterson (Shell?) still in use.	no - time lag	no
2-6	Michigan	12/13/78	12/15/78	TV news report	Grand Rapids police. News clipping. Police report.	Severe left side impact. 2 yr. in Jany CR, left rear. Facial cut. Adults injured.	12/18/78	Obt.
2-7	Texas	1/19/79	1/19/79	Texas Highway Patrol	Photos taken. Investigation terminated.	Child in carrier not designed for auto use.	no - no CR	-
2-8	New Mexico	1/11/79	1/11/79	New Mexico State Police	Police report. CR unavailable due to litigation.	Severe head-on into tree. 2 mo. in GM Infant - no injury. Mother fatal.	1/24/79	Insp.
2-9	Texas	1/8/79	1/9/79	Texas Highway Patrol	Police report.	Low severity car into pole. 3 mo. in center front in unsecured Bobby Mac. Minor injury.	1/22/79	Insp.
2-10	Pennsylvania	11/25/78	11/28/79	Physicians for Auto Safety	Police report. Telephoned father.	Severe head-on. 2 yr. in GM CR w/tether attached. No injury. 4 yr. lap belt. Fx pelvis.	12/6/79	Insp.
2-11	California	7/8/78	8/2/78	Clipping from IIHS	Attempts unsuccessful.	Fatal 2 mo. in "child seat". Head, internal injuries.	no - lack info	no

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C. R. Obtained or Inspected
2-12	California	9/3/78	9/11/78	Emergency room physician	Attempts to reach attending physician unsuccessful.	Infant in Century Trav-L-ette. Fx femur.	no - lack info.	no
2-13	Various	10/75 - 8/78	9/12/79	Strolee	none	21 unsolicited testimonials.	no - time lag	no
2-14	New York	9/18/78	9/18/78	New York State Police	Further police information	Low-damage. 3 mo. in rear-facing Strolee.	no - minor	no
2-15	Michigan	9/23/78	9/23/78	HSRI employee	Police report.	Intersection crash. 2 yr. in Peterson on opposite side. No injury. 3 yr. in lap belt - minor.	9/23/78	Obt.
2-16	California	5/23/78	9/23/78	Magazine article	Police report - receipt delayed.	Severe head-on. 6 mo. in "infant seat and seat belt." Driver fatal.	no - time lag	no
2-17	Michigan	9/22/78	9/27/78	Ottawa County Sheriff Dept.	Police report.	Rollover. 16 mo. in GM child seat, tether not attached. No injury.	10/12/78	Insp.
2-18	Texas	6/9/78	9/27/78	Local police	In litigation.	CR failure. Facial lacerations.	no - time lag	no
2-19	Virginia	2/10/78	9/31/78	Women Leaders in Highway Safety	Virginia Crash Investigation Team report #99	Fatal 6 mo. in unsecured, lateral facing Bobby-Mac 2-in-1. 2 yr. in untethered frame seat.	available	no
2-20	California	9/2/78	9/31/78	Newspaper clipping	Dynamic Science case no. DSI-78-AB-5	8 mo. in infant "carry seat" in crash with ACRS vehicle. Ejected. Minor injuries.	available (no CR)	-
2-21	Washington	8/13/78	8/29/78	ACTS	ACTS report	Side impact. 2 yr. in GM child seat, tether not attached.	no - minor	no

