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Modular Seat-Shells and Standardized Manufacture of Individually Shaped Seats for the Severely Disabled—The Tubingen Experience

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Over the years, proper seating for the severely disabled has been neglected. Often, an approximate position of the patient in commercially available ''grandfather-chair'' seats, upholstered with cushions, seemed to be sufficient for the needs of these individuals. Custom shaped seats manufactured in the usual manner to taking a plaster cast, and molding the seat-shell of plastic material on this plaster model, after rectification, have proven to be helpful at least for limited periods, especially for growing children. However, often, during the time of plaster taking, an unfavorable position of a child, especially in cerebral palsy children, could be achieved, causing a permanently defective position for the child in such a seat. Moreover the entire process was time consuming, requiring the presence and active participation of an experienced and, therefore, expensive orthotic specialist. Also, the presence of the patient for a long period was necessary in comparison to our present procedure.

In 1978, we started a program for the improved manufacture of seats, using prefabricated seat shells and standardized patterns for the manufacture of individually shaped and adjusted seats for patients with seating problems, due mainly to neuromuscular diseases like cerebral palsy, muscle dystrophy, multiple sclerosis, and so on.

The idea was to improve the seating comfort of our patients and to increase the adjustability

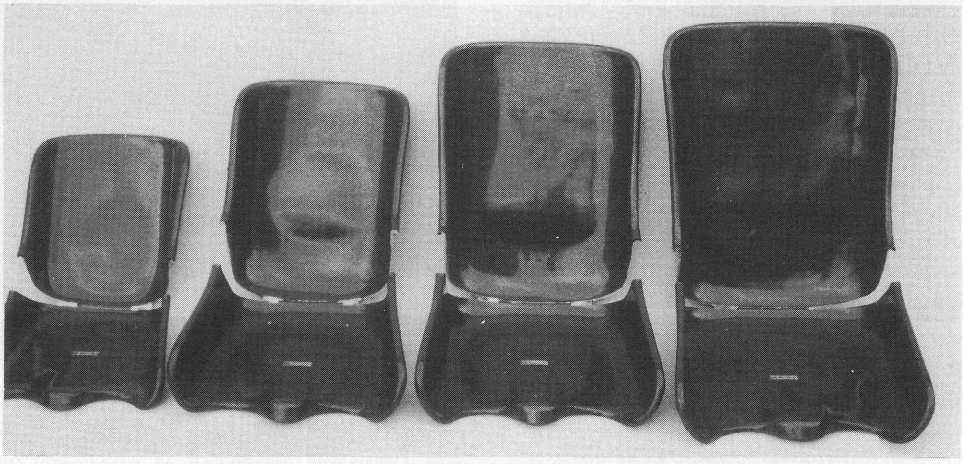

Figure 1. Four of six sizes of the modular seatshell. Two hinges connect the back and seat sections.

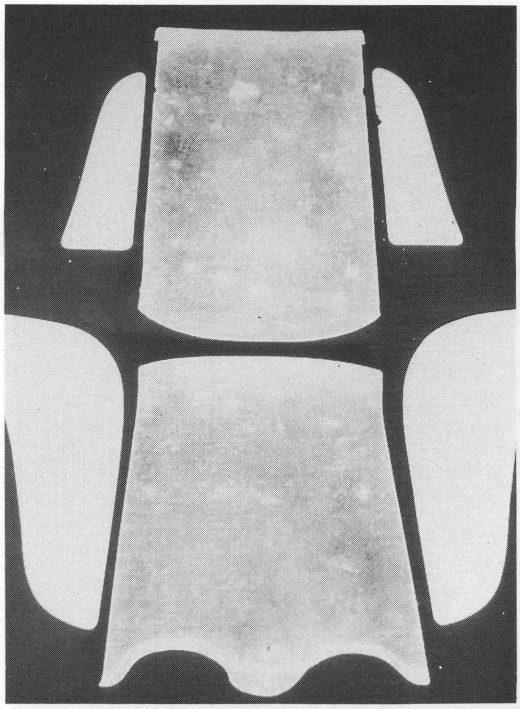

Figure 2. Seat, back, two upper side, and two lower side inner sections to be mounted in the seatshell.

