

AMBULATORY CHILD SEAT

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Abstract:

We propose a physical prototype of a gurney-compatible-child seat for transporting children in ambulances. Current seats do not recline; Emergency Medical Technicians (EMTs) must take the child out of the seat and remove the seat from the gurney to lay the child in the supine position for specific medical treatments. However, this procedure takes up valuable time (~3 minutes) and prolongs the time it takes to reach the hospital. With these thoughts in mind, a prototype was designed to recline and the need to remove the seat from the gurney to lay the child in the supine position was eliminated. Also, our prototype supports children (1-10 years old) of various anatomical features unlike current ambulatory child seats. Initial testing of four subjects (1-10 year old) has given promising results, but more testing needs to be done to assess prototype's mechanical and safety constraints. Also, we need to seek lighter yet robust materials to fabricate future design of the child seat.

Introduction:

Ambulances, although essential for saving lives, are not known for protecting the occupants in the case of a crash. There are roughly 5000 ambulance crashes each year, causing on average one fatality per week and serious injuries daily. Recently, ambulance safety has gained attention mainly due to research conducted by Dr. Nadine Levick, an emergency physician, and Dr. Marilyn Bull, a pediatrician.

In one particular study, Dr. Levick studied a group of 206 patients under the age of 14 who were transported in ambulances in 1999. Dr. Levick found that 37% of the children were unrestrained or in a person's lap. And more than 50% were on the gurney, of which 10% were not restrained, while others used only one of the two sets of adult straps on the gurney.

Clearly, these statistics by Dr. Levick are alarming and highlight the lack of attention child safety has been given over the years. If the majority of children are strapped in improperly on a gurney, children will sustain severe injuries in the event of an accident. More importantly, Dr. Levick's research highlights the need for improving child safety in ambulances. Recently, more Emergency Medical Technicians (EMTs) are getting trained in properly restraining children to prevent injuries in the event of an accident [1, 2]. However, there is more work that needs to be done to improve the safety of children in ambulances.

a. Background:

Our client, Tom Brazelton, MD, MPH, a pediatrician at University of Wisconsin-Madison Hospital and Clinics, is interested in improving the safety of current child passenger safety seats used in ambulances to transport children to the hospital. Specifically, Dr. Brazelton is interested in incorporating several features in child passenger safety seats to make them more conducive to ambulances and emergency situations.

Based on the recommendations by Dr. Levick, children, who do not meet the minimum criteria to fit (for details, see section c) onto an adult gurney, must be transported in a child seat in an ambulance. Research by Dr. Levick has shown that not only is the upright position most comfortable for a child in a child seat, but children are also less likely to suffer severe head injuries in the upright position in the event of an accident [3].

At present, when a child needs to be transported in an ambulance, he or she is first placed in a child seat and strapped down in the seat with a harness. Once the child is secured in the child seat, the seat is then placed onto a gurney and strapped down with two adult straps located on the sides of the gurney as shown in Figure 1.



Figure 1: Shows Child Passenger Safety Seat strapped onto a gurney in the upright position. Research has shown that upright position is safest position to transport a child in an ambulance.

However, at times, a child needs to be placed in the supine position (i.e. flat on his/her back) in the case of respiratory issues (i.e. not breathing properly) or low blood pressure due to a severe infection or injury. During such instances, a child is taken out of the child seat and the seat is removed from the gurney in order to put the child in the supine position on the gurney. It can take anywhere up to three minutes to remove the child seat from the gurney and to lay child in the supine position on the gurney [4].

b. Problems with Current Design:

The current method works effectively for children who only stay in the upright position while being transported (Figure 2). However, the current method fails when a child needs to be put in the supine position, as the child seat does not recline and two adult straps to which the seat is strapped down prevent the child seat from reclining. One has to physically remove the seat from the gurney in order to lay the child in the supine position. This procedure, described in the background section in detail, is time consuming and can take up to three minutes. More importantly, this procedure prolongs the time it takes to reach the hospital, because the ambulance needs to be pulled over in order for EMTs to remove the seat from the gurney. Furthermore, if the child is in the supine position, he/she can only be strapped down by the two adult straps on the gurney which are not designed to strap down children. This poses further risk of injury in the event of an accident.