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-22	Michigan	10/5/78	10/5/78	Local police	Father unavailable - in jail.	4 mo., 16 lb ejected from GM Infant Carrier.	no - minor	no
2-23	Tennessee	9/20/78	10/9/78	Emergency room staff	Police report requested.	4 mo. in unknown CR. 2 other children. Minor injuries.	no - minor	no
2-24	California	10/?/78	10/12/78	ACTS	none	Child in infant home carrier and lap belt.	no - no CR	no
2-25	Tennessee	9/15/78	10/31/78	Emergency room staff	Police report.	1 yr. in CR. No injury. Side-swipe.	no - minor	no
2-26	Michigan	10/11/78	10/16/78	Ingham County Sheriff	Medical records.	3 yr. in lap belt. Fatal in other vehicle.	no - no CR	no
2-27	Tennessee	10/18/78	10/31/78	Emergency room staff	Police report delayed. Mother interviewed.	Right rear impact. 2 Yr. in pre-213 Peterson, left rear, properly secured. Facial cut from broken mirror.	no - rear/side	no
2-28	California	10/?/78	10/31/78	ACTS	none	9 yr. in lap belt. No injury.	no - no CR	no
2-29	Tennessee	10/30/78	12/5/78	Emergency room staff	Police report.	4 mo. in unknown CR. No injury. Minor intersection collision.	no - minor	no
2-30	Kentucky	11/21/78	11/21/78	Kentucky State Police	Police report.	1 yr. in CR, right rear. Right front collision. Injury unknown.	no - minor	no
2-31	Michigan	11/29/78	12/11/78	HSRI-HDAI team	Police report. Level II case #3781129FLM	ACRS vehicle (did not deploy) with 2 yr. in GM Child Seat, center rear. Minor front-right crash.	no - minor	no

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-32	Texas	12/1/78	12/5/78	Texas Highway Patrol	Police report.	Van into ditch. 1 1/2 yr. in Kantwet, right front. Head lacerations from side of CR.	no - rollover	no
2-33	Michigan	12/1/78	12/2/78	Local police	Police report.	Minor front corner impact. Child in rear, not in real CR. Reported as failure. No injury.	no - no CR	no
2-34	Tennessee	11/13/78	12/11/78	Emergency room staff	Police report requested, wrong one received.	1 yr. in unknown CR. Forehead contusion, abdominal contusion. No fx.	no - lack info.	no
2-35	Michigan	8/26/78	1/8/79	Michigan Dept. St. Hwys. & Trans.	Mother interviewed.	Minor rear-end. 1 yr. in GM Child Seat, not tethered. No injury.	no - minor	no
2-36	Tennessee	12/23/78	1/15/79	Emergency room staff	Police report requested.	3 yr. in CR, front seat. Abrasion over sternum.	no - lack info.	no
2-37	Tennessee	12/17/78	1/9/79	Emergency room staff	Police report requested.	2 mo. in infant CR. Red spot on right temple.	no - lack info.	no
2-38	Tennessee	11/24/78	1/9/79	Emergency room staff	Police report requested.	3 mo. in "infant seat" which "fell over." Head injuries.	no - misuse	no
2-39	Tennessee	11/11/78	1/9/79	Emergency room staff	Police report requested.	8 mo. in infant CR. Facial abrasions, Fx leg.	no - lack info.	no
2-40	California	8/?/78	11/4/78	Magazine article	Police report requested.	Head-on with truck. 6 mo. in "infant seat with seat belt." Moderate injuries. Driver fatal.	no - time lag	no

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-41	no entry							
2-42	Maryland	1/?/79	1/22/79	Bobby-Mac Co.	none	7 mo. in Bobby-Mac. Rollover. Facial scratch.	no - rollover	no
2-43	Louisiana	1/?/79	1/22/79	Bobby-Mac Co.	none	4 mo. in Bobby-Mac, center rear. Rollover. No injury.	no - rollover	no
2-44	no entry							
2-45	Iowa	12/22/78	1/23/79	Iowa Dept. of Public Safety	Police report.	8 mo. in Bobby-Mac in center front. Head-on. No injury.	no - personnel unavailable	no
2-46	California	1/13/79	2/6/79	Clipping from IIHS	none	3 wk. in "infant seat belted", in rollover.	no - rollover	no
2-47	Michigan	12/15/78	2/16/79	HSRI employee	none	Miscoded ACRS case.	no - time lag	no
2-48	Michigan	2/4/79	2/22/79	Driver	Police report.	Head-on collision. 1 yr. in GM Child Seat secured around bottom. Not tethered. No injuries.	3/1/79	Obt.
2-49	New York	1/15/79	2/22/79	Calspan	none	Impact with truck. 9 mo. and 2 yr. in CR's in rear.	no - time lag	no
2-50	New York	1/?/79	2/22/79	Calspan	none	Vehicle totaled. No injury to 3 occupants.	no - lack info.	no
2-51	California	1978	2/15/79	Bobby-Mac Co.	none	High-speed rollover. 10 mo. in Bobby-Mac. No injury.	no - rollover	no

