Newsletter...

Prosthetics and Orthotics Clinic

Vol. 2, No. 3 / 1978 Autumn (Issued Quarterly)

Concerning Externally Powered Prostheses

The first issue of Volume 2 of the Newsletter contained an article that outlined the history of externally powered prostheses and posed the question "why aren't externally powered devices generally available to patients in the U.S.?"

The next issue contained an article by Michael Quigley stating that in his opinion the primary reasons were that prosthetists have not yet had available adequate training as well as the high costs of components, and suggested that specialized regional centers be established to meet the needs of those patients for which externally powered prostheses are indicated.

The following article and letters were received in response to these two articles.

EXTERNALLY-POWERED UPPER-LIMB PROSTHESES

AN AMERICAN DILEMMA

The discussion by A. Bennett Wilson, Jr., in Vol. 2, of the Prosthetic and Orthotic Clinic Newsletter is an excellent historical summary of the saga of externally powered upper-limb prostheses. Ben Wilson has brought to this forum an abundance of personal knowledge about the development of these devices that can only be known by one who has been intimately involved with the problem. I think it also raises the question, when one considers the present state of the art and the availability of American made components why more could not have been done and is not being done.

As one who has been intimately involved in the treatment of patients with upper-limb deficiency for the past 17 years, I have experienced the frustrations that are unique to this area of medical delivery. In the Juvenile Amputee Clinic at the D.C. General Hospital, in Washington, D.C., we have cared for almost 300 children with one or more limb deficiencies. I remember, vividly, when I first began this work in 1961, telling parents that in five years we should have available for the child (bilateral upper amelia), a good set of externally powered arms. Much to my chagrin, five years later we were unable to deliver this needed service to a degree that satisfied the patient or the Clinic Team. After 17 years, there are still unfulfilled expectations.

One then has to ask the question, why has there not been greater progress in the United States? Research money has been available, to a limited extent and powered arms have been developed. These events have been developed historically by Ben and will not be reported in any depth here. I would mention the Michigan Feeder Arm, which was a very useful arm for the purpose of eating, in the young age group. Once the child became older, there was no model available. The Michigan Electric Hook was developed out of a similar need and can be purchased commercially today. We are using, at the present time, a number of these in our clinic. The Coordinated Arm, developed at the Ontario Crippled Children's Center, and which succeeded the feeding arm, can be purchased from a Variety Village in Toronto, Canada, but the problem is that this unit is suitable only for the younger child. There is literally nothing as good as the Coordinated Arm available for the older child or adult.

Another approach we have utilized is the combination of the OCCC electric elbow with the Michigan electric hook, in what we have termed a "Hybrid" prosthesis. Today, our experience has been satisfactory, as we are able to combine both units to operate with a single electrical system, supplied by one battery. Even under these circumstances, it is very difficult to import the electric elbows from Canada. The cost is not inconsequential, when one considers that the purchase of both items will be close to $1,000 and then one has to consider the cost of fabrication.