In addition, since the current child safety seat is non-collapsible and space is limited, the child seat is not carried at all times in ambulances. If the EMTs do not bring along a child seat to the site of an accident and discover that there is a child passenger, they have no choice but to transport the child directly on a gurney and rely on the two adult straps on the sides of the gurney. Like the previous problem, this situation also poses a similar risk.

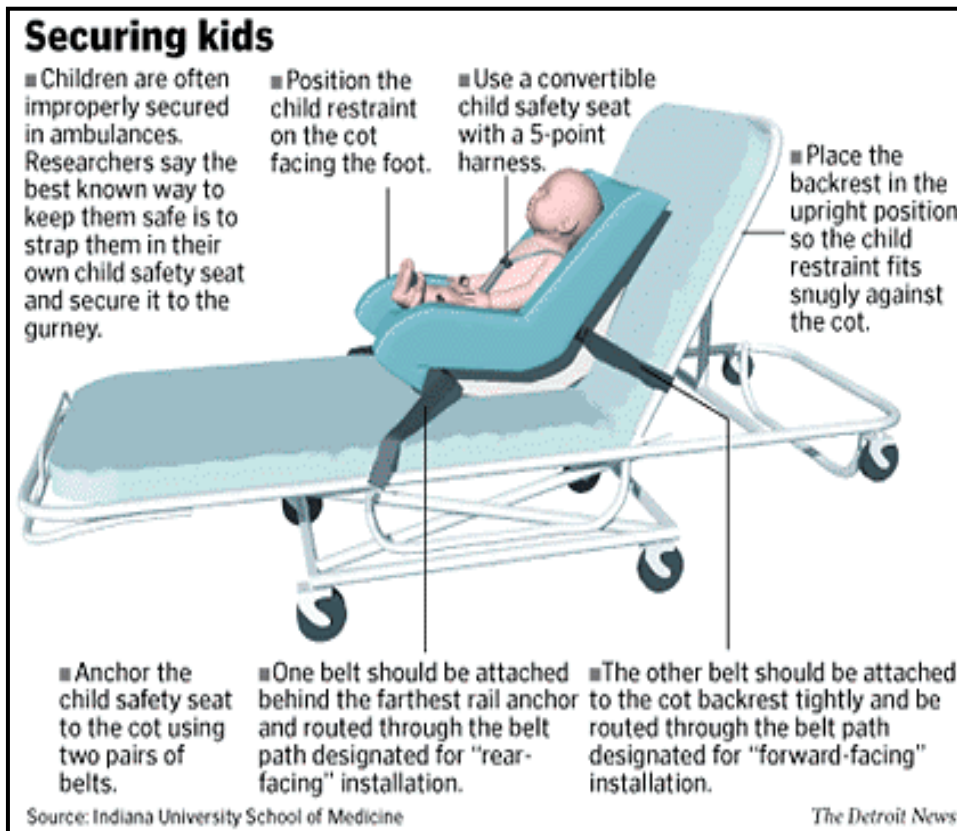


Figure 2: Shows Child Passenger Safety Seat strapped onto a gurney in the upright position. The two black straps on the gurney prevent the seat from reclining.

c. Design Idea and Constraints:

In this paper, we attempt to explain our prototype that tackles the problems faced with current safety passenger child seats. We have developed a safe and compact child seat for transporting children (6-30 kg) in ambulances that allows EMTs to recline the child in the seat from the sitting position to the supine position when strapped onto a stretcher in a child seat.

Specifically, we built a prototype that is compatible with current gurneys. Generally, current gurneys come in one size (100 cm long and 50 cm wide) and consist of two long adult straps (Figure 2). Keeping this in mind, our design had to be compatible with the gurney itself and the two straps that hold down the design on the gurney.