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-52	California	11/29/78	3/15/79	Newspaper clipping	none	Side impact with truck. 18 mo., restraint unknown. Skull fracture. Driver fatal.	no - time lag	no
2-53	North Carolina	2/27/79	3/7/79	Highway Safety Res. Center, N. Carolina	Police report. Transcript of HSRC interview.	4 mo. in Strolee, left rear. Roll-over. No injury. Driver belted, sore neck.	available	no
2-54	North Carolina	11/10/78	3/15/79	HSRC	Police report. Letter from mother.	Minor collision. 15 mo. in CR, right front. Pregnant driver belted. No injuries.	no - minor	no
2-55	Ontario	2/4/79	3/15/79	Clipping from IIHS	none	Car-train collision. 17 mo. in CR, minor injuries. Parents fatal. Car dragged.	no - unusual	
2-56	Michigan	4/16/79	4/16/79	HSRI employee	Police report.	Left side collision. 4 yr. unhar- nessed in GM Child Seat, tethered, right front. Minor head injury.	4/19/79	Obt.
2-57	Ontario	5/3/79	5/7/79	Consumer's Assoc. of Canada	Canada Consumer & Corp. Affairs report and photos. Police report.	Left side impact. 16 mo. in Dorel 333, not tethered, left rear. Fx arm, facial laceration.	5/14/79	Insp.
2-58	Ontario	5/5/79	5/7/79	Consumer's Assoc. of Canada	Police report.	Fatal ejection of 4 mo. held by father, left rear. CR in vehicle not in use.	5/15/79	Obt.
2-59	Pennsylvania	2/27/79	3/26/79	Bobby-Mac Co.	Police report. Medical records.	Severe head-on. 21 mo. in Bobby-Mac Deluxe, right front, no shield. Facial injury. Driver fatal.	4/12/79	Insp.

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-60	Iowa	4/23/79	5/21/79	Iowa Dept. of Transportation	Newspaper clipping	Head-on with truck. 1 yr. unrestrained, fatal.	no - no CR	
2-61	Pennsylvania	5/19/79	5/24/79	NHTSA	Police report.	Left side impact. 10 mo. in Bobby-Mac, center front. No injuries.	no - minor	no
2-62	Minnesota	4/12/79	4/26/79	ACTS	Police report requested. Family unreachable.	Side impact. 6 mo. twins in GM Infants.	no - lack info	no
2-63	Michigan	3/5/79	4/30/79	HSRI NASS team	Police report. NASS report.	Rear impact. 2 yr. and 4 yr. in rear seat in CR's. 4 yr. not secured. No injuries	no - rear-end	no
2-64	Ontario	7/16/79	7/18/79	Local police	Police report	Minor front corner impact. 1 yr. in CR center rear. No injury.	no - minor	no
2-65	Ontario	7/23/79	7/25/79	Local police	Police report	Rear end. 3 yr. in lap belt, right rear. Fx skull.	no - no CR	no
2-66	Ontario	7/23/79	7/26/79	Local police	Police report.	Minor front corner impact. 4 yr. in CR, left rear. No injury.	no - minor	no
2-67	Ontario	8/2/79	8/4/79	Local police	Police report.	Frontal impact. 3 yr. and 1 yr. in rear in CR's. No injuries. Low speed.	no - minor	no
2-68	Michigan	8/11/79	8/13/79	HSRI accident investigator.	Police report.	Head-on. 1 yr. in GM Infant, right front. 2 yr. in Teddy Tot 6600. Glass lacerations.	8/16/79	Obt.

