

MOBILE BED/WHEELCHAIR DEVELOPMENT^a

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INTRODUCTION

The objective of this project is to develop a bed that has the physical dimensions, including width and features of a standard hospital bed, and that also has the additional feature of being capable of automatically folding itself into a configuration resembling a powered wheelchair, preferably no wider than a conventional wheelchair so as to enable maneuverability. Such a device would provide mobility within the confines of the hospital and its immediate area of level ground to a severely paralyzed patient without the necessity of transfer from bed to a conventional powered wheelchair. The most significant gain in rehabilitation which should accrue from the bed/wheelchair combination is the independent mobility available to such a patient without the necessity of waiting for one or more attendants and the nuisance of being transferred from bed to wheelchair by others. A secondary but important gain would be the very substantial savings in labor to the hospital's staff. If practical, such a bed/wheelchair device might also be very helpful to a homebound patient in a house designed with freedom from high door sills and steps, permitting mobility within the house and perhaps to an outdoor porch or patio.

The original predicted time for completion of this project was one year. Significant progress was made, however, after only 2½ months. The original production plan included two phases. Phase I was to fabricate quickly a first prototype that did not necessarily meet all of the specifications required of the final version but that was: 1. Capable of being folded into a semblance of a sitting position comparable to the usual hospital bed; 2. electrically powered and equipped with a joystick

^aPaper presented by James Allen.

control system that could be operated by a paralyzed patient; and 3. possessing sufficient maneuverability to negotiate easily the halls and walkways within the wards and adjacent areas of a large rehabilitation hospital (Rancho Los Amigos). It was believed that this first model could be fabricated with minimal expenditure of time and money to provide facilities for preliminary clinical evaluation. This hasty patient trial should indicate to a certain degree: 1. patient-user acceptance, 2. neighbor patients' attitudes, 3. attitudes of nurses and ward staff, 4. utility for patient transport, and 5. possible desirability of additional design features not originally conceived.

PHASE I

Phase I has been completed except for the accumulation of data from the preliminary clinical evaluation. Design of the vehicle was accomplished by shortening the under-carriage or frame of a standard manually operated foldable hospital bed (by cutting approximately 4 ft. from the head end) (Fig. 1 and 2). Under the shortened head end of this reduced bed was placed a 12-volt d.c. power drive system similar to the drive mechanism of the Scat electric wheelchair. This vehicle is controlled by a joystick proportional-control system operated by feeble motions of one hand.

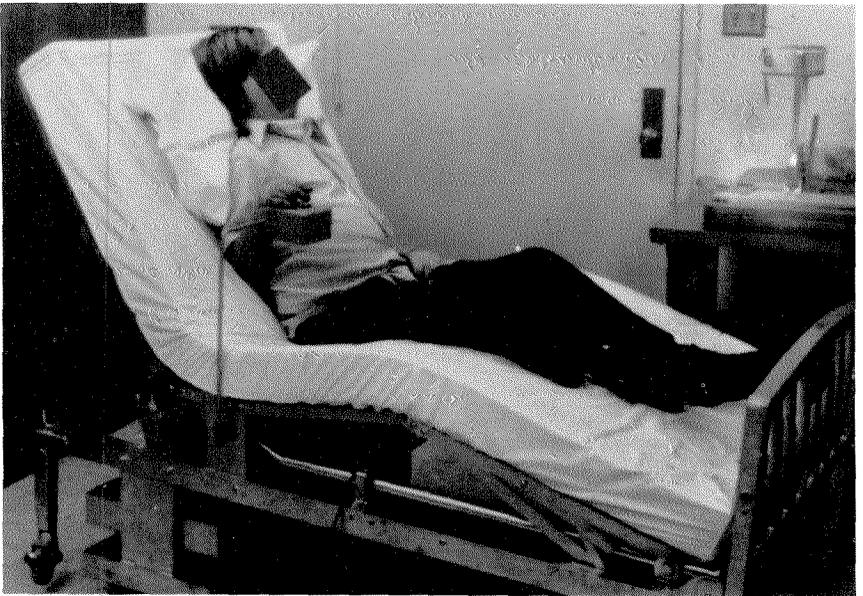


FIGURE 1.—Phase I modified conventional hospital bed, with frame shortened approximately 4 ft. from head end. Head end rests on electric wheelchair drive unit with joystick proportional control system.