In addition, our prototype secures children up to 10 years old. Generally, children under 10 years old do not meet minimum height criteria needed to be placed onto a gurney without a child seat. We've found that 99th percentile weight of a 10 year old is around 30 kg, shoulder width of 30.8 cm, and hip to shoulder height of 44 cm. As a result, our prototype is compatible for a 10 year old who falls into the 99th percentile in weight, shoulder width and hip to shoulder height.

Also, our prototype reclines (120-180 degrees) while it is strapped onto a gurney so that EMTs do not have to remove the seat from the gurney to lay the child in the supine position. This was one of the most important requirements of our prototype and the biggest limitation of current child seats. A reclining mechanism in our prototype reduces the time it takes to lay the child in the supine position. Also, a reclining mechanism makes our prototype more compact as one will be able to fold the prototype and keep it in ambulances at all times.

Lastly, our prototype does not restrict EMTs' ability to care for a child. If the prototype hindered EMTs ability to care for a child, it would do more harm than good. We have taken many parameters and design constraints into consideration before fabricating our prototype. For detailed design constraints, please refer to the Product Design Specifications (PDS) in the Appendix.

Design:

Keeping the current child seat and gurney constraints, we incorporated four new features into existing child passenger safety seats to overcome the limitations current that these seats pose. We did not make drastic changes to the overall design of the child seat, because we did not believe the overall design was problematic. The overall layout of the child seat was carved out plywood. To the overall design, we incorporated four features: reclining mechanism, strap anchor, leg support and back track. Once we incorporated the four new features into the child seat, we covered the prototype with foam and fabric to give it padding.

a. Reclining Mechanism

The main reason that the existing child seats are not used to lay child flat on the gurney is because the child seat did not recline. In our prototype, we have added a reclining mechanism which does not require one to remove the seat, and the child can be laid in the supine position in the child seat.

Our initial prototype design comprised of two quarter discs overlapping each other while joined at the bottom angle. When they slide over each other they end up forming a semi-circle which will make the chair lay flat on the gurney, as desired. Also, there is a locking mechanism on this design, as a child seat needs to be locked in one position when the child is strapped onto a gurney in a child seat. The lock is simple, spring-like, and very effective. However, there was a problem with this design. This prototype design was bulky; for the seat to be stable the discs had to be thick for support and needed more surface area for different positions. Since our goal was to reduce bulkiness of the child seat, we did not pursue this specific reclining mechanism (Figure 3).

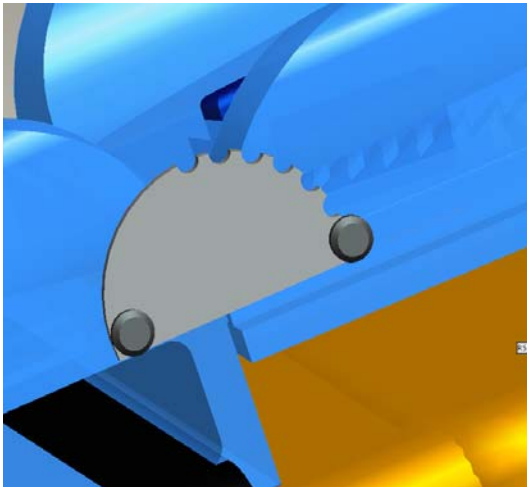


Figure 3: Initial Reclining Mechanism Design

For our prototype, instead of the discs, we decided to use two rectangular wooden plates. Each plate was permanently connected to a circular (8 cm diameter) wooden disk on one edge of the plate with wooden nails. One plate was nailed into the bottom right base with two L-shaped brackets. The second plate was screwed down onto the right arm of the backrest. We also bored out a track in the second plate to allow it to freely move vertically. Eventually, the two plates were connected together through the circular wooden disks with a bolt and a nut. This arrangement allowed the top plate to move freely in the vertical direction while the plate nailed on the base stayed fixed in one position as the backrest moved (Figure 4, 5).