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-69	New York	9/ ? /78	10/9/78	Strolee	none	Rollover. 22 mo. in Strolee. No injury.	no - rollover	no
2-70 thru 2-73	various	8/78 - 10/78	1/25/79	Strolee	none	2 head-on's, 2 rollovers. No injuries.	no - time lag	no
2-74 thru 2-78	various	7/78 - 1/79	3/3/79	Strolee	none	Various impacts. Children not injured or minor bruises. Other occupants injured.	no - time lag	no
2-79	Ontario	7/23/79	7/25/79	Local police	Police report requested.	Rollover. Child in Strolee.	no - rollover	no
2-80	Ontario	6/29/79	7/25/79	Local police	Police report requested.	6 mo. in infant CR. Fx ankle. 3 adults fatal.	no - lack info.	no
2-81	New York	7/ ? /79	7/31/79	Physicians for Auto Safety	none	4 yr. held by adult. 8 yr. in lap belt.	no - no CR	no
2-82 thru 2-84	various	5/79 - 7/79	8/15/79	Strolee	none	Side and rear impacts. Children under 1 yr. in Strolees. No injuries.	no - time lag	no
2-85	Ontario	8/7/79	8/13/79	Local police	Police report.	Side impact. 4 yr. in lap/shoulder belts. No injuries.	no - no CR	no
2-86	Ontario	8/11/79	8/13/79	Local police	Police report.	Rear-end, totaled. 6 mo. in CR right rear. 3 yr., left rear, lap belt. Minor injuries	no - rear-end	no
2-87	Ontario	8/11/79	8/13/79	Local police	Police report.	Rear-end. 11 mo. in Strolee, left rear. No injury.	no - rear-end	no
2-88	Ontario	8/13/79	8/13/79	Local police	Police report.	Rear-end. 6 mo. in CR, right front. No injury.	no - rear-end	no

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-89	Ontario	8/20/79	8/21/79	Local police	Police report requested.	Frontal impact. 2 yr. and 4 yr.	no - lack info.	no
2-90	Ontario	8/26/79	8/27/79	Local police	Police report requested.	Rollover. 2 yr. male.	no - rollover	no
2-91	Missouri	8/21/79	9/10/79	Clipping from IIHS	none	Rollover. 8 mo. in CR. No injury.	no - rollover	no
2-92	Tennessee	8/22/79	9/10/79	Clipping from IIHS	none	Rollover. 16 mo. in CR. No injury.	no - rollover	no
2-93	New York	8/27/79	9/10/79	Clipping from IIHS	none	Rollover. 17 day in infant carrier. No injury.	no - rollover	no
2-94	Ontario	9/23/79	9/24/79	Local police	Police report.	Van/motorcycle impact. 2 yr. in CR, center front. Minimal injury. Cyclist fatal.	no - minor	no
2-95	Ontario	10/12/79	10/15/79	Local police	Police report delayed	Left side impact. 1 yr. in CR in left rear, forward facing. No injury. Driver minor injury.	no - time lag	no
2-96	Ontario	10/23/79	10/24/79	Local police	Police report.	Rollover. 1 yr. in CR in right rear, 3 yr. in belt, left rear. No injury.	no - rollover	no
2-97	Michigan	10/19/79	10/22/79	HSRI accident investigator	Police report. Telephoned driver.	Minor front left impact. 8 mo. in Century, facing forward, right rear. Bit tongue.	no - minor	no

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-98	North Dakota	7/9/79	7/17/79	North Dakota Highway Safety Office	Police report.	Head-on. 1 yr. in lap rear center. CR left rear vacant. 4 yr. in unsecured CR, right rear. Injuries.	7/24/79	1 - Insp 2 - no
2-99	Michigan	10/29/79	11/6/79	GM employee	Police report.	Head-on into truck. 4 mo. in GM Infant right front, no harness, secured. No injury.	11/6/79	Obt.
2-100	Ontario		11/7/79	Local police	Police report requested.	Frontal impact, 8 mo. in forward facing CR. Belt too loose. CR hit dash.	no - misuse	no
2-101	Ontario	10/8/79	10/17/79	Local police	Police report.	Front left impact. 20 mo. in CR in rear left. No injury.	no - minor	no
2-102	Ontario	11/9/79	11/14/79	Local police	Police report.	Front corner impact. 8 mo. in Strollee, tethered to head rest, center front. No injury.	11/20/79	Insp.
2-103	Ontario	12/9/79	12/14/79	Local police	Police report.	Fatal. 7 mo. in Dyn-0-Mite center front. Severe side impact. CR crushed.	12/19/79	Obt.
2-104	various	11/78 - 11/79	11/8/79	Strollee	none	2 rollovers, (1 involved head fracture), 2 rear ends, 1 ejection, 1 head bump, 3 no injury.	no - rollover, rear-end, & time lag	no
2-105	Ontario	10/13/79	12/3/79	Ontario Ministry of Transport and Communications	Police report.	5 yr. in lap belt in right front. Minor injuries.	no - no CR	no

