DESIGN OF PAEDIATRIC PROSTHESES FOR THE UPPER LIMB

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INTRODUCTION
In the last few years the provision of paediatric prostheses for an upper limb deficit has become increasingly common. However, the earliest age at which externally powered devices might be useful is still the subject of some controversy within the prosthetics field (1),(2),(3).

Some developments have been based on adult equipments. Others have been specifically designed for children. In both cases it is usual to provide only one control option. However, design for children during the early years should take particular account of development, not just the size and weight of the device, but also the grasping patterns, response speed and control systems of choice (4).

DISCUSSION
It is often said that these prostheses are supplied to ‘treat the parents’. While it would be surprising if suitable equipment did not help the family mourning process (5),(6), this cannot be sufficient justification alone for their provision. Systems should be designed to provide something which is useful to the infant even if we may not be able to quantify their perceptions. It follows that it is important to consider the development and importance of control and grasp patterns of the non-dominant anatomical hand.

The very young child may well neglect the prosthetically fitted limb when first fitted. Although they might resist the donning of the prosthesis to the point where a secondary retention system is needed and then ignore the device when worn. Features which focus the child’s attention on the prosthesis can be provided by adding some purposeful function as well as the dress and gross activities for which a passive, cosmetic device should be provided.

EXTERNALLY POWERED PROSTHESIS
The SIEEPER Snap hand has been designed with this in mind. Initially, the device is light enough to be used as a passive hand, no battery or electronic sensor system is required at this stage. A closing drive is provided by a spring and as soon as it is felt to be appropriate objects can be fitted into and held by the hand. This provides a focus for the child’s interest. At the next developmental landmark and during a socket renewal, a pull switch is fitted, which is operated as the child reaches objects in the mid-line.
Later and as the infant becomes more aware, a single site, threshold switch, myo system can be fitted. The control switch can be set low and this means that the child can understand the mediation of the controlling action and secondly it will be tolerated by the prosthetic naturally. Some fitting have been provided at the earliest age at which such a prosthesis will be learned. One fitting has been done as early as 4 months. Other groups have provided fitting as early as 4 months or so, when the child is in these limbs much later, at 4 years or so, when the child is in a structured learning environment. As a prelude to an a structured learning environment. As a prelude to an environment, the child opens a structured learning environment. As a prelude to an environment, the child opens a structured learning environment.

It has been argued, that external power should be provided at the earliest age at which such a prosthesis will be tolerated. It has been argued, that external power should be provided at the earliest age at which such a prosthesis will be tolerated. It has been argued, that external power should be provided at the earliest age at which such a prosthesis will be tolerated. It has been argued, that external power should be provided at the earliest age at which such a prosthesis will be tolerated. It has been argued, that external power should be provided at the earliest age at which such a prosthesis will be tolerated.

BODY POWERED DEVICE

Existing cable driven devices have finite step grip force adjustments provided by springs. Because the drive geometries are simple, operation by the very young can be difficult. The initial closing or opening force has to be set low and this means that the device does not have a very useful grip. However, with the advent of mechanical design software for computer aided design, linkage simulation can provide 'designer' inputs and outputs. Figure 1 gives a sense of how the new gripper used these techniques, providing reasonable grip forces at low openings. The design of the new gripper was a joint effort of the University of New Brunswick and the Open Prosthetics Project.
These devices illustrate some of the considerations used when designing for the developmental patterns of paediatric prostheses. Their design addresses developmental stages between the ages of four months and four years, not only by size changes, but also with the provision of a variety of control options.

REFERENCES