FIGURE 2.—Phase I modified conventional hospital bed.

Initial observations indicate that the device is exceptionally maneuverable in spite of its larger width and length compared with conventional wheelchairs and in many driving situations is actually easier to manage than a regular electric wheelchair. Only one patient, at the time of the conference, had used the bed/wheelchair, and his experience was limited to 5 days. Though no conclusions could be made at that time, a motion picture was shown illustrating mobility of the bed under control of the quadriplegic patient on walkways in the patios of the hospital and even across grass.

PHASE II

Phase II includes the design and fabrication of an improved device with the following features:

- a. In the bed mode, the device was to have all of the physical dimensions and characteristics of a standard electrically powered hospital bed.
- b. In a wheelchair mode, the device was to have a structural configuration similar to a normal electric wheelchair, though slightly larger than the average wheelchair.
- c. Conversion from mode one into mode two was to be automatic, requiring the patient to make only one input control command.
- d. Driving control in the wheelchair mode was to be proportional and adaptable to any type of control transducer, i.e., joystick operated by hand or by chin cup, puff or sip, tongue control, etc.

Phase II likewise involved modification of an essentially conventional

hospital bed, starting with shortening of the frame and mounting the shortened head end of the bed upon a modified Scat wheelchair drive mechanism (Fig. 3). In addition to the motorized drive for the entire structure, motorized drives of the bed folding mechanism are also provided, as in many conventional hospital beds in present day use, in contrast to the hand cranks for elevation of knees and of back as provided in the Phase I model. Legs with small casters are provided under the head end of the bed for additional safety, but normally they clear the floor with weight carried only on the casters at the foot and on the driving wheels of the modified wheelchair motor mechanism. Additional battery capacity is provided to operate the bed folding as well as the mobility feature. A foam rubber mattress is used in contrast to the conventional tufted mattress.

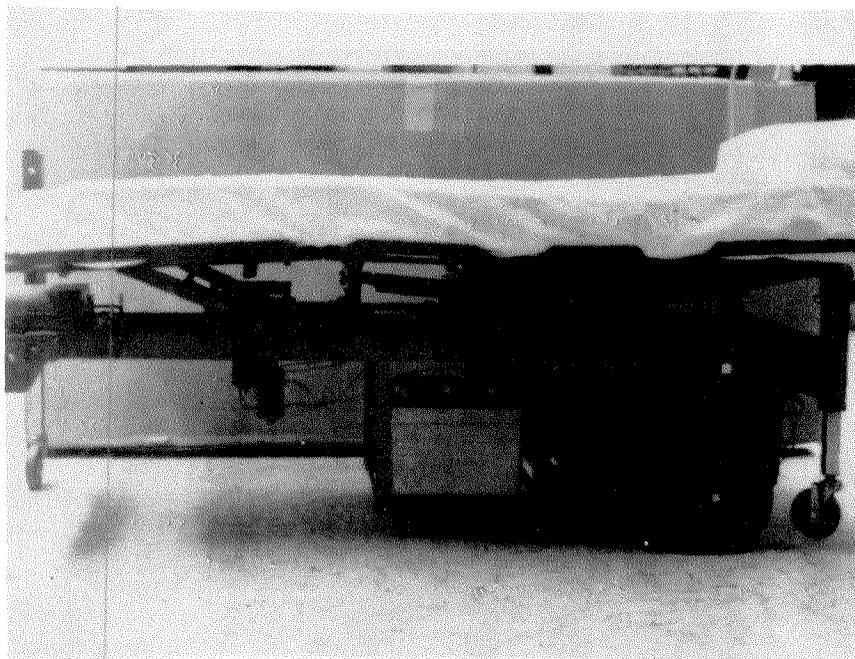


FIGURE 3.—Phase II modified conventional hospital bed on electric wheelchair drive. Knee and back elevation are also motorized.

