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Education in prosthetics and orthotics

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Historically most of the truly competent people who have become skilled in all phases of the prosthetics and orthotics field have achieved this position by self-study, reading and discussion, participation in meetings, and a varied clinical experience; all of which was preceded by a vigorous and stimulating apprenticeship during their early formative years which contributed to these desirable patterns of work and study. Others, however, have been less fortunate in their personal attributes and preparation; consequently, they have few significant contributions to make in any area of prosthetics and orthotics and in fact do not provide acceptable service.

Variation in ability between people engaged in a profession is to be expected and is a good thing, but in the field of prosthetics and orthotics there is far too much difference between the capabilities of various practitioners. This disparity may be attributed to the fact that there has been a lack of orderly, organized, systematic training and educational opportunities in which all prosthetist-orthotists could participate prior to their entry into this field. Consequently, the level of a person's professional ability is more dependent upon chance exposure to various experiences than on a planned educational programme designed to transmit efficiently the cumulative knowledge of the profession.

One of the major purposes of institutionalized training in the field of prosthetics and orthotics is to minimize this variation in professional abilities and to assure that every qualified prosthetist-orthotist displays a minimum competency in all phases of his profession.

Before discussing a programme for the education and training of the professional prosthetist-orthotist, it would be well to review the responsibilities and functions of such individuals. In summary terms, the three pervasive responsibilities of the professional prosthetist-orthotist are:

1. To serve as a co-equal member of the clinic along with the physician or surgeon and therapist providing consultative advice; to participate in discussions and share in decisions regarding prescription, evaluation, and formulation of the prosthetic-orthotic treatment programme.

2. To provide prosthetic-orthotic service to patients, which implies all of the necessary intellectual and manual skills (design, measure, cast, fit, align, etc.) required to supply an appliance of excellent quality.

3. To be aware of, and contribute to, the progress and growth of the profession through such means as research and development activities, participating and exercising leadership in professional associations, and recruiting and training new entrants into the field.

It is indeed difficult to summarize all of the skills, capabilities, knowledge and understanding that a professional prosthetist-orthotist should have in order to satisfactorily fulfill these responsibilities. As we consider the matter, it seems that there are six areas of skill and knowledge which are indispensable:

(a) Physical sciences, including mathematics
(b) Biological sciences
(c) Psychological sciences
(d) Mechanical skills and crafts
(e) Communication skills
(f) Personal and cultural qualifications.

Physical Sciences

A mechanic may be defined as someone who performs manual work in the fabrication of some structure or device. As such, the prosthetist-orthotist has functioned as a mechanic for hundreds of years. The shortcoming in this approach is that the mechanic (or technician),

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not being exposed to many of the relevant principles evolving from the physical sciences, is taught to reapply the techniques he has learned in all situations with minimal variation.

Basic physics and chemistry, mechanics (the branch of physical science that deals with forces and energy and their effect on bodies), and properties of materials are the particular areas of concern to the prosthetist-orthotist. Fundamental principles derived from such studies are requisite to the design and production of prosthetic-orthotic devices.

It is also clear that little can be accomplished towards learning and applying these principles without a command of basic mathematics and geometry. Consequently, the study of all of these subjects becomes important.

Biological Sciences

The mechanical product (machine) which the prosthetist-orthotist fabricates must be integrated with a biological entity (the human being). It must be fitted and worn in the closest intimacy to the body of the wearer for the purpose of improving the physical resources of that individual. In view of this, knowledge from the biological fields of anatomy, physiology, and kinesiology is indispensable for the qualified practitioner.

In recent years, we have begun to learn some new things about how the human body functions as a mechanical system. This field of knowledge is called "biomechanics" and the adequacy of efforts at physical restoration is completely dependent upon a grasp of this new science, the principles of which govern the motions of the human body.

Since the patients treated in the prosthetic-orthotic field all have some form of neuro-musculoskeletal disorder, the study of biological science must extend into the areas of pathology and pathomechanics, that is, abnormal as well as normal function.

Psychological Sciences

Since the prosthetist-orthotist creates a product to be worn by a human being, success or failure will be influenced by the opinions, attitudes, feelings, likes and dislikes of that human being. The experienced prosthetist-orthotist knows that in many instances the critical problem in the successful fitting of a prosthesis or an orthosis lies with the psychology of the wearer rather than in any physical or biological problem. The prosthetist-orthotist must, therefore, be capable of understanding and relating to his patients so that he can work constructively with the individual's psychological attributes rather than at cross-purposes. Patients, peers, professional colleagues, and prosthetist-orthotists themselves must be viewed in psychological terms and dealt with in a similar manner.

Mechanical Skills

In spite of the stress placed on the academic and theoretical knowledge required by the prosthetist-orthotist, we do not intend to underestimate the mechanical abilities involved in the fabrication of an appliance. Practitioners must learn the characteristics of the major materials —wood, metal, plastic—and master the manipulative skills which will enable the production of an appliance no less adequate than the one that they are able to conceive.