Figure 4: Prototype Reclining Mechanism (outer view)



Figure 5: Prototype Reclining Mechanism (inner view)

In addition, we added a pin mechanism to lock the seat in the upright and in the flat position. To do so, we bored two holes where the two plates were connected through the two wooden circular disks; one hole was made at the upright position and the other at the flat position. Thereafter, we permanently fixed a long pin next to the two holes to lock the reclining mechanism in position (Figure 4).

b. Strapping Mechanism

One of the major problems with using current child seat models for ambulatory purposes is the difficulty and time cost in adjusting the unit to fit a broad range of sizes of children. With the child seat's normal use this is admittedly not a big problem. Though a child will grow, the seat will only need to be adjusted at most every few months. When applied to an ambulatory setting however, EMTs arriving on the scene of an accident must be able to adjust the child seat nearly instantaneously upon finding a child requiring immediate transport to a medical facility. For this reason, one of the major modifications we have put into our design is to include adjustable sliding strap anchors for each shoulder strap.

Current child seats use usual horizontal slots in the back of the seat to fit certain increments of child sizes, but the straps must be fed through many holes and tied around the seat in a complex manner that is fairly time consuming. As seen in the following depictions of the component, unlike current strap system, our design utilizes two diagonal slots that run from the top, wide position (for a taller child) to the bottom, narrow position

(for an infant or smaller child). This allows for quick and easy modifications as well as many more options for the height at which the straps can enter the back of the seat (Figure 6).

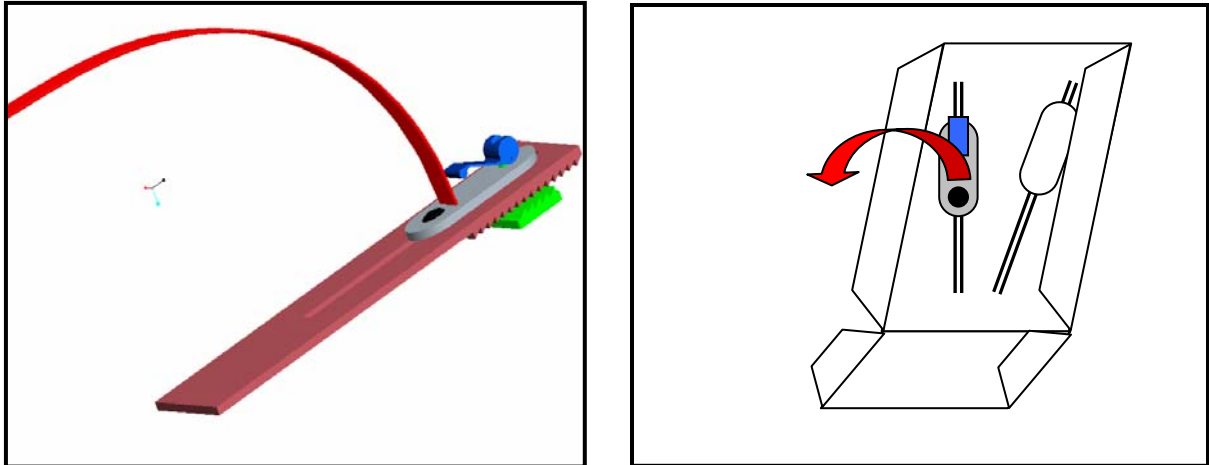


Figure 6: Strapping Anchor Mechanism alone (left). Strapping Anchor layout on the prototype (right).

The base of the anchor (shown in gray in Figure 6) should ideally be made of a strong thin metal oval. It must be tough enough to keep the strap (red) from being pulled out in an accident while remaining firmly attached to the back of the child seat. In order for the anchor to lock in place, an over-center latch (blue) is used. It can be made out of plastic, but must be rigid enough to keep the bottom flat area from deforming and letting the lock slip open. This latch is coupled with a plastic block (green) on the back side of the anchor containing several ridges which fit into similar ridges on the back of the child seat along the slot. When in the “open” position the latch releases pressure from a pin running through the back of the seat holding this block firmly to the ridges. The anchor can now be easily adjusted to fit any size child. When in the desired position, the latch is flipped to the “closed” position, securing the anchor in place.