As shown in Figure 4 (a view from the head end of the bed), the full width of the hospital bed is available when the structure is flat in the conventional bed mode. The control unit can be swung out of the way by an attendant to facilitate nursing care.

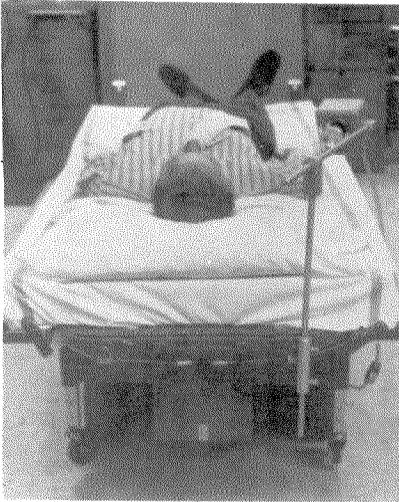


FIGURE 4.—Head view of Phase II bed showing full width in flat position. Control box can be swung to the side when not needed.

A foldable steel frame is provided to allow: 1. narrowing of the bed and 2. buckling of the foam mattress into a trough-like configuration, both to protect the patient and to make the wheelchair configuration narrower than the conventional hospital bed, as illustrated in Figures 5 and 6. Universal joints in the side rails supporting the outer edges of the mattress (Fig. 7), transmit to each section the torque derived from cranks at the head of the bed attached to cables anchored to the base of the bed, and thus tensed when the head of the bed is raised, as shown in Figure 6. The cells of the foam mattress apparently collapse sufficiently to prevent undue buckling of the mattress in the hip area, as might occur with more conventional mattress designs. In the chair configuration, with the side portions narrowed, these side portions appear to be equivalent to segmented bunk rails rather than the horizontal supports under the mattress which they form in the flat bed configuration.

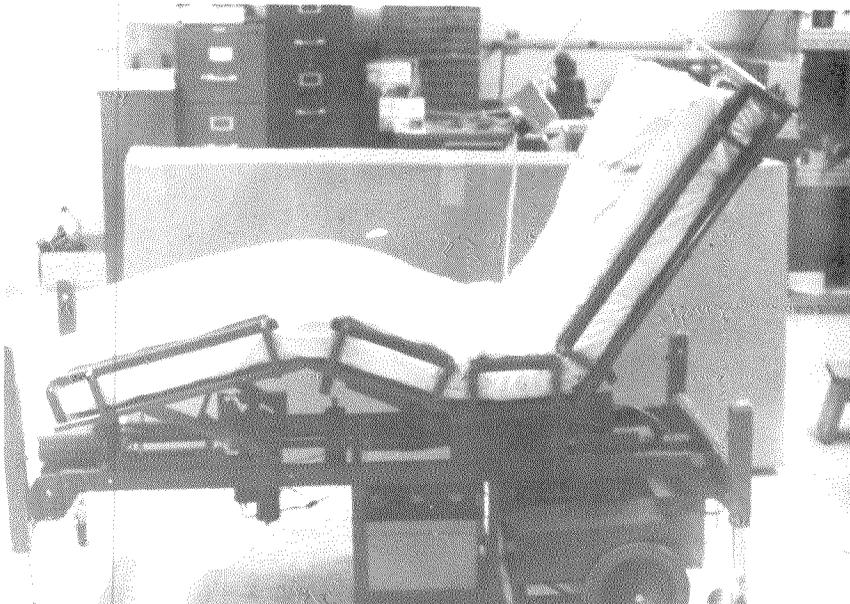


FIGURE 5.—Side rails fold upward and inward when legs and back are raised into the chair position, forming the foam rubber mattress into a trough-like configuration.

