

The Global Evolution of Custom Molded Seating: Options and Methodologies

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Overview of Evolution:

Research and development of custom molded seating for complex rehabilitation patients began in Canada and the United States in the late 1960's. Early custom seating prototypes were used with children with cerebral palsy. In the 1970's, orthotic specialists and biomedicine engineers in Canada and the United States pioneered several types of custom molded seating options including: vacuum forming plastic around plaster molds, hand-carved foam and ply, molded plastic insert (MPI), and rigid and semi-rigid polyurethane molded foams. As the orthotics and prosthetics industry began engineering products that could be mass-produced, the earliest forms of adjustable micro-modular seating (AMMS) were being invented. Matrix was the first type of AMMS prototyped in Canada, while in the United States, foam-in place (FIP) emerged and came into wide use.

As technology advanced into the 1990's, the prosthetics and orthotics industry introduced CAD/CAM technology. CAD/CAM technology is currently being used around the globe for both foam and ABS plastic custom seating molds. Today, custom molded seating continues to improve through the use of vacuum forming and CAM/CAD, FIP, plaster casting techniques, and AMMS.

Custom Molded Seating in the US and Canada was pioneered by Douglas A. Hobson, PhD, P Eng. He entered into the field of assistive technology in 1963 in Winnipeg, Canada. As a leader in developing assistive technology service programs in Winnipeg and Memphis, TN, he established RESNA in 1979, being the youngest member of the founding group of five (Staros, Traub, Reswick, McLaurin, Hobson) and lead the early wheelchair standards activity in RESNA in partnership with Colin McLaurin, ScD.

Types of custom molded seating around the globe:

- Vacuum forming plastic around plaster molds
- Hand-carved foam and ply
- Molded Plastic Insert (MPI)
- Rigid and semi-rigid polyurethane molded foam
- Foam in Place (FIP)
- CAD/CAM digital technology (Is this custom molded seating, or is this used to determine the seating and positioning?)
- Adjustable Micro-Modular Seating (AMMS)

Advantages & disadvantages custom molded seating systems

❖ Plaster casting around custom vacuformed ABS thermoplastic and foam molds:

These custom seats consist of ABS, thermoplastics, or foam used to replicate the shape of a plaster cast mold.



PROS:

Clients:

- Hypotonia and mild-to-moderate spinal or orthopedic deformities
- Captures severe deformities such as scoliosis, rib humps and lordosis
- ABS thermoplastic molds are low profile, light weight

Evaluators/Technicians:

- Capturing the client's shape is relatively quick
- Low cost materials
- Simple methodologies

CONS:

Clients:

- Can be too noisy for clients with cognitive impairments who are easily agitated and have sensory impairments (vacuum machine noise)
- Clients with profound physical and mental disabilities who also have severe spastic or mixed muscle tone, startle reflex and other abnormal reflexes may be challenging to mold
- Foam molds are relatively bulky

Evaluators/Technicians:

- Process of fabricating the plaster mold can be time consuming
- Manufacturing time may be long
- Process can be messy
- Cannot see through cast to check the fit or adjust once set

❖ **Foam in Place (FIP) custom molds:**

These custom seats use liquid foam and various chemicals that are mixed in a bag (Liquid Sunmate) to create a foaming reaction and producing a foam mold in a short period of time.



PROS:

Clients:

- Molds quickly; do not have to sit for a long period of time while the mold hardens
- Foam has ability to fill in deep concave spinal curves and asymmetries
- Captures severe deformities such as scoliosis with rib hump and lordosis

Evaluators/Technicians:

- Fast production time
- Minimal technician time
- Modifications can be made on-the-spot once foam hardens
- Reduces number of visits for clinicians

CONS:

Clients:

- Patients may be irritated with heat caused by exothermic reaction
- Sensory impairments need to be assessed
- Patient populations with high agitation and behaviors (profound physical and mental disabilities) can be extremely challenging to custom mold with plaster and foam-in-place because of constant movement, severe spastic or mixed muscle tone, startle reflex and other abnormal reflexes.
- Inconsistencies can occur with the density of the foam

Evaluators/Technicians:

- Errors can occur in positioning of clients during the hardening of the mold. You only get one chance to get it right. It's a one-time shot! Need to know how to manipulate the mold during the hardening process.
- Ability to change the seating system once the mold is produced is limited
- Process may require several people to assist in molding

❖ *Digitized/Machine carved foam and ABS thermoplastic custom molds:*

CAD/CAM technology u- Uses the bead-bag-vacuum approach to make a temporary mold of the client. A magnetic digitizer/micro-computer assembly is used to record the surface contour manually with a stylus. The computer software then generates a 3-D image. This 3-D image is then received by a computer-controlled carver (foam molds) or a vacuum-form machine (ABS thermoplastic molds).

CAM/CAD technology with manufactured custom seating



PROS:

Clients:

- No discomfort for patient
- Meets the needs of wide range of patient population
- Client populations with severe physical and behavioral issues, can be molded with reduced agitation (no noisy machines)
- ABS thermoplastic molds are- low profile, light weight

Evaluators/Technicians:

- Digitizing process is quick and easy
- Manufacturing time decreased due to less materials needed
- Modifications can be incorporated into the mold's image using software
- No messy foams or chemicals
- Increased efficiency, accuracy and versatility
- Reduction in unforeseeable environmental risks

CONS:

Clients:

Foam Molds:

- High profile, bulky

ABS Thermoplastic Molds:

- May be difficult to capture more severe (deep) concave and lordotic spinal deformities.
- Possible pressure issues with boney prominences

Evaluators/Technicians:

- Ability to change the seating system once the initial mold is produced is limited
- Methods in digitizing and computer generated changes to incorporate modifications need to be accurate
- Cannot see through the mold

❖ Adjustable Micro-Modular Seating (AMMS):

AMMS utilizes a flexible sheet of interlocking nylon segments, which is molded around a client in a seated position. The segments can be loosened or tightened, or added or removed, during the molding process. This allows for changes to be made and correction in posture to be achieved. The molding process can occur via a direct fitting of the client or fabricated from a plaster cast mold.

Evolution of Custom Molded Seating Systems



Year 2000 and currently:

Matrix Easy Fit (Matrix Seating, UK and Matrix Seating USA)



Evolution of Custom Molded Seating Systems



Year 2000 and currently:

Free Form Seating (Symmetric Designs, Canada)



PROS:

Clients:

- Corrective positioning
- Increased air circulation
- Dynamic seating provides shock absorption
- Provides flexibility and movement in areas where spasticity is frequent
- Less transfers during modifications
- Slim in profile

Evaluators/Technicians:

- Easy to adjust and modify as client's grow and change
- See-through design allows for good airflow, significantly decreasing moisture and heat retention while reducing risk of pressure sores and skin breakdown
- Shape adjustment can be made directly

CONS:

Clients:

- Weight
- Different appearance
- Choice of component colors is limited (aesthetics)

Evaluators/Technicians:

- Time in direct fittings
- The infinite level of adjustment in the segments
- Technical and clinical knowledge must be more extensive due to its infinite adjustability.

Conclusion:

The choice of custom molded seating for each complex rehab patient is ultimately a decision based on client needs and preference. There isn't one option that will meet everyone's needs. Therapists and ATPs work together to assess the patient's immediate needs and recommend the best seating solution. Considering the possibility that spinal and postural deformities can be corrected with the use of a seating system is a new methodology in the United States. Steven Cousins, PhD, BASc, MSc, PhD, PEng, in collaboration with an orthotic engineer in Sweden, began exploring the possibilities of using AMMS for corrective positioning in the late 1990s. As this methodology is better understood through case studies and research, custom molded seating will evolve into a new generation.