Finally, a small secondary metal pin (black) also runs through the slot. This pin has two main functions. One way it improves the design is that it helps provide more support and stability to the mechanism, making it even easier to slide the anchor when adjusting. The other main benefit of using this pin is that it helps hold the strap and anchor even more firmly to the back of the seat. It eliminates any excess stresses on either end of the anchor in case of strong pulling forces (Figure 6).

For the model of the mechanism to be included in the prototype, there were a few simplifications, as well as substitutions for materials. This was due to limited time, limited resources, and the level of functionality required. Most components of the entire seat were made using wood that was donated to us. For sliding strap anchor, this included the main part of the latches, the ridges on the back of the seat, and the blocks holding the

anchors in place. The bases of the anchors, as well as part of the main pin, were made from scrap pieces of thin plastic piece. The lower parts of the pins were made using screws with large flat heads. Under the brims of these heads (between the heads and the back of the blocks) we placed small rubber washers to absorb some of the force occurring during latching and unlatching. This allowed the latch to be easy to open and close, but still stay firmly in place once closed. Because the bases are small and this prototype will not be tested with large forces, we made a couple of simplifications. First, we opted not to include the secondary pin in our model of the design. Second, we simply looped the strap through a slit in the plastic anchor. If a functional prototype were to be made however, it would need to include all the original components, as well as stronger materials. Figures below show finished sliding strap anchor; the figure on the left shows the front of the prototype and the figure on the right shows the back of the prototype (Figure 7, 8).

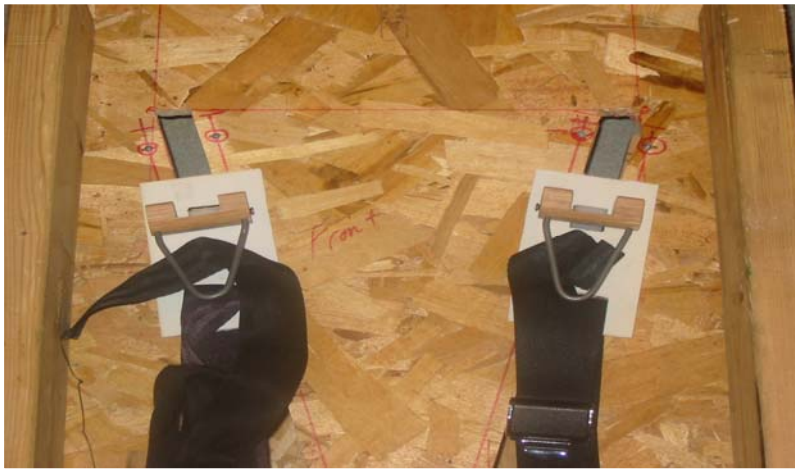


Figure 7: Strap Anchor of Prototype (Front View)



Figure 8: Strap Anchor of Prototype (Back View)

c. Leg Rest

The slide-out leg rest was added to the seat to elevate the child's legs, if necessary. In the case where the patient's blood pressure drops, or needs more blood flow to the brain or other organs, it is desirable to raise the patient's legs. This mechanism will allow an EMT to easily pull out the flat leg rest in an emergency situation, and raise child's legs. When the seat is completely reclined, using the leg rest will put the patient in a completely horizontal position, the best position in which to administer emergency care.



Figure 9: Leg Rest of prototype

The leg rest is mounted in the base of the seat. It is comprised of wood and metal tracks used for mounting drawers. It is 35.6 cm wide, and it extends 30.5 cm out of the base of the seat. The 30 cm extension from the base will accommodate the knee to foot length of most children under 30 kg. The leg rest height is 2.5 cm below the level of the seat. It was placed as high as possible in the base to create the most horizontal surface possible when extended. The metal tracks allow the leg rest to move smoothly into and out of the base of the seat. They are designed with grooves that prevent the leg rest from sliding out too easily when it is pushed all the way in. Also, the tracks allow the leg rest to be lifted slightly and locked into place when it is pulled all the way out. This assures that when the leg rest is needed in an emergency situation, it will not move from its position accidentally. This is an imperative feature in a moving ambulance (Figure 9).

d. Back Rest Track

The back rest track anchors the back of the seat to the stretcher, while allowing the seat to recline. In order for a child car seat to be stable in a crash, it must be anchored not only on its base, but also on its back to prevent movement of the upper part of the seat. A problem is encountered when the seat is reclined. Since the hinge point of the seat is several centimeters above the hinge point of the stretcher, when they are reclined simultaneously, the back of the seat moves relative to the back rest of the stretcher. This prevents the back of the seat from being strapped to the stretcher directly. The back rest track allows parallel movement of the back of the seat with respect to the stretcher while the seat is being reclined (Figure 10).