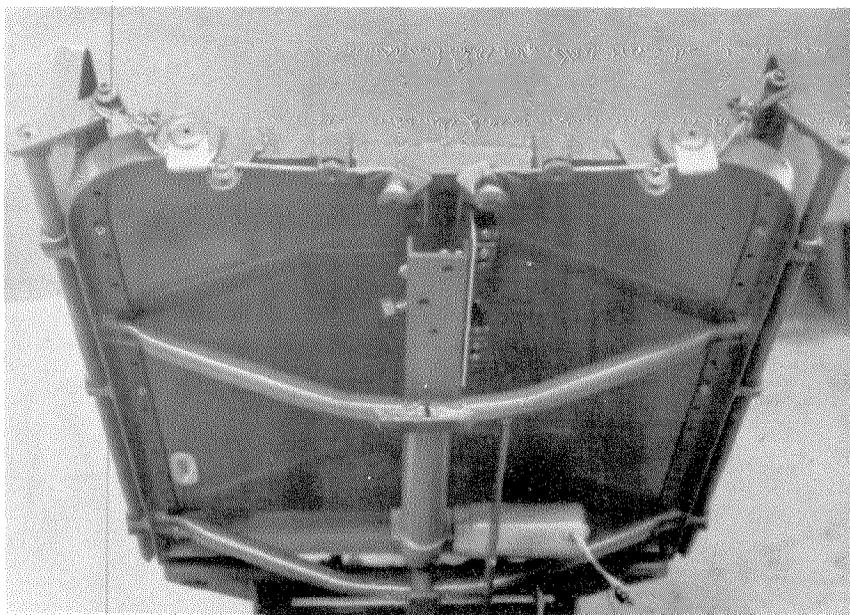


FIGURE 6.—Head of bed/wheelchair, Phase II, shown in raised position, tensing cables attached to cranks on side portions forcing them to rotate and thus forcing the mattress into a narrower trough-like configuration.

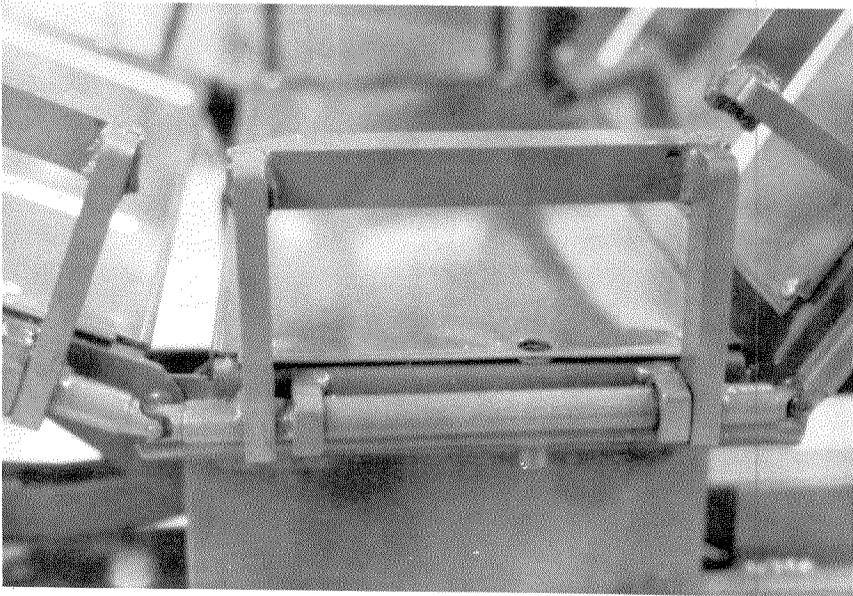


FIGURE 7.—Closeup of universal joints in side rails transmitting torque to rotate side portions.

In the Phase II configuration, a joystick control with a chin cup for control by a severely paralyzed patient is mounted on a box supported from a post at the head of the bed. It is anticipated, however, that several other types of control can be supplied to meet the needs of individual patients.

Additional motion picture footage, not available at the time of the Chicago conference, has been prepared to demonstrate mobility of the Phase II bed both indoors and outdoors.

PHASE III

Supplementation of the project has been requested to permit construction of a third bed as a prototype for a finished product, in contrast to modification of existing commercial hospital beds. While this is under design and construction, clinical trials of the first two models will continue.