The net result is that unless one is extremely zealous, it is not possible

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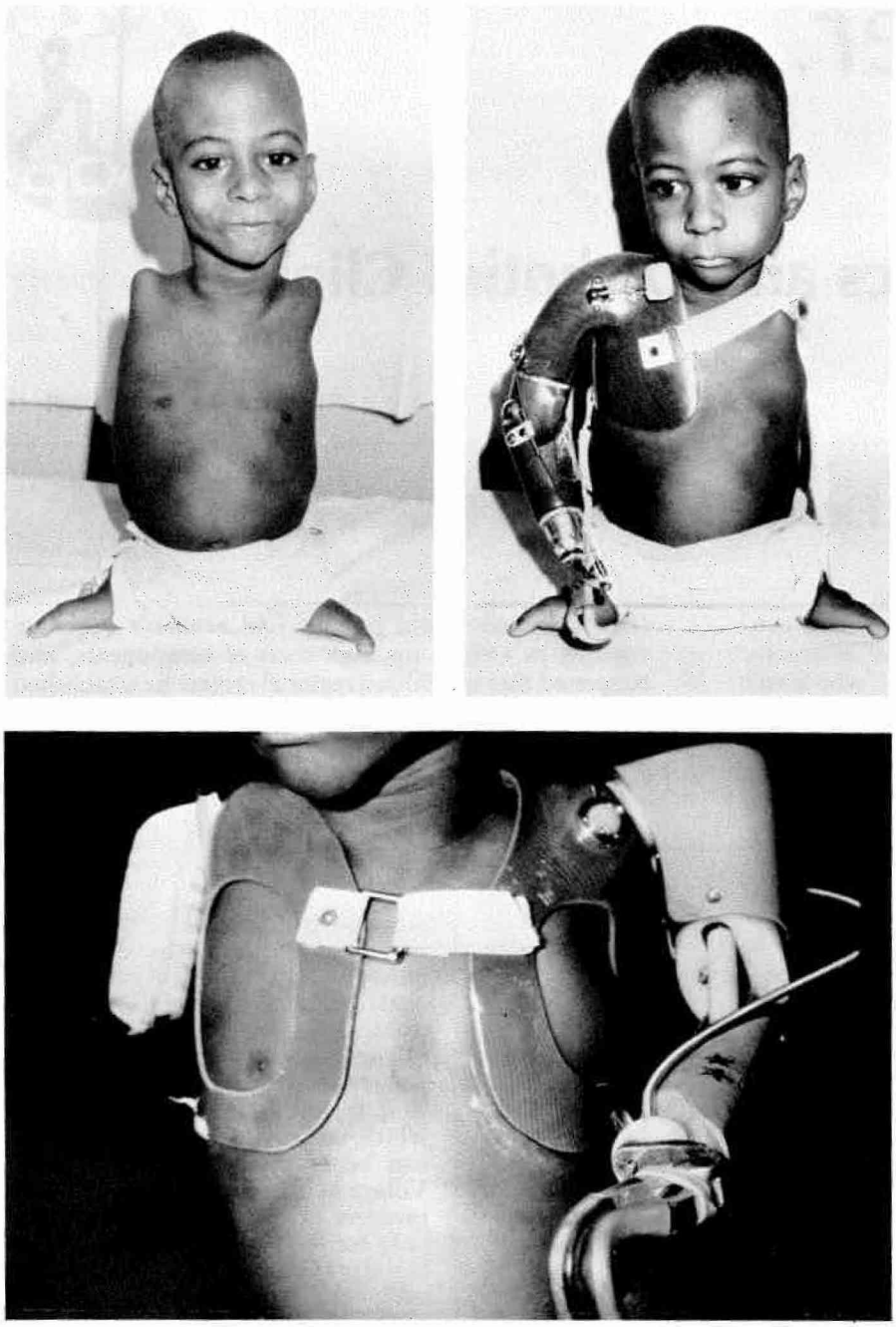


Fig. 1. This male was born with bilateral upper amelia and lower complete phocomelia. After acquisition of sitting balance, he was fitted with a shoulder disarticulation type prosthesis with nudge control for elbow lock and unlock and with terminal device and forearm lift control by chest expansion. At age five, a Michigan Feeder Arm was applied, and his feeding time and ease of eating were enhanced.

to supply children with severe limb deficiencies with externally powered devices. When they are supplied, there are mechanical problems, electrical problems, and frequent repairs are necessary. The "down time" is considerable. For this reason, many clinicians and patients have been discouraged and have abandoned use of these devices.

It is ironic that the greatest development has been made for the patient with the below elbow deficiency. The Otto Bock System is available in a number of sizes and provides excellent cosmesis and function. Our experience has been satisfactory with this device. The cost, however, is considerable and this may be one reason that this prosthesis has not been applied extensively in this Country, in spite of the fact that there are large numbers of children with below-elbow level deficiencies. It is also a fact that below-elbow patients function quite well with body powered equipment. In either case, American industry has not been at the forefront. The majority of commercially available devices today have been develop in Europe or Canada.