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2-106	Ontario	10/20/79	12/3/79	OMTC	Police report.	3 yr. in lap belt in left rear. No injuries.	no - no CR	
2-107	Ontario	11/1/79	12/6/79	OMTC	Police report.	Rear end. 2 yr. in CR in right rear at impact. Minor. No injuries.	no - minor	
2-108	Ontario	11/2/79	12/3/79	OMTC	Police report.	Minor front right impact. 1 yr. in CR in center front. 2 yr. in lap belt in front right. No injuries.	no - minor	
2-109	Ontario	11/2/79	12/3/79	OMTC	Police report.	Front impact. 3 mo. in CR in center front. No injuries.	no - minor	
2-110	Ontario	11/4/79	12/3/79	OMTC	Police report.	Left front impact. 7 mo. in CR in center front. 3 yr. in lap belt in center front. Minor injuries.	no - minor	
2-111	Ontario	11/5/79	12/3/79	OMTC	Police report	Rear end and right front impacts. 1 yr. in CR in front right. No injuries.	no - minor	
2-112	Ontario	11/6/79	12/3/79	OMTC	Police report.	Head-on at intersection. 2 yr. in CR in left rear. 3 2 and 3 yr. in lap belts in rear. 5 mo. unrestrained in rear. No injuries	no - minor	
2-113	Ontario	11/6/79	12/3/79	OMTC	Police report.	Left side impact. 3 yr. in CR in left front. No injuries.	no - minor	

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-114	Ontario	11/6/79	12/3/79	OMTC	Police report.	Front impact. 1 yr. in CR in center rear. Minor injuries.	no - minor	
2-115	Ontario	11/7/79	12/3/79	OMTC	Police report.	Front impact. 9 1/2 mo. in CR in center rear. 3 yr. in lap belt in right rear. No injuries.	no - minor	
2-116	Ontario	11/8/79	12/3/79	OMTC	Police report.	Head-on. 1 yr. in CR in right rear. 4 yr. in lap belt in left rear. Minor injuries.	no - minor	
2-117	Ontario	11/8/79	12/3/79	OMTC	Police report.	Minor accident. Vehicle impacted with guidepost. 6 mo. in CR in centerfront. 3 yr. in CR in left rear. No injuries.	no - minor	
2-118	Ontario	11/9/79	12/3/79	OMTC	Police report.	Front left impact. 6 wk. in CR in left rear. 6 yr. and 7 yr. in lap belts. No injuries.	no - minor	
2-119	Ontario	11/9/79	12/3/79	OMTC	Police report	Front left impact. 6 mo. in CR in center front. CR not secured and lodged under driver's elbow.	no - misuse	
2-120	Ontario	11/9/79	12/3/79	OMTC	Police report. Father interviewed.	Right side impact. 1 yr. in CR in front right. Driver had severe belt bruises.	no - crush behind CR	
2-121	Ontario	11/9/79	12/3/79	OMTC	Police report.	Minor front right impact. 1 yr. in CR in right rear. 2 1/2 yr. in lap belt in left rear.	no - minor	

