PROFESSIONAL EDUCATION IN PROSTHETICS AND ORTHOTICS

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Some prosthetist-orthotists are highly skilled and competent in the mechanical crafts associated with their field and others are not. Some are especially competent in maintaining good patient relations, others are not. Another prosthetist-orthotist is particularly adept in explaining his point of view to physicians and therapists with whom he works. Another is well trained in diagnosing the problems of the lower extremity amputee, while still another seems to have a particular competency for work with paralytic children. As a consequence we find many different types and levels of skill among the prosthetist-orthotists of today. Although all of these people have been trained for their vocations, their training in many instances has been fortuitous and extremely variable in type, quantity, and quality, and the resulting diversity in capabilities reflects this wide variation in background.

Most of the truly competent people who are skilled in *all* phases of this 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.

All-in-all, 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, this lack of balance, may be attributed to the fact that there is no orderly, organized, systematic scheme of training and education in which all prosthetists-orthotists 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 any planned educational program designed to efficiently transmit the cumulative knowledge of the profession.

One of the major purposes of college level training in the field of prosthetics and orthotics is to minimize this variation in professional abilities and to assure that *every* qualified prosthetist-orthotist has a minimum competency in all phases of his profession: in the mechanical crafts, in human relations, and in the knowledge of the scientific subjects which provide understanding of the process of prosthetic and orthotic restoration and patient management.

The Prosthetic and Orthotic Profession

Of course, the decision as to what training a qualified prosthetist-orthotist should have depends in a large measure upon what one considers the duties of the prosthetist-orthotist to be. If one views this field as a profession with varied and serious responsibilities for the welfare of the orthopedically disabled patient, one is inclined to recommend a lengthy and arduous period of training for people entering this vocation. If, on the other hand, one thinks of these people as mechanics or technicians who are solely to execute detailed instructions provided them by the physician or surgeon, one can visualize a need for very much less preparation. In this latter instance lesser abilities and training are required.

It is, therefore, important that the reader understand from the outset from which vantage point we view the prosthetist-orthotist. In a previous publication, we have described the field of prosthetics and orthotics as follows:

> Prosthetics is the professional field which is concerned with the design, fabrication and fitting of *artificial limbs*, while Orthotics is concerned with the design, fabrication and fitting of *braces*. The prosthetist-orthotist, starting with measurements, or a cast of the patient's affected limb or body part, selects the appropriate materials and components and then fabricates, aligns and fits the prosthesis or brace to the patient for the purpose of correcting or minimizing the individual's disability.
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> A well qualified prosthetist-orthotist requires a basic knowledge of human biology, especially functional anatomy and physiology, and must be familiar with the principles of biomechanics as a prerequisite for planning, aligning and fitting artificial limbs or braces. In additon to a knowledge of the characteristics and qualities of the materials used in these devices, he must develop skill in the use of hand and power tools so that he can apply his theoretical and technical knowledge to the actual production of prosthetic and orthotic devices. In his daily work, the prosthetist-orthotist utilizes the principles of human engineering in a most practical way.
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> The prosthetist-orthotist works very closely with physicians and surgeons, as well as physical and occupational therapists, rehabilitation counselors and other rehabilitation personnel. His responsibilities require that he be able to communicate and interact effectively with the other professional members of the rehabilitation group. He must also obtain the respect and confidence of his patients. Therefore, an understanding of the general principles of psychology and psychological aspects of disability are most helpful to the prosthetist-orthotist in the interpersonal and interprofessional aspects of his field.

It is clear then, that we use the term prosthetist-orthotist to refer to the professional field involving the design, fabrication and fitting of prostheses and braces with major emphasis on patient care and co-equal participation

as a member of the rehabilitation team. This paper is therefore not concerned with the training of the prosthetic and orthotic mechanic (technician) who functions essentially as an artisan under the guidance of a professional prosthetist-orthotist. Mr. Goldstine's article in this issue deals with the training of personnel for this occupation in some detail.

The responsibility for the welfare of the patient insofar as prosthetic and orthotic restoration is concerned is borne primarily by the prosthetist-orthotist and the surgeon who has prepared the amputation stump or the physician who has treated the orthopedic disability in anticipation of fitting an appliance. Since this is so, we can hardly compromise concerning the quality of service which we expect from any individual who has this important responsibility placed upon him. This fact certainly does not permit the professional prosthetist-orthotist to work independently of, or without guidance of other members of the rehabilitation treatment team, but it does imply that he provides a unique service to the patient which goes far beyond that of a "mechanic" and which no other group in our society is prepared to offer. Since he must provide this service, he must be optimally trained for his assigned tasks.

It is indeed difficult to analyze in any detailed way all of the skills, capabilities, knowledge and understanding that a top quality prosthetist-orthotist should have. As we consider the matter, it seems that there are six areas of skill and knowledge which are indispensible to the proper practice of this field:

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

a. *Physical Sciences*

A mechanic may be defined as someone who applies in a practical fashion, principles drawn from the physical sciences to the fabrication or construction of some structure or device. As such, the prosthetist-orthotist has functioned as a mechanic since the beginnings of recorded history. He has understood on a relatively rudimentary level the properties of various materials and how to utilize them in the fabrication of a prosthesis or brace.