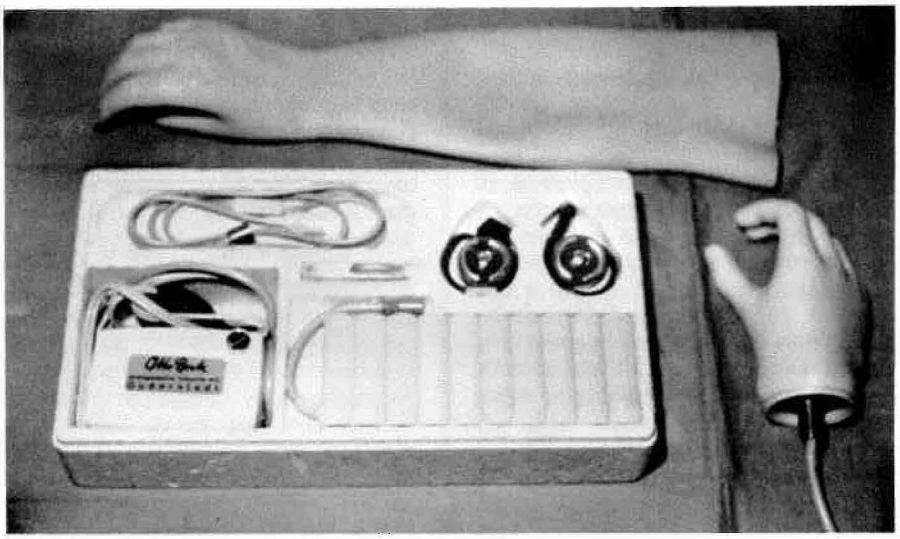
I recently had the opportunity visit Doctor Rolf Sorbye, in Oreb Sweden, who in collaboration w Systemteknik has developed an e cellent below-elbow self-containe self-suspended prosthesis, usi myeoelectric control. This devi has been fitted to a number of ch dren as young as 18 months and t results are extremely promisin Two prostheses are fabricated f each patient so that there is n "down time" when one prosthesi becomes inoperative and need bench repairs. The cost per patient therefore, is approximately $6,00 for the pair of arms. There is unde development, at the present time, i Sweden, another multi-functional hand (also for the below-elbow level), which will provide powered function for grasp, release, dorsi- and palmar flexion of the wrist, and supination and pronation of the forearm. The project is funded by a joint effort on the part of the Swedish Government and private industry. It is unfortunate that we have not been able to have a similar effort in this Country. Dr. Dudley Childress, at Northwestern University has developed an excellent self-contained, self-suspended below-elbow system, using myeoelectric control. The fact of the matter is that this and similar devices, developed in this Country, have not found a manufacturing outlet for disbursement. It is, therefore, a financial matter that in the face of limited demand the manufacturers cannot produce these items at a cost that will make it profitable. It seems to me, therefore, that this is an area, where the Government should intervene and subsidize this effort. There are numerous precedents throughout industry in this regard. The railroads, the airlines, and the shipbuilders have been subsidized. The renal dialysis program is one health area where Government is presently providing a subsidy. The precedent is there. There also needs to be an effective lobbying effort mounted, not only by the profession, but by the affected individuals, that is, patients and their parents. I believe that this is the essence of the problem. The technical "know how" is available but what is lacking is sufficient funding to make these devices in sufficient numbers so that they can become available to patients. It is fortunate that there are not a large number of patients. Ironically, were there large numbers of patients and a large demand, then the cost, of course, would be reduced. In the absence of this unfavorable manufac-

turing circumstance, subsidies must be given to industry so that the necessary devices can be produced and made available at reasonable cost.