On the back of the seat, two pieces of PVC pipe are mounted, one on each side. They are each 28 inches (71.1 cm) long, extending nearly the length of the back of the seat. They are screwed into the back of the seat, and are raised off of the back by $\frac{1}{2}$ " (1.3 cm). The PVC has a $\frac{7}{8}$ " (2.2 cm) outer diameter (Figure 10).

The anchored piece is not directly connected to the seat. It consists of a piece of plywood, 18" by 12", and four wood pieces, one screwed to each corner. Each wood piece has a $\frac{7}{8}$ " round hole drilled through it where the PVC tracks slide through. There is a slot cut out leading into each hole where the screws connecting the PVC to the back of the seat can slide through. The tight fit of the PVC pipe in the wood prevents any front to back or side to side motion of the seat with respect to the anchored piece. However, the back of the seat can easily slide up and down in relation to the anchored piece. When the anchored piece is attached, the distance from the bottom of the anchored to the back of the seat is 4" (10.2 cm).



Figure 10: Back rest design of the prototype

When the seat is strapped to the stretcher, the seat and stretcher are in the upright position, and the anchored piece is placed near the bottom of the PVC tracks. The seat is prevented from moving forward, or side to side. Then when the seat and stretcher are reclined, the anchored piece slides upward in relation to the back of the seat and remains firmly strapped to the stretcher (Figure 10).

Materials

Wood was the material of choice in constructing our prototype for a multitude of reasons. The main reason for using wood was the cost. In our initial meeting with our client, we were notified that we would be receiving little if any monetary assistance for material purchase. With this limited budget, wood was an obvious choice. Another reason for using wood was the ease in machining. For the most part, our group had very little previous experience in the machine shop. Wood is fairly easy to machine and the cost allowed us to use trial and error in making certain components. This was extremely

important because many of our components took custom pieces and being able to easily modify the component quickly was essential. We were also hoping to make a fairly light prototype and wood is lighter than many other materials. We used plywood, particle board, and traditional 2x4's.

Other materials that were used in the construction of our prototype were PVC piping and polycarbonate. PVC was used in place of metal piping due to its cost and manufacturability. The polycarbonate was utilized in a high stress application. We had been using wood, but the wood continually failed during testing. We used foam from a sofa cushion for padding and covered the padding with fabric. Screws, nails, staples, metal hinges, and glue were used to hold the materials together.

a. Material Cost

The majority of the supplies used to construct the prototype were scraps found in the machine shop or were given to us by client. A handful of materials were purchased by the students, but the total cost was minimal. Refer to the table below for cost of all supplies. We were able to make the entire prototype with \$20.00.

Materials	Cost
Plywood, Wood, Foam, Straps	Donated to us by our client
Hinges, Hooks, Nails, Screws, Nuts and Bolts	\$ 10.00
Sliding Bars	\$ 5.00
Fabric, Glue	\$ 5.00
Total Cost	\$ 20.00

Table 1: Cost of Materials used to build the prototype

Testing:

After completing our prototype, we tested it on four volunteers who were 1, 4, 6 and 10 years of age. First, we placed each volunteer in the upright position and strapped them down in the prototype with a 3 point harness (Figure 11). Thereafter we tightened the shoulder straps to ensure each volunteer was sitting in the seat comfortably. After securing the strapping mechanism in place, we locked the straps in place with the latches. Once securing each volunteer in the seat, we gently shook the seat sideways to ensure that the strapping system was in place properly.