We might then ask what more should an individual know about the physical sciences (physics and chemistry) in order to improve the services he can offer. The shortcoming in the mechanic's or technician's approach is that he has not been exposed to many of the significant principles evolving from these sciences (especially theoretical mechanics) and therefore tends to reapply the techniques he has learned with minimal variation in all situations. Actually it is more important that the fundamental physical (engineering) principles controlling prosthetic and orthotic fit and alignment be understood and that they then be varied to meet the needs of each individual patient. The same holds true of the chemical and metallurgical principles involved in the fabrication of orthotic-prosthetic devices.

Very little can be done towards applying these scientific engineering principles without a command of elementary mathematics and geometry. Consequently, the study of these subjects also becomes important. Lastly, since a considerable portion of the prosthetist-orthotist's efforts are directed towards the customized *design* of artificial limbs and braces, skill in descriptive geometry and mechanical drawing is also significant.

b. *Biological Sciences*

It is obvious that the mechanical product (machine) which the prosthetist-orthotist fabricates must become 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 to some degree. In view of this, it becomes clear that knowledge from the biological fields of anatomy, physiology and kiniesology are indispensible for the qualified practitioner.

As a matter of fact, we are just now beginning to learn some new things about how the human body functions as a mechanical system. This new field of knowledge is called "biomechanics" and progress in prosthetics and orthotics rests squarely on the study and understanding of these new concepts. The adequacy of one's efforts at physical restoration are completely dependent upon his grasp of the science of bio-mechanics whose principles govern the motions of the human body. Only by a command of fundamental biological principles, cross-fertilized by a familiarity with the principles of physics and chemistry, can the prosthetist-orthotist hope to design and produce an appliance which will provide optimal results for the individual patient.

c. *Psychological Science*

The prosthetist-orthotist is *not* involved in creating a physical mechanism which will work together with a series of other inanimate objects that have no opinions, attitudes, feelings, likes and dislikes. Rather, he creates a product which is to be worn by a human being and its success or failure will be influenced by all of the characteristics that human being possesses. The experienced prosthetist-orthotist knows that in many instances the critical problem involved in fitting a brace or artificial limb lies with the psychology of the wearer rather than in any physical or biological problem.

No one is suggesting, of course, that the prosthetist-orthotist become an expert psychiatrist or psychologist, but we are suggesting that a working knowledge of scientific psychological principles is mandatory so as to avoid fundamental and obvious errors in human relations. The prosthetist-orthotist must be capable of such understanding of his patients so that he can work constructively with the individual's psychological attributes rather than at cross purposes.

The psychological question, of course, does not begin or end with the patient. There are the other professional groups to be dealt with; all of whom have a serious concern with the welfare of the disabled. These other people, therapists, rehabilitation counselors, physicians, social workers, etc. are no more or less human beings than the prosthetist-orthotist and the patient. Consequently, they too are to be viewed as psychological beings and dealt with as such.

d. *Mechanical Skills*

In spite of the stress that we have 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 artificial appliance. Consequently, the individual must learn the characteristics of the three major types of materials—wood, metal and plastic—which are used in prosthetic and orthotic appliances. He then develops a mastery of these materials by applying the manipulative skills which will enable him to produce an appliance no less adequate than the one that he is able to conceive.

e. *Communication Skills*

We cannot overlook the need for reasonable ability in the use of spoken and written English. 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.

There are a large number of otherwise competent prosthetist-orthotists today who function at a serious disadvantage in that they do not have the verbal skills necessary to defend their points of view in a discussion or meeting. Lacking this skill they often give way to suggestions for changes in artificial limbs or braces which are less worthy than their own ideas on the subject.

f. *Personal and Cultural Qualifications*

Lastly, there is certainly the need for the prosthetist-orthotist to be a well informed, cultured citizen of our society so that in his social and professional behavior 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 is 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 therefore quite mandatory that the professional prosthetist-orthotist be offered the opportunity for training and experiences which will assist in his achieving and maintaining a satisfactory personal adjustment.

Certainly, this is a very impressive list of requirements that we have set forth for the professional prosthetist-orthotist. While history has shown us that many satisfactory appliances are made by people with far less complete backgrounds, the point remains—Is not the quality of prosthetic and orthotic service significantly improved when the patient is cared for by an individual with greater knowledge and skill? And, is not every orthopedically disabled person entitled to receive optimal treatment regardless of which prosthetist-orthotist he happens to select?

Socio-Economic Status of the Prosthetist-Orthotist

Leaving for a moment the discussions of the knowledge and skill required by an individual prosthetic-orthotist, let us consider how the members of this group appear in the eyes of other people. A number of prosthetist-orthotists have been quite disturbed concerning the lack of status and respect in which they are held. Although many have been aware of this problem they have not always been able to do anything about it. Perhaps a clue to the solution of this unsatisfactory situation may be found, at least partially, in the introductory remarks of this article.

It is not unlikely that the individual skills and abilities of various prosthetist-orthotists are well respected. But what seems to be lacking is a significant number of top quality prosthetist-orthotists who have that particular balance of knowledge, skill and personal attitudes which brings forth respect in whatever aspect of their professional field they are engaged. There is a relatively small percentage of prosthetist-orthotists who have achieved these high levels of acceptance and regard. However, the number is insufficient to provide the public with the proper "image" of the field so as to stimulate proper social and economic rewards. If the qualifications of these leaders are examined, one finds