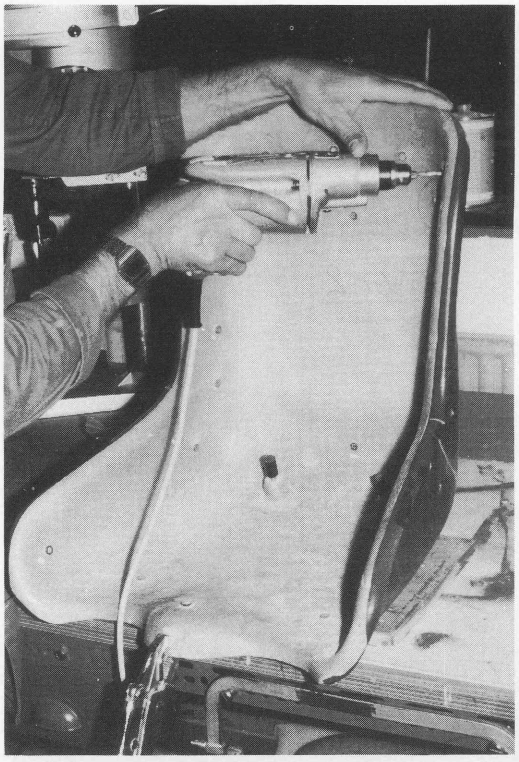

Figure 3. Use of the permanent pattern, or die, for drilling of screw holes, in a standardized array, in the seatshell for mounting of the inner sections.

for growth and clothing. At the same time we wanted to reduce the amount of work necessary, especially for the orthotist.

Presently, there are six different sizes of prefabricated seat shells made from glassfiber-reinforced polyester resin. These are divided in the seat and the back section and are connected with strong hinges integrated into the laminated resin (Figure 1). For each size of these seat shells, standardized inserts of polyethylene are necessary to form a second innershell. The inner shells consist of one seat, one back, two upper and lower lateral parts (Figure 2). The parts of the innershell are fixed to the outer seat-shell with screws. The holes are drilled with the use of a permanent pattern or die (Figure 3). This allows for the quick exchange of one or the other part of the seat. They can also be removed for easy cleaning, reshaping, or for the addition of spacers between the inner and outer wall for proper fit with respect to clothing and climate (Figure 4). Foot-rests,

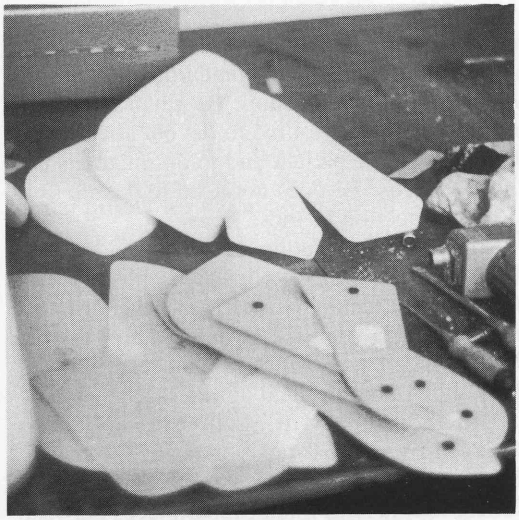

Figure 4. In the foreground, spacers for insertion between seatshell and inner shell to allow for seasonal variation in clothing. In the background can be seen foam rubber pieces to be glued to the inner shell.

Figure 5. Foam rubber pieces have been glued in place and ground to proper contour and fit.

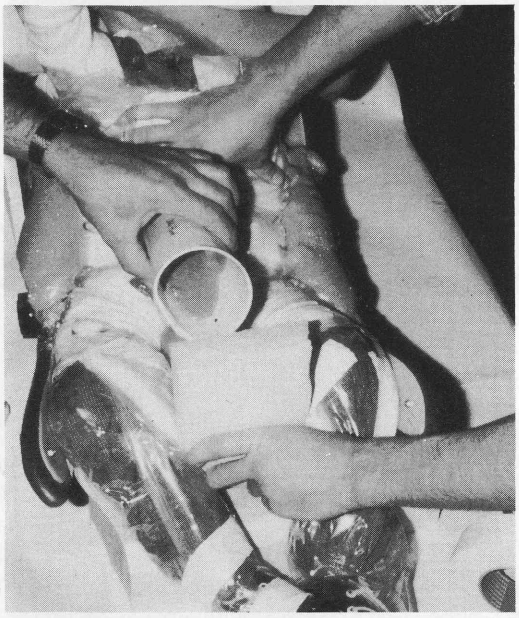

Figure 6. The child is held in place while the void between him and the seat is filled with polyurethane foam. Child is protected against exposure to foam with a layer of plastic film and against thermal burns with a layer of foam rubber. This also allows for the layer of foam rubber to be subsequently added for comfort.

headsupports, handles, quick-exchange boards are also prefabricated in standardized sizes and on stock in the workshop. By this means, the orthotist gains more time to devote attention to the needs of the patient and to optimize his position, because he does not need to devote time to the production of these items.