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2-122	Ontario	11/9/79	12/3/79	OMTC	Police report.	Front left impact. 1 yr. in CR in right rear. No injuries.	no - minor	no
2-123	Ontario	11/10/79	12/3/79	OMTC	Police report.	Right side impact. 3 yr. in CR in center front. No injuries.	no - minor	no
2-124	Ontario	11/11/79	12/3/79	OMTC	Police report.	Rear-end impact. 6 mo. in CR in rear left. No injuries.	no - rear-end	no
2-125	Ontario	11/12/79	12/3/79	OMTC	Police report.	Minor front left impact. 5 1/2 mo. in CR in rear center.	no - minor	no
2-126	Ontario	11/12/79	12/3/79	OMTC	Police report.	Rear-end impact. 2 yr. in CR in rear right. 4 yr. in lap belt in rear left.	rear - end	no
2-127	Ontario	11/12/79	12/3/79	OMTC	Police report.	Side impact to right rear. 16 mo. in CR in center front. 6 yr. in lap belt in right front.	no - minor	no
2-128	Ontario	11/14/79	12/6/79	OMTC	Police report.	Front impact. 2 1/2 yr. in CR in rear left. 1 yr. in CR in rear center. No injuries.	no - minor	no
2-129	Ontario	11/14/79	12/3/79	OMTC	Police report.	Left side impact. 2 yr. in CR in in rear right. No injuries	no - minor	no
2-130	Ontario	11/13/79	12/3/79	OMTC	Police report.	Front left impact. 5 yr. in CR in rear center. No injuries.	no - minor	no

Log #	Location	Accident Date	Notification Date	Notification Agent	Telephone follow-up/ Reports received	Case Notes	In-depth Investigation	C.R. Obtained or Inspected
2-131	Ontario	11/13/79	12/3/79	OMTC	Police report.	Minor rear left impact. 2 yr. in CR in rear left. No injuries.	no - minor	no
2-132	Ontario	11/13/79	12/3/79	OMTC	Police report.	Right front impact. 10 mo. in CR in rear center. 2 yr. in lap belt in rear left. No injuries.	no - minor	no
2-133	Ontario	11/13/79	12/3/79	OMTC	Police report.	Side impact to right rear. 1 yr. in CR in rear left.	no - minor	no
2-134	Ontario	11/14/79	12/3/79	OMTC	Police report. One mother interviewed.	Head-on. Front left impact to each car. 1 1/2 yr. in #1 car in CR in rear right. 2 1/2 yr. in #2 car in CR in rear right.	no - minor	no
2-135	Ontario	11/15/79	12/3/79	OMTC	Police report.	Front impact. 14 mo. in CR in rear right. No injuries.	no - minor	no
2-136	Ontario	11/15/79	12/3/79	OMTC	Police report.	Minor front impact with pedestrian. CR in rear center.	no - minor	no
2-137	Ontario	11/15/79	12/3/79	OMTC	Police report.	Left front corner impact. 13 mo. in CR in rear center. No injuries.	no - minor	no
2-138	Ontario	11/16/79	12/3/79	OMTC	Police report.	Front impact. 2 yr. in CR in rear left. Sudden stop. Minor injuries.	no - minor	no
2-139	Ontario	11/16/79	12/3/79	OMTC	Police report.	Rear-end impact. 4 yr. in CR in rear center. No injuries.	no - rear-end	no

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2-140	Ontario	11/22/79	12/17/79	OMTC	Police report.	Left front corner impact. 8 mo. in CR front right. No injuries.	no - minor	no
2-141	Ontario	11/22/79	12/17/79	OMTC	Police report.	Side impact to right front. 3 yr. in CR in rear right. Minor injuries to driver.	no - minor	no
2-142	Ontario	11/24/79	12/17/79	OMTC	Police report.	Rear-end impact. 1 yr. in CR in center front. Minor injuries to driver.	no - minor	no
2-143	Ontario	11/24/79	12/17/79	OMTC	Police report.	Rollover. 2 yr. in CR in rear right. 5 yr. in lap belt in rear left. Minor injuries to all.	no - rollover	no
2-144	Ontario	11/15/79	12/17/79	OMTC	Police report.	Left rear corner impact. 5 yr. unrestrained in front right.	no - no CR	no
2-145	Ontario	11/23/79	12/17/79	OMTC	Police report.	Rear-ended. 2 yr. in CR in left rear. No injuries.	no - minor	no
2-146	Ontario	11/24/79	12/17/79	OMTC	Police report.	Front left corner impact. 1 yr. in CR in center front. No injuries.	no - minor	no
2-147	Ontario	11/20/79	12/17/79	OMTC	Police report.	Front left impact. 1 yr. in CR in front right. No injuries.	no - minor	no
2-148	Ontario	11/12/79	12/17/79	OMTC	Police report.	Front left impact. 2 yr. in CR in rear left. 4 yr. in lap belt in rear center. No injuries.	no - minor	no

