

## Modular prosthetics—a philosophical view\*

J. FOORT

Department of Surgery, Division of Orthopaedics, University of British Columbia, Vancouver.

### Introduction

This will be my definition of a *modular system*: "A system of elemental parts which can be combined in a variety of ways to arrive at the functional entity desired from among a variety of functional options which the system allows". The fewer parts required for the greatest variety of options, the more efficient is the modular system. (Imagine a system that could be adapted to both prosthetic and orthotic applications!). In prosthetics, the term modular is almost synonymous with tubular or endoskeletal structures. These designs have their origins in experimental devices such as the universities in the United States were making as far back as the 1950's. At Winnipeg, where the first system went into clinical use, the term "pylon prosthesis" was replaced with the term "modular prosthesis" when that term gained favour. The more recent designs are the systems we think of as modular now. I will accept these as representative of the modular concept, but not without discomfort. I believe other approaches would be more viable and should be entertained.

What I will do now is look at modularization from a variety of viewpoints so that users and designers may approach a little closer should they wish to improve or replace the current designs. Viewpoints considered will be those of;

- 1) the designer
- 2) the prosthetist
- 3) the amputee
- 4) the institution
- 5) the paying agency
- 6) the citizen.

### 1 The designer

The designer wants to make things easy for himself by designing a system which is (a)

efficient in operation; (b) reliable over a long time span; (c) easy to put right when it goes wrong; (d) easy to manufacture. In order to meet such criteria he will adopt everything which is already available and tested for use in his system. For example, when the Winnipeg system was designed, the Berkeley pneumatic swing phase control unit was modified and used, the modification being related to the production requirements of the local manufacturers; the Northwestern University Hip Disarticulation Joint was included by the addition of a simple part; the wedge disc alignment method, modified to suit the system being designed, and the SACH foot were adopted. Tubing already in use in the Berkeley designs and hose clamps from the automotive industry were also adopted. The system was designed without other input. In addition the designer *must eventually* consider all of the people who will come in contact with his system, anticipating the different needs they have. However, the wants and needs are not immediately known. Experience *with* a new system precedes opinions *about* such a system. This means that a design must evolve over a period sufficiently long to allow formation of judgements and the resulting inputs. Only when a total picture has been formed can the designer finalize the system. Thus, the designer expects the system to "grow", expects feedback, and expects a certain degree of tolerance from those who commit themselves to having such new systems developed.

### 2 The prosthetist

What the prosthetist wants may vary according to his clients or those who influence the course of treatment and maintenance care. When I went to Winnipeg in 1963, I faced the incoming stream of amputees essentially alone,

---

All correspondence to be addressed to Mr. J. Foort, Department of Surgery, Division of Orthopaedics, University of British Columbia, 2740 Heather Street, Vancouver, B.C. Canada V5Z3J4.

---

\*Based on a paper presented at the ISPO International Course on Above-knee Prosthetics, Rungsted, November, 1978.

these were new amputees undergoing rehabilitation and entering an overloaded system. A system of prosthetic components was needed which would allow me to attach plaster sockets, temporary plastic sockets and definitive sockets; a system that would be sufficiently cosmetic to be acceptable to amputees and others who dealt with them at each stage; a system that would be included throughout the entire process from early initiation of rehabilitation to discharge and follow-up. My function as a prosthetist was to;

- (a) reduce the time it took to initiate prosthetic management of the patients,
- (b) accelerate the process once management was started
- (c) speed up and simplify the process rehabilitation,
- (d) improve the quality of prosthetic management.

I saw modularization comparable to that used in experimental devices as the answer. At the time, the only devices available were the standard Berkeley Adjustable Legs; heavy, clumsy, designed for short term and intermittent use, and unsuitable for out-patient use. The alternative needed would be readily available, fast and easy to adjust, inexpensive, functionally acceptable, durable and sufficiently cosmetic. In the beginning, the system designed was too fragile for use except within the hospital, however it was gradually improved until it was possible to make definitive prostheses using the various components for a large proportion of the amputees being served. Criticisms relating to noise, failures, damage to clothes and appearance were overcome sufficiently to allow use of the system as the major procedure in the treatment scheme. Other criteria met included fitting under clothes unobtrusively, being tamper proof, being sufficiently light-weight, being no more expensive than functionally equal alternatives and being easy to manufacture. Besides meeting these sorts of requirements, before the prosthetist is satisfied there is one more important factor. The system must be sufficiently *universal* in application before he can risk committing himself to it. New systems which face the world alone often fall over this rock. A prosthetist facing a system which he has not experienced before and for which he has no parts can be thrown into confusion when faced by it on a prosthesis from another region. He may try to talk the amputee seeking help out of it or refer

him back to distant lands for maintenance. The prosthetist wants something familiar and available. That is why he wants to be introduced to a new system (whether he knows it or not!) by means of a co-ordinated effort which includes him, the designer and the educator.