Another aspect of the problem, which is paradoxical, is that there has been so much effort put into the below-elbow level, where the need, as I see it, is not nearly as great as it is in the above-elbow and the shoulder-disarticulation levels. The patients with more proximal limb deficiencies are greatly in need of externally powered devices. Yet the powered devices that are available for the proximal cases, are not the most efficient. The available commercial items, even at great cost, are not representative of the best technology available in this country, today. This can be partially explained by the fact that the numbers of patients affected at the higher level are substantially less than those at the below-elbow level. It is also natural to work on problems where success is more readily obtained. The challenge is there at the shoulder-disarticulation level and the above-elbow level, where these patients desperately need more function. There is need in this country for a concerted effort to develop and provide powered arms for patients with the more proximal limb deficiencies. It is a blight on our record as a nation, with such sophisticated technology and industrial and productive capacity, that this area of human need has been so long unfulfilled.

by

Charles H. Epps, Jr., M.D.
Professor and Chief, Division of Orthopaedic Surgery, Howard University, Washington, D.C.



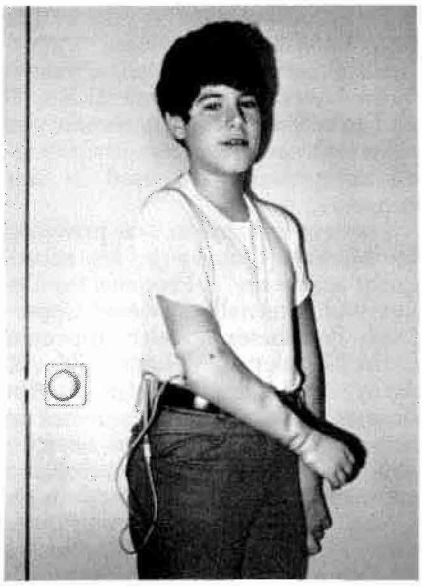
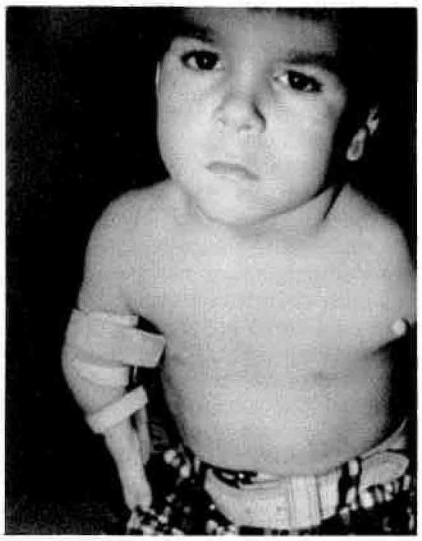
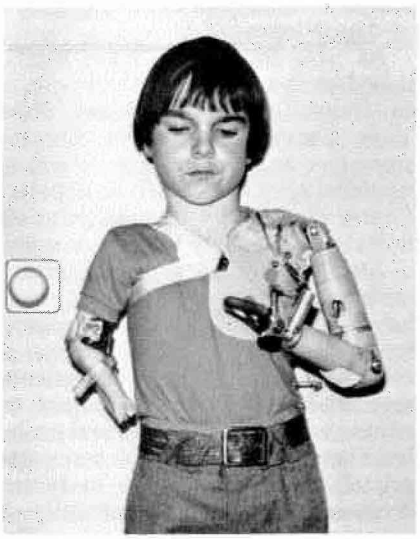


Fig. 2. A fourteen-year-old with partial transverse hemimelia fitted with a Otto Bock Myoelectric hand that is available in a kit as shown. The battery pack can be attached to the belt. The shirt covers the wire and the socket resulting in excellent cosmesis.