In addition, we moved each volunteer in the supine position from the upright position. This was done by first unlocking the strapping mechanism and removing the locking pin

from the reclining lock mechanism. Next, the back rest was gently reclined. As the back rest made a contact with the surface on which it lay, the locking pin was inserted back in the reclining lock mechanism. Again, the straps were tightened, and once the volunteer was strapped down comfortably, the straps were locked in place with latches. Thereafter, we shook the seat sideways to ensure that the strapping system was in place properly.

We also tested our prototype on a gurney and strapped it directly on the gurney with two straps in shown in Figure 2. In addition, we moved the prototype from the upright to the supine position while it was attached to the gurney.

Results:

After testing all four volunteers, we found that it was easy to place each volunteer in the upright position as well as in the supine position (Figure 11 and 12). We did not experience any difficulty and we were able to move the child from the upright position to supine position in less than 30 seconds. The six year volunteer was tall; therefore, he needed to use the foot rest in the supine position (Figure 12).



Figure 11: 1 year old subject in upright (left) and supine position (right)



Figure 12: 6 year old subject in upright (left) and supine position (right)

Similarly, we obtained successful results when we tested our prototype on a gurney. We strapped the prototype in the upright position with two straps (Figure 2) and observed that our prototype fit exactly on the gurney. As we lay the prototype from upright to the supine position, we were able to move the prototype without any difficulty from one position to another. The back rest track was very helpful, and moved simultaneously with the prototype as we changed from the upright position to the supine position or, vice versa.

Current Problems and Possible Solutions:

One of the main problems with our current design is the mass of the device. Due to our budget constraints, wood was used which is not only heavier than the polymer we hoped to use, but is also more brittle. Another problem with the prototype is the flat back and seat. We had hoped to put more curvature into the design (in the lumbar region) to make the seat more comfortable for the children. If done with foam, we feel that this would make the chair more adaptable to different sized children. We also realized the chair needs more padding around the head and the shoulders. The chair also has some very square corners. These square corners could damage the stretcher to which it is secured.

Another problem with the current design is the fact that there is only one position setting for the seat buckle between the legs of the child. Adding different settings would allow the EMT to customize the seat for each child. The current design does not contain any handles for carrying or for hanging the chair for storage.

a. Adjustable Shoulder Strap

One of the main problems with the adjustable shoulder strap is attempting to adjust the straps when the seat is in the upright position. When in the laying position, the shoulder straps adjust easily. On the other hand, in the upright position, gravity forces the catches to engage which stops the straps from sliding. A design change will be required that retains separation between the catches and the seat when the chair is upright position.

Another question with the shoulder straps is the strength of the mechanism. During an accident, all of the force will be on the connection of the straps to the plate of the adjusting mechanism. In order to assure safety of the seat occupant, our design must secure the straps to the frame of the device.

b. Locking Mechanism

The current locking mechanism only allows the user to set the chair in two positions. While we only require two positions (upright and reclined), different stretchers may have different upright settings. It would be advantageous to allow the EMT's to be able to lock the seat in any reclined position desired.

There is also a great deal of moving pieces involved in this mechanism. Any time a component contains moving pieces, it is important to identify any pinch points. Pinch points are especially important in this case because the hands of the child in the seat will be very near the mechanism. Adding a cover would eliminate this problem.

An additional problem with the mechanism is the locking pin. When locking the seat in place, there is nothing that let's the EMT know if the seat is actually locked. Some type of positive reinforcement should be built into the mechanism to allow the EMT to feel when the seat is locked. Another problem with the pin is the fact that the pin could slip out. When the pin is engaged, there must be a button to press to allow the user to remove the pin rather than just being able to pull the pin out.

c. Leg Rest

The current leg rest works well, but we did not incorporate vertical supports. A very large force applied to the end of the leg rest while the leg rest is out may snap off the current leg rest. A support would eliminate the problem.

d. Back Rest Track

For the most part, the back rest track works extremely well. In the future, we would like to add a stop to prevent the back rest from slipping off the tracks. Another improvement would be to add a mechanism that would lock the back rest in place once the seat is taken off of the stretcher.