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2-149	Ontario	11/25/79	12/17/79	OMTC	Police report.	Front impact with deer. 1 yr. in CR in rear center. Deer killed.	no - minor	no
2-150	Ontario	11/13/79	12/17/79	OMTC	Police report.	Left front impact. 3 yr. in CR in rear right. 7 yr. in CR in in front right. No injuries.	no - minor	no
2-151	Ontario	11/14/79	12/17/79	OMTC	Police report.	Right front impact. 1 yr. in CR in rear center. No injuries.	no - minor	no
2-152	Ontario	11/14/79	12/17/79	OMTC	Police report.	Rear left corner impact. 3 yr. in CR in rear center. No injuries	no - minor	no
2-153	Ontario	11/14/79	12/17/79	OMTC	Police report.	Front right corner impact. 8 mo. in CR in rear center. No injuries	no - minor	no
2-154	Ontario	11/14/79	12/17/79	OMTC	Police report.	Side impact to right rear. 1 yr. in CR in rear center. No injuries	no - minor	no
2-155	Ontario	11/15/79	12/17/79	OMTC	Police report.	Left side impact. 1 yr. in CR in rear right. No injuries.	no - minor	no
2-156	Ontario	11/19/79	12/17/79	OMTC	Police report.	Right rear corner impact. 1 yr. in CR in center front. No injuries.	no - minor	no
2-157	Ontario	11/22/79	12/17/79	OMTC	Police report.	Left front side impact. 6 mo. in CR, pelvic belt only, in rear right. No injuries.	no - minor	no

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2-158	Ontario	11/16/79	12/17/79	OMTC	Police report.	Side impact to right and left front. 1 yr. in CR in rear center. No injuries.	no - minor	no
2-159	Ontario	11/16/79	12/17/79	OMTC	Police report. Mother interviewed.	Side impact to left front. 1 yr. in CR in rear right. Minor injuries.	no - minor	no
2-160	Ontario	11/22/79	12/17/79	OMTC	Police report.	Front left impact. 20 mo. in CR in rear center. No injuries.	no - minor	no
2-161	Ontario	11/21/79	12/17/79	OMTC	Police report.	Impact to rear right. 1 yr. in CR in front left. No injuries.	no - rear-end	no
2-162	Ontario	11/23/79	12/17/79	OMTC	Police report.	Impact to right side. 3 yr. in CR in rear right. No injuries.	no - minor	no
2-163	Ontario	11/27/79	12/17/79	OMTC	Police report.	Rear impact to left side. 2 yr. in CR in rear right. 2 yr. in lap belt in rear left. No injuries.	no - minor	no
2-164	Ontario	11/27/79	12/17/79	OMTC	Police report.	Front impact. 5 mo. in CR in rear center. 3 yr. unrestrained in front right. No injuries.	no - minor	no
2-165	Ontario	11/29/79	12/17/79	OMTC	Police report. Mother interviewed.	Minor front impact. 1 yr. in CR in front right. Minor injuries.	no - minor	no
2-166	Ontario	11/28/79	12/17/79	OMTC	Police report	Front left impact. 1 yr. in CR in rear center. 4 yr. in lap belt in rear right. No injuries.	no - minor	no