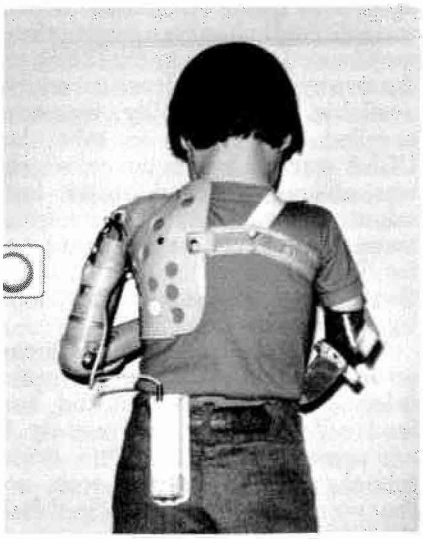


FIG. 3. This youngster with right upper phocomelia and left amelia was given an opposition post early. A standard left shoulder-disarticulation prosthesis provided little function. A hybrid system utilizing an OCCC electric elbow and a Michigan Electric Hook, provides greater function. Both units are powered by one battery pack.

Dear Mr. Wilson:

I would like to express my appreciation for your continuing efforts to get externally powered prosthesis into common practice. The feeling I presently get from practitioners is that external power is too expensive and too experimental to warrant the investment of time necessary to be able to fit such devices. I find it sad that such a powerful tool for rehabilitation is often ignored because it is new, and I hope by all our efforts we can improve the delivery of these systems.

We are presently fitting a VA Fidelity powered elbow-hand system and have found patient acceptance and quality of this system quite good. A proportional control system for the elbow and noise reduction are the only things needed to make this an excellent system.

Although we have not used the Bock system, it appears to be quite good and well packaged to make it easy to fit. These two systems have the potential of satisfying most of the amputee population once they come into wider use.

One other system that appears to have been ignored is power assist units for conventional arms. One such system was outlined by Prior in *Bulletin of Prosthetic Research*, October 24, 1978, page 43, which to me seems to have great merit, since it uses standard components and techniques to a large extent.

In your article you outlined the development of external power. I found this useful as I have only been in the field three years. The main problem you stated in the article was the lack of a good system for external power, but I would disagree that this is the problem. My main difficulty has been to get information and training in the fitting of the two systems which are currently available. At our facility, we were enrolled three times to take the UCLA external power course which was always cancelled at the last minute. I have found this very frustrating as we had patients lined up for fittings after the course, and they, as well as I, were disappointed by the cancellation.

I did attend the seminar in Chicago last summer and found it most informative. However, it did not lead to VA certification. Presently, I am signed up for the Otto Bock school, after a two year wait, so that we can fit that system. So, I feel that if the training were improved the systems available would satisfy most of the need, or at least show the direction research needs to take.

To conclude, I would like to see the academy (AAOP) take an active role in prompting the education for external power since from my standpoint, at least, it has been very hard to get information on systems in use.

Yours truly,

Wayne K. Daly, B.S., C.P.O.
Webb's K.E. Karlson Co.
Portland, Oregon

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Dear Mr. Wilson:

I wish to comment on your article on "Externally Powered Upper-Limb Prostheses," which appeared in the Newsletter, Volume 2, No. 1, and to respond to the question you raised why so few externally powered components are used in this country.

I believe the answer was provided by Michael Quigley in his subsequent article on "A Proposal for Delivery of Externally Powered Upper-Limb Prostheses," which appeared in the Newsletter, Volume 2, No. 2. As he states, the average prosthetist does not gain enough experience in fitting externally powered devices, and, therefore, cannot develop the competence and sophistication required to adequately fit these prostheses. His suggestion, with which I wholeheartedly agree, is to establish specialized fitting centers which are able to handle a sufficient volume of arm amputees and which have a total team available to evaluate prospective users of externally powered prostheses.

As you know, we have established such a center at the Institute of Rehabilitation Medicine, New York University Medical Center, some five or six years ago, which is modeled after the INAIL Prosthetics Center directed by Hannes Schmidl in Italy. We believe that this success in fitting externally powered upper-limb prostheses, which we, too, have experienced in our fitting center, is based on two factors: one, a relatively large volume of patients seen leads to increased expertise in coping with complex technical problems and, two, the total team approach employed results in better screening of patients. Specifically, a prospective patient for an externally powered prosthesis is seen by a team consisting of physician, prosthetist, physical therapist, psychologist, social worker, vocational counsellor and occupational therapist. This is done on a one-to-one basis; that is, the patient is not seen in a so-called "clinic" atmosphere: rather, he is seen by the team member on an individual basis. The major advantage of this approach is that the patient can relate his or her problems to the team member in a way which may not be possible if the patient is confronted by the team as a whole, as this might inhibit the patient. Such evaluation generally will require an entire day, which is followed by a clinic team meeting the next day without the patient present. A decision as to whether the particular patient is a candidate for externally powered devices is based on the reports by the individual team members and which must be positive.

I feel that only in this way the success and more widespread use of externally powered upper-limb prostheses can be enhanced. Or, to put it another way, technical sophistication, as is possible today, must necessarily require greater prescription sophistication engaging the various rehabilitation disciplines. The success in fitting externally powered upper-limb prostheses, in our experience, is not necessarily attributed to better hardware, but rather to careful, individualized pre-prosthetic evaluation.

Sincerely yours,

H.R. Lehneis, Ph.D., C.P.O.
Director
Orthotics and Prosthetics
Institute of Rehabilitation
Medicine
New York University

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Dear Mr. Wilson:

Your review article in the last issue of the *Newsletter* was of considerable interest. I particularly appreciated the excellent picture of the Vaduz hand.

Your question concerning why powered limbs are so difficult to obtain—except for the below-elbow electric hands—is without a simple answer. However, at risk of controversy and oversimplification it seems to me that these limbs will be available as soon as Otto Bock or some other major prosthetics company markets the powered components. This is not to saddle industry with the problem, because several companies have been very progres-

sive in this area. Rather this statement is made to point out that until powered systems are produced and sold by a prosthetics company which can back them with technical knowledge, maintenance organizations, education programs, and promotional material they will not penetrate very deeply into the general practice of prosthetics. However, when people are trained to fit the systems to amputees and when these people have confidence in the systems as well as in the supplier's ability to help with problems, the systems become readily available.

Why then aren't more powered upper-limb systems being manufactured? There are perhaps several reasons for this. (1) It may not be economically feasible to manufacture and sell the systems. (2) The systems or components available or being developed may not be of sufficient functional quality to warrant production. (3) The sometimes whimsical nature of human affairs does not always bring a good component and a manufacturer together; or at least do not bring them together under optimal conditions at the proper time.

The economic problem will likely be around a long time. One solution is for people in research and development work to attempt to design systems which have high probability of being manufactured at a reasonable cost. Of course, another solution would be for government agencies to step in with their purchasing power, but who can say they would make better decisions than those of the private marketplace?

The functional quality of a powered upper-limb systems will also be a continuing problem. I am a reluctant apologist for the field of powered upper-limb prosthetics, because progress does seem slow. Nevertheless, when one contemplates what this field is attempting, one can readily realize the difficulties. Sidney J. Harris, now of the Chicago Sun-Times, has said, "Computers may soon replace many people who work with their minds; but nothing can replace that finest tool of all, the human hand." In upper-limb prosthetics, we rather foolhardily try, even though we know lack of perfection in the prostheses severely limits their widespread acceptance and availability.

Getting research and development (R&D) work transferred effectively to business enterprise is also a difficult problem. Some companies do their own R and D, and this makes the best connection with production. Organizations (CPRD) can perform an important service here. This group was able to take some of the randomness out of the field (reduce the entropy, so to speak) so that bridging the gap between R and D and production was not completely haphazard.

On a positive note, let me say that progress is being made. Private prosthetists here in Chicago now fit powered elbows (child size), powered wrist rotators, and powered hands. Ten years ago this would have been unheard of. This progress is also evident in many other locations of the United States and Canada. We have a long way to go, but a beachhead exists.

Sincerely,

Dudley S. Childress, Ph.D.
Director, Prosthetics
Research Laboratory
Northwestern University

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Dear Mr. Wilson:

The conclusion which Mike Quigley has reached to provide externally powered prostheses is not a solution. It is a conclusion. And it is one which determines on the face of very few facts that difficult problems should be referred out of the general practice of prosthetists. This referral to one of a proposed four centers would increase the efficient service and expertise available to the patient. The prosthetist refers away a problem and the patient receives better service. A nice package. It needs thinking about.