Future Considerations:

Other than making the changes mentioned in the previous portion to eliminate design problems, it is important to determine the exact materials and plans for manufacturing the child safety seat. The first step would be to design a sturdy frame out of steel to attach everything to. The next step would be to make molds for injection molding any polymer parts. After that, a material that is easy to sterilize would need to be selected to cover the padding and frame of the seat.

Once a final design is determined and an acceptable prototype is produced, crash testing would be required. Crash testing would have to be conducted in the upright and the reclined positions with the seat attached to a stretcher.

After crash testing, instructions for user guide would have to be developed to train EMT's. The guide would contain instructions for changing strap settings and for securing the seat to the stretcher.

If this plan of action is followed, the result should be a safe method of transporting children in an ambulance in an upright or reclined position.

References:

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Appendix

Product Design Specification-Final Draft

Revised: 12/5/05

Project: Ambulatory Child Seat (Child Seat)

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Function: The goal of this project is to develop a safe method of transporting children in ambulances that allows the EMT's to recline the child from the sitting position to the lying position when the child seat is strapped on a stretcher.

Client Requirements:

The child safety seat:

1. Must be compatible with current stretchers;
2. Must secure a child (5-30 kg) in the event of an accident;
3. Must not restrict the EMT's ability to care for the child;
4. Must be cost-efficient (maximum cost: \$100.00) and user-friendly;
5. Must be collapsible, or at least no larger than current seats;
6. Must recline from 100 to 180 degrees;
7. Must be easily sterilized and not cause any contamination.

Design requirements:

1. Physical and Operational Characteristics

- a. *Performance requirements:* The safety seat should secure a child from 5-30 kg. during normal ambulance transport and in the event of an accident. The seat should also recline from upright (110 degrees) to reclined (180 degrees) position.
- b. *Safety:* The seat must not provide any physical or mental harm to the user. It must not interfere with work of the EMT. In the event of an accident, the seat should protect the occupant and stay secured to the stretcher.
- c. *Life in Service:* The safety seat should be rigid enough to endure at least 2 years of normal service, yet in the event of an accident the seat may deform and may need to be replaced. .

- d. *Shelf Life:* The shelf life will differ depending on how the seat is constructed and how much it costs. However, the life and the durability of the child seat must be maximized to the best of the ability.
- e. *Operating Environment:* The seat will be either stored in an ambulance or in a hospital. The seat will need to sustain and function properly in various temperatures (0-45° C). The seat should not be flammable.
- f. *Ergonomics:* The seat should comfortably secure a child in the specified weight and height range. The mechanism of reclining the seat should also be intuitive and not require a great deal of force and special training.
- g. *Size:* The seat should be compatible with current stretchers and should collapse to fit in the cupboard on an ambulance. Further, the seat should fall in the weight ranges of the current automobile child seats.
- h. *Weight:* The seat must not weigh more than 25 Kg and must be easily carried.
- i. *Materials:* The device can be made of any material (i.e. plastic) as long as it is durable and does not cause any physical harm to the user and the operator.
- j. *Appearance, Color, form, shape:* The device must not be bulky and can be of any shape or color as long as it aesthetically appealing and compatible with current stretchers.

2. Production Characteristics:

- a. *Quantity:* Only one seat is needed for the prototype and testing purposes but millions are needed for ambulances all across the world.
- b. *Target Product Cost:* Depending on the functions of the device and materials it is made of, it can cost up to \$200.00. Since we will be modifying a pre-built child seat, it will cost significant less.

3. Miscellaneous

- a. *Standards and Specifications:* The seat will be in direct contact with humans; therefore, it will need to be successfully tested on dummies and other similar models before it can be approved for children. Furthermore, it needs to fit the current Emergency Vehicle Safety guidelines set by hospitals and National Highway Transport Safety organization.
- b. *Competition:* No such type of models (described in the function section) exist in the market. However, there are thousands of companies that make automobile child seats which are closest to what our client is looking for. However, the current child seats still need to be modified in order to meet our client's needs.