Prior to the initiation of this fitting procedure, the responsible physician, physiotherapist, occupational therapist, and the orthotist have to decide what they want and how the patient is to be best positioned with respect to his daily living and physical abilities.

The individual fitting of the module is achieved by optimal positioning of the patient in a seat shell of appropriate size and by positioning roughly cut foam rubber pieces between the patient's body and the sidewalls, seat, and back of the seat shell.

After having made a rough alignment of the foam rubber pieces, they are glued to the inner parts of the seat. Then they are removed entirely and ground down to the proper shape until each of the six pieces fit properly (Figure 5).

Another solution is used for children with extensive spasticity. After selection of the proper size seat shell and inner-liner, the child is covered completely, including legs, arms and head, with layer of foam rubber and isolated by a piece of plastic foil or film. This is to prevent polyurethane foam from coming into direct contact with the patient's clothing or skin and to prevent burns. The patient is then positioned as well as possible in the modular seat shell. This is preferably done by the therapist or the mother of the child so as to prevent spasticity as much as possible and to optimize the posture of the child.

If necessary, a foam rubber wedge is placed between the knees to create slight abduction of the legs. Then, the free space between the body and the seatshell module is filled with polyurethane foam (Figure 6). After the foam hardens,

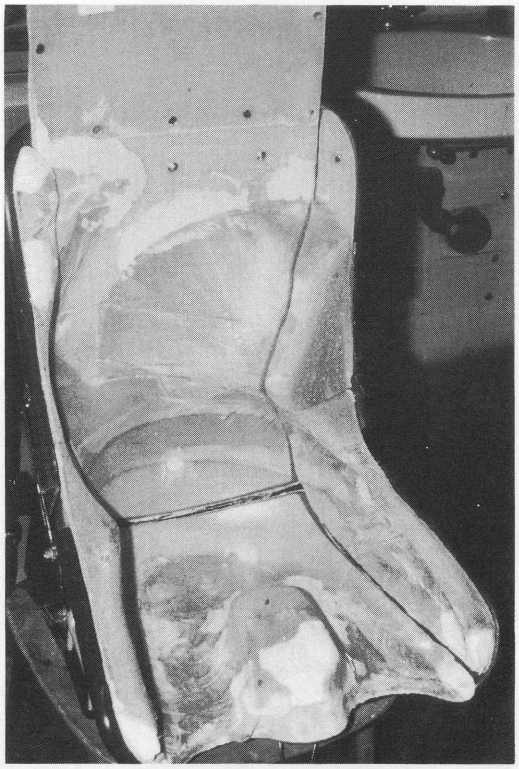

Figure 7. Seat following completion of the foaming procedure.

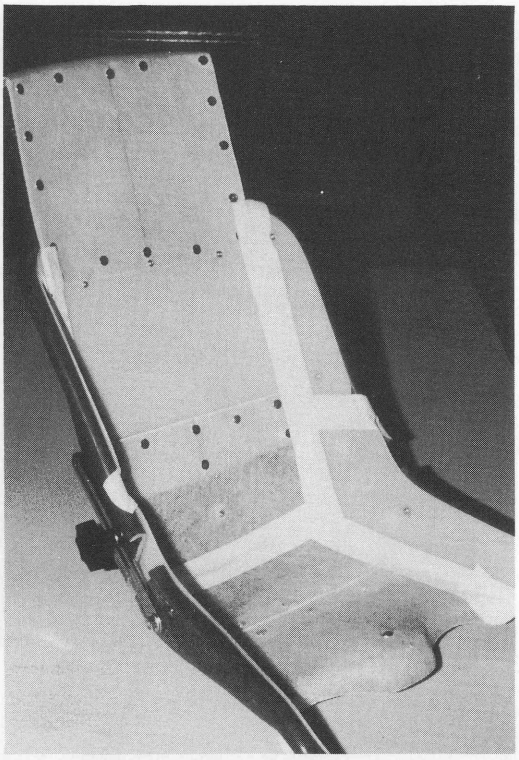

Figure 8. Section of polyethylene added to the top of the innershell to serve as the foundation upon which an integrated headrest will be built.

the child is removed from the seat and the foam is cut along the borderlines of the six parts of the insert, including the lengthened backpart for a headsupport if its use is necessary (Figure 7).

Each piece of foam is then ground to the proper fit and covered with a layer of foam rubber to prevent pressure sores and for sitting comfort.

The same procedure is carried out for those seats for which polyurethane foam was not used. By adding more foam rubber and grinding the six different parts to proper fit, an individually optimized shape of the interior of the modular seat shell is achieved.