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2-167	Ontario	11/24/79	12/17/79	OMTC	Police report.	Front impact. 1 yr. in CR in front right. No injuries.	no - minor	no
2-168	Various	8/76 - 8/79	11/13/79	Strolee	None.	5 head-ons, 3 rear-ended, 1 rollover, 1 side impact. No injuries.	no: rollover, rear-ended, time lag	no
2-169	Ontario	11/30/79	12/20/79	OMTC	Police report.	Minor right rear impact. 2 yr. in CR in center front. No injuries.	no - minor	no
2-170	Ontario	12/2/79	12/20/79	OMTC	Police report.	Front left impact. 4 yr. in CR in center rear. No injuries.	no - minor	no
2-171	Ontario	12/3/79	12/20/79	OMTC	Police report.	Minor right front impact. 1 1/2 yr. in CR in right rear. No injuries.	no - minor	no
2-172	Ontario	12/3/79	12/20/79	OMTC	Police report.	Minor front impact. 2 yr. in CR in center rear. No injuries.	no - minor	no
2-173	Ontario	12/4/79	12/20/79	OMTC	Police report.	Left side impact. 4 yr. in CR in center front. No injuries.	no - minor	no
2-174	Ontario	12/5/79	12/20/79	OMTC	Police report.	Right front impact. 1 yr. in CR in right front. No injuries.	no - minor	no
2-175	Ontario	12/7/79	12/20/79	OMTC	Police report.	Left front impact. 2 yr. in CR in center front. No injuries.	no - minor	no
2-176	Ontario	12/8/79	12/20/79	OMTC	Police report.	Minor rear impact. 1 yr. in CR in right rear. No injuries.	no - minor	no

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2-177	Ontario	12/8/79	12/20/79	OMTC	Police report.	Minor left rear side impact. 2 yr. in CR in right rear. No injuries.	no - minor	no
2-178	Ontario	12/9/79	12/20/79	OMTC	Police report.	Left front and side impact with pole. 2 yr. in CR in left rear. No injuries.	no - minor	no
2-179	Ontario	12/9/79	12/20/79	OMTC	Police report.	Minor left side impact. 1 yr. in CR in right rear. No injuries.	no - minor	no
2-180	Ontario	12/9/79	12/20/79	OMTC	Police report.	Left front impact with pole. 3 yr. in CR in left rear. No injuries.	no - minor	no
2-181	Ontario	12/9/79	12/20/79	OMTC	Police report.	Left front impact. 5 mo. in CR in center rear. No injuries.	no - minor	no
2-182	Ontario	12/10/79	12/20/79	OMTC	Police report.	Front impact. 3 yr. in CR in right front. 6 mo. in CR in right rear. No injuries.	no - minor	no
2-183	Ontario	12/13/79	12/20/79	OMTC	Police report. Grandmother interviewed.	Left side impact. 2 mo. on mother's lap in right front. Minor bruises.	no - non use	no
2-184	Ontario	12/13/79	12/20/79	OMTC	Police report.	Vehicle # 1 rear-ended by right side of vehicle # 2. In vehicle # 1: 2 yr. in CR in left rear; 2 yr. in CR in right rear. In vehicle # 2: 2 yr. in CR in right front. No injuries.	no - minor	no

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2-185	Ontario	12/13/79	12/20/79	OMTC	Police report.	Right side impact. 9 mo. in CR in center front. 2 1/2 yr. in CR in right front. No injuries.	no - minor	no
2-186	Ontario	12/14/79	12/20/79	OMTC	Police report.	Right front impact. 2 yr. in CR in left rear. No injuries.	no - minor	no
2-187	Ontario	12/14/79	12/20/79	OMTC	Police report.	Left front corner impact. 7 mo. in CR in center rear. No injuries.	no - minor	no
2-188	Ontario	12/14/79	12/20/79	OMTC	Police report.	Front impact. 2 yr. in CR in center rear. No injuries.	no - minor	no
2-189	Ontario	12/15/79	12/20/79	OMTC	Police report.	Left front corner impact. 3 yr. in CR in left rear. No injuries.	no - minor	no
2-190	Ontario	12/15/79	12/20/79	OMTC	Police report.	Left front corner impact. 2 yr. in CR in center rear. No injuries.	no - minor	no
2-191	Ontario	12/17/79	12/20/79	OMTC	Police report.	Left front impact. 8 mo. in CR in center front. 2 yr. in CR in right rear.	no - minor	no