Communication Skills

The need for adequate abilities in the use of the spoken and written language must not be overlooked. There is no possibility of the prosthetist-orthotist being able to communicate his ideas, opinions and points of view to his patients or to his professional associates without an adequate command of language skills.

Personal and Cultural Qualifications

Lastly, there is the need for the prosthetist-orthotist to be a well-informed, cultured citizen so that in his social and professional behaviour he may be respected as a mature, understanding person in many areas rather than considered a narrowly informed individual.

The personal and personality characteristics of people in professional work are of the utmost significance, since the ability of a patient to accept service is directly related to his opinion of the individual providing the service. It is mandatory, therefore, that the professional prosthetist-orthotist be offered the opportunity for broad educational and life experiences.

We have, then, specified the areas of knowledge from which subject matter should be drawn, and oriented the curriculum content towards the goals represented by the professional responsibilities of the prosthetist-orthotist.

Before turning to the matter of an "ideal" curriculum, several basic assumptions on which the curriculum rests must be mentioned

1. Graduates will practice their profession utilising *prefabricated* prosthetic-orthotic components. Therefore, training in the production of such items as prosthetic feet and orthotic joints need not be offered.

2. The fields of prosthetics and orthotics are not separate and distinct entities. Rather, there is a considerable (and growing) degree of overlap in the knowledge and skill required in both areas. Therefore, the educational programme should offer concurrent training in both specialities.

3. The academic level of the education programme and the value and acceptance of the degree or diploma issued on successful completion of the course of study should be comparable to that of other health professionals (therapists, counsellors, etc.). The training should be offered by an existing, accredited, recognised educational institution at the post-secondary school level.

For some years, we at New York University have been conducting a prosthetics-orthotics education programme to prepare individuals for entry into the field and, because of the considerable thought that has been devoted to it, I will venture to use our own programme as a basis for a suggested curriculum. The courses listed

TABLE 1—SUGGESTED PROSTHETIC-ORTHOTIC CURRICULUM
(4 years)

	Class Hours		
	Lecture	*Lab.*	*Total*
Physical Sciences (including mathematics)			
Algebra and Trigonometry	45	—	45
Introductory Chemistry	45	45	90
Introductory Physics	45	60	105
*Mechanics	45	—	45
*Properties of Materials	30	—	30
	210	105	315 (8%)
Biological Sciences			
Introductory Biology	45	60	105
Anatomy and Physiology	90	30	120
Orthopaedic and Neuromuscular Pathology	30	—	30
	165	90	255 (6%)
Psychological Sciences			
Introductory Psychology	45	45	90
Psychology of the Physically Handicapped	45	—	45
	90	45	135 (3%)
Communication—Personal and Cultural			
English Composition and Speech, Social Sciences, Humanities, Liberal Arts, and other sciences	570 (approx.)		570 (14%)
Manual Skills and Concepts			
Mechanical Drawing	15	75	90
General Metalworking	15	75	90
*Prosthetic and Orthotic Techniques	30	180	210
	60	330	390 (10%)
Professional Specialization			
*Biomechanics	30	—	30
*Above-Knee Prosthetics	40	200	240
*Below-Knee Prosthetics	30	150	180
*Lower-Limb Orthotics	60	90	150
*Upper-Limb Prosthetics	30	105	135
*Upper-Limb Orthotics	15	60	75
*Spinal Orthotics	30	105	135
*Professional Problems in Prosthetics and Orthotics	30	—	30
Clinical Affiliations (supervised practical experience)	—	1440	1440
	265	2150	2415 (59%)
Totals	1360 (33%)	2720 (67%)	4080 (100%)

*These courses are offered in our own facility by our own faculty—remaining courses are given by other departments in the University.

in Table 1 comprise a four-year programme of 131 academic credits with a total of 4,080 hours of classroom instruction (1,360 hours of lecture and demonstration, and 2,720 of laboratory experience). Upon successful completion of the curriculum, the student is awarded the degree of Bachelor of Science.

It is important to note that the last group of courses entitled "Professional Specialization" accounts for approximately 60 per cent of the total number of instructional hours. When the additional 10 per cent devoted to "Manual Skills and Concepts" instruction is added one approaches 70 per cent of the total class contact hours for the specialized prosthetic-orthotic training. This reflects the considerable amount of time required to develop the necessary prosthetic-orthotic skills. However, even with this substantial time allocation, we find it necessary to be very selective and to limit the variety and types of prostheses and orthoses fitted and fabricated by the students so as to assure their unquestioned understanding of basic principles and procedures.

Space will not permit any further discussion of the detailed content of the specialized prosthetic-orthotic courses. It will suffice to point out that considerable agreement regarding the topics to be covered in these specialized courses was achieved at the International Study Week on Prosthetic-Orthotic Education sponsored by the University of Strathclyde, Glasgow in July, 1974 and outlined in the associated publication (Hughes, 1976).

In conclusion it may be of interest to mention briefly that long-term training opportunities are available in prosthetics and orthotics throughout the world. Detailed information on fourteen institutions offering such programmes was identified at the International Study Week. Six of the institutions were in North America, five in Europe, two in Asia and one in the Middle East. There is reason to hope and expect that this number will increase in the years ahead.

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