A headrest may be made from a separate piece of polyethylene padded with foam rubber and shaped to properly fit the individual patient. It is fixed with adjustable metal bars on the backside of the seatshell. Another solution is the so-called integrated headsupport which is not removable, in contrast to the above-mentioned type. It is made from a sheet of polyethylene as an elongation of the polyester innerlayer of the back (Figure 8) on which foam rubber is glued and shaped to size. An additional pillow for the neck and head is easily removed and attached to the headrest by means of Velcro® fasteners.

In most cases, additional fixation of the patient is necessary to prevent him from falling out of the seat, e.g. during a sudden spastic convulsion. In moderate cases, safety belts adapted to the seat may be sufficient. If a more secure purchase is necessary, the lateral parts of the backrest are elongated at the level of the sternum and closed in around the front of the chest by an additional belt (Figure 9); or, an entire thoracic pad, made of a sheet of polyethylene, covered with foam rubber and ground to a snug fit, is fixed firmly to the seat by a hinge on one side and a clasp on the other to provide

Figure 9. Completed seat showing restraint system and anterior thoracic extension.

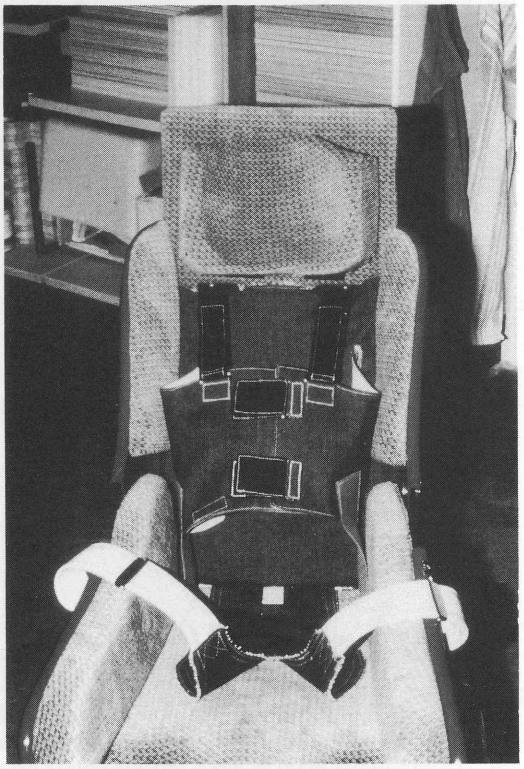

Figure 10. Completed seat showing apron and belt arrangement for restraint.

proper hold of the body. In severe cases, for example in athetoid spasticity, we use a kind of apron with a belt-system (Figure 10) to keep the pelvis and the trunk in proper position within the seat.

It is essential to provide enough free space for the bent knee joints. If necessary, the module and the seat part have to be cut out to allow for comfortable sitting. The abduction wedge must fit correctly too; otherwise it may increase spastic adduction patterns.

Due to the hinges between the seat and the backpart, and a stop on either side of the seat module, the patient can be leaned back in his seat, if desired.

In patients with limited movement in the hip joints, the seat part may be divided longitudinally. Then, each half can be adjusted independently to the individual position of either leg.

Additional armrests are used to prevent injuries to hands and arms if they are uncontrollable. For children and wheel-chair-bound adults a removable table may be added to the seat within the range of motion of both arms and the body, providing enough space for playing with toys, eating, paper work, and so on.

Finally, prefabricated footrests make sure that the entire body is in a proper and comfortable position. Our footrest is adjustable to height and inclination as dictated by the patients' needs.

The quick-exchange board system allows for easy removal of the entire seat from the wheel chair, normal chair, or the regular seat of a car. The wooden board of the seat is fixed with one or two special clasps and a "U" shaped metal stop to a second board which is screwed to the wheel chair or another chassis. This disconnecting device provides stable and safe fixation of the seat and the patient to the respective underlying surface.

If it seems preferable to first try the unfinished seat before finishing, the patient uses the seat at home for one or two weeks. After a final check and correction, the different parts of the

insert are removed once more and covered with a strong and long lasting colored nylon-velour. This gives the entire assembly a lively appearance, quite different from the ordinary ''medical'' wheelchair design.

Since we started this seating program, approximately 500 patients have been fit with this device. Each was provided with an individually shaped seat by using modular seat shells and pre-fabricated componentry to the largest extent possible. Only a few severely handicapped individuals had to be fit in the conventional manner by taking an individual plaster of Paris cast to create a mold for a seat. Thus, we recommend the use of prefabricated modular seat shells and componentry for satisfying the seating needs of the physically disabled.

From the Editor: This article was received too late for inclusion in the Fall, 1986 issue devoted to seating and thus is presented in this issue. The authors' effort in submitting it is greatly appreciated.

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