Anyone involved in the development of externally powered prostheses and orthoses, regardless of their professional background . . . prosthetist, engineer, physician, therapist, or any of the vast group of "interested folk" . . . can state very few absolutes about the current technology. In fact, this level of technology is, by its nature, at the same time highly sophisticated and profoundly primitive. It is the kind of thing, research thing, which one must continue to do until there is some clear understanding of the mechanisms involved to obtain the desired results. When that level of understanding is obtained, the technology will no longer present the problems of logistics, cost, and ethics that it presents today.

It is baffling how organizing centers always sound so appealing and solves so little for the proposed beneficiaries. Boston is an easy one day drive from Baltimore. It is a scant 45 minute flight. Yet, for all the convenience of our transportation system, there are no patients in Baltimore who look forward to a trip to Boston for an adjustment to a malfunctioning prosthesis. They don't want to spend that much time to have something fixed. Neither do their employers want to give them the time. The system does not work for the patient or the center. The whole thought is so premature. The media has blasted us with each new advance that has been made. The public is convinced the technology is available on a useful scale instead of the makeshift that it really is. We have a developed technology and we are going to use it, regardless.

The proposed system would limit the number of people currently attempting to develop powered prostheses to a manageable, meaningful level for the patients involved. A single mind is a terrible thing to waste, but it is absurd to eliminate all the thought processes of all the prosthetists, orthotists, engineers, physicians, and therapists from the necessary evolution of externally powered prostheses. All, that is, except those chosen few. The Washington planners are good at this kind of organization. It is referred to as the bureaucracy and it is as much a part of American life as apple pie. If the choice were mine, I would take some of the pie and pass on the bureaucracy.

This kind of organized science stifles the imaginative. Before we decide what to do about externally powered prostheses, we had best extract something of value from them. As the research progresses, there are constantly pieces in need of better control, more efficiency, less unpredictability. Conclusions to determine how to utilize the developments cannot be made until the developments themselves have been lifted through the current level of concurrent disagreement and amazement. The technology thus far developed for externally powered prostheses needs all the help it can get to do this. It does not need to be limited in centers. It must be expanded. The leaves of a tree do not thrive when the roots are not called upon to work.

The history of prosthetics and orthotics clearly illustrates that beneficial technology evolves out of the existing system. It is not, cannot be

injected as attempted by the V.A. study. If you take a perfectly healthy human being and inject him with snake venom, it will certainly make him sick. The same holds true if the information allotted to complete an assigned task is misleading, incomplete, or the material itself faulty.

If, as I am suggesting, the good ideas evolve, how can it be controlled? It cannot. It must not. Development of acceptable levels of technology is a collective enterprise. Information is scattered, dissected, reassembled, disassembled, scattered and the process is repeated over and over again. It does not take long for the evolution to work. Lewis Thomas, president of the Memorial Sloan—Kettering Cancer Center in New York, has a theory on the evolution of technology. He states, "What it needs is for the air to be made right. It you want a bee to make honey, you do not issue protocols on bees (and you'd better do this quickly, for solitary bees do not stay alive) and you do what you can to arrange the general environment around the hive. If the air is right, the science will come in its own season, like pure honey."

Sincerely,

C.H. Dankmeyer, Jr., C.P.O.
Dankmeyer, Inc.
Baltimore, Md.

Dear Mr. Wilson:

I found Mr. Quigley's article, "A Proposal for Delivery of Externally Powered Upper-Limb Prostheses," which appeared in the Newsletter, Vol. 2, No. 2, not only of interest and in agreement with my own philosophy on the subject, but also with regard to his comments on the hook-versus-hand prescription for new amputees. The philosophy of prescribing a hook first, which was established shortly after World War II and unfortunately is still part of the training programs for physicians and surgeons, prosthetists and therapists, is one in dire need of revision.

As we all know, since that time there have been many social and economic changes which should be considered in the prescription of any prosthesis. While it is appreciated that before the institution of Medicare and Medicaid and other social agencies, the vast majority of amputees needed the most functional terminal device to be vocationally competitive. Today, with the advent of numerous social institutions, this is no longer necessarily true as patients can be retrained and be financially supported. I totally agree with Mr. Quigley's statement that most amputees do not want a hook, but rather wish to be fitted with a hand terminal device. I believe, with due consideration for the social changes that occurred over the past twenty or so years, that it would be appropriate to reconsider prescription of prosthetic hands, when the patient so desires, which particularly with myoelectric control, have been vastly improved, rather than forcing a new amputee to wear a hook terminal device first.

One can assume that the psychological trauma of the loss of an upper limb, which, in general, is far more severe than the loss of a lower limb, is likely to be aggravated by having to wear a hook, which represents an obvious badge of disability. This is not to say that the hook terminal device should be discarded, but rather that the patient should be given a freer choice based on his vocational goals and psychological make-up, and be included as a team member in the prescription of his or her prosthesis.

Sincerely yours,

H.R. Lehneis, Ph.D., C.P.O.
Director
Orthotics and Prosthetics
Institute of Rehabilitation
Medicine
New York University

Editorial Comment

"Major Factors Surrounding the Reader's Viewpoint"

A careful analysis of Dr. Epps paper and the letters indicate two major points that we agree upon:

1. Manufacturers need to be subsidized in order that new developments can be made available at reasonable costs.
2. That more knowledge is needed by prosthetists and other members of the clinical team in application of what is available.

Mr. Daly points out the problem of acquiring the information and skills necessary to manage these patients properly.

Dr. Lehneis describes an interesting screening process that at first appears to be costly, but actually could be more effective and efficient than our present methods.

Mr. Dankmeyer certainly makes some valid arguments for more participation by practicing prosthetists throughout the country and against the center concept proposed by Mr. Quigley. We hope to hear more on this subject, especially from Mr. Quigley.

What surprises me is that none of the respondents brought up the possibility that the function of externally

powered devices by-and-large lack the sensory feedback provided in the body-harness systems and that perhaps if this were corrected the acceptance would be higher, the market would be greater, and the price would be lower.

I am also surprised that no one suggested that in order to reduce costs it might be appropriate to develop a national plan for manufacture (as well as research and development) of externally powered devices. If the clinicians could agree on a limited armamentarium, from the various units available, I should think that a government subsidized program could be justified and executed. At the same time a national plan for research and development could be put into operation that would eventually provide the next generation of devices and techniques, that in turn would provide "more for the money." A resolution of the points of view set forth by Messrs. Quigley and Dankmeyer would certainly be a part of the national plan.

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Concerning the Next Issue

"Immediate post surgical fitting of prostheses"

Partly because of the good response on the part of readers to the articles on externally powered prostheses we are not publishing a lead article on a new subject this month, but it is our intention to have the feature article in the next issue discuss immediate postsurgical fitting of prostheses. Meanwhile readers are invited to send in comments and observations on this subject as well as comments and observations on the essay that appeared in the previous issue by Charles Pritham, "Concerning Suspension, Alignment, and Control."

The Editorial Board also welcomes any comments concerning orthotics and prosthetics as well as to how this publication can serve clinicians better.

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NOTICE OF TECHNICAL MEETINGS AND SEMINARS

American Academy of Orthotists and Prosthetists Seminars

1979, Jan. 25-27, AAOP Round-Up Seminar, Konover Hotel, Miami Beach, Florida

1980, AAOP Round-Up Seminar, Palm Springs, California

Other Agencies and Organizations

1978, October 31-November 4, AOPA national Assembly, Town & Country, San Diego, California.

1980, June 22-27, World Congress of Rehabilitation International Winnipeg Convention Center, Winnipeg, Canada.

1980, AOPA National Assembly, New Orleans, Louisiana