If we consider systems now available and think in terms of what the prosthetist might demand of them, I would say that his main demand would be for a system which will not threaten his relationship with his client. He will not go on using devices which fail to meet such criteria as I have indicated. The system must stay mechanically and cosmetically viable for the longest period of time, be easy to use, be easy to maintain, etc. The people who will benefit from using the system in their prostheses must be sufficiently numerous to make stocking of parts and systems practical. Or alternatively, he must have quick and easy access to the parts and system. While he accepts that *the criteria for using the system for prescription purposes are defined by those people on whom the system works well*, he cannot afford to scatter his efforts among many systems which all do essentially the same thing. Considering that the bulk of the amputees passing through a service where modular prosthetics can be used are geriatrics, there are reasons for optimism with regard to modular systems. The prosthetist will accept them for the suitable cases when his job is made easier and that is something the designer and producer must take seriously.

### 3 The patient

The patient wants a system which is;

- (a) very cosmetic
- (b) very light weight
- (c) never fails him
- (d) noise free
- (e) adjustable by himself, and which he can maintain to some extent, and why not?
- (f) quick to service
- (g) low cost
- (h) offers a variety of functions from which to choose
- (i) organized to permit him to change sockets for improving his comfort
- (j) organized to stay with him through all phases of his management and follow-up care
- (k) organized to introduce no hitches in the various stages of his care.

#### 4 The institution

Modular prosthetics suits institutions, such as Rehabilitation Centres, very well. All of the patients needs can be met right in the centre. In my Manitoba experiences I found that the managers were enthusiastic for getting the patient through the process smoothly. To them, the less visible the process and the prosthetists were the better they liked it. In fact, I got the feeling that if a system could be devised which would eliminate the prosthetist some would be even better pleased. The prosthetist can hold a prominent position in rehabilitation more by facilitating passage of amputees through the system than by providing various and novel options. When the managers in Manitoba saw how easily the modular system could facilitate the process they were keen to have the prosthetic services within the institution. What they discovered was that prosthetics was a small enough part of the array of needs that are met by such a service that the modular prosthetic system was not enough. What was needed was *total modularization and standardization*. This would utterly suit institutions. Cost is not the problem so much as speed. Nothing must bog down the flow. Follow-up must be unproblematic and undemanding, otherwise the growing cadre of "treated" patients will return to retard the process. Designers must be aware of such factors and make their designs suit the needs of various institutions within which the systems will be used including home and work-place.

Managers prefer a single system which has a predictable cost and which can be made available without controversy or delay. They do not want to be confused with a variety of terms and descriptions. Designers can satisfy this need to quite an extent. I feel that designers have been remiss in not developing the various modular systems along lines which make the systems compatible in terms of interchangeability of parts and functional elements. An example of what *should* be done is illustrated by the Winnipeg designers who are making their polycentric knee compatible with the Bock system. But see how it is; various pipe sizes; various bolts, nuts, screws; different alignment methods; different attachment systems, clamps, locks. What a hodge-podge! No wonder the concept moves slowly into service. There must be greater integration, more coherence and a minimum of parts covering a maximum of

situations before the institutions can embrace modularization more securely.

#### 5 The paying agency

When the state or other agency pays for the service which might include provision of modular prostheses, what is most wanted is predictability. When users complain or costs vary the agencies become resistant. Designers must aim to overcome such difficulties through design. Nor can the agencies be expected to initiate services along new lines, they are essentially conservative, perhaps necessarily so. The demand must come from without. Only when it can be demonstrated that the agencies will *gain* from use of a system without penalty to their clients will they shift from one system to another or include an additional system. But the paying agencies have real stake *in finding out!* Therefore, they should, along with the institutions which would carry out the processes necessary, support evaluation programmes with their funds for new things, including modularized prosthetic systems.

Correctly developed, modular prosthetics will decidedly be to the advantage of the paying agencies.

#### 6 The citizen

The citizen hardly cares. He pays willingly for an adequate service because it is an infinitesimal part of the costs of living, also, he is not unsympathetic. His views of any assistive device relate more to how it distracts him from any illusion he prefers to maintain. Thus, he will see prosthetics as a limp or a noise or a bulge, and we can say, his interest is primarily one of cosmetics. This is where modular prosthetics is falling down too. The state must give the needed support for the solution to such aspects of the problem as the manufacturers cannot solve. Designers must be supported while the problems are being solved. As far as the amputee goes, speaking from the point of view that he too is a citizen, he has a right to expect that better systems be developed with community or state funds. He has a right to regain lost function, have improved comfort and gain or remain in social dignity. To view the shortcomings in modular systems one need only think of women and children or to think of the working man in relation to modular components. At least we have seen a move

toward soft covers. Soon the Winnipeg Carver will make a restoration in a more automated way, on demand for widespread distribution, giving a product very nearly matched to the natural contours of the missing limb, possibly leading us to banks of prefabricated covers for a

certain proportion of the amputee population. But other options are required. The hard user will not accept soft covers which disintegrate within weeks. Designers must pay attention to the development of two piece systems to add to the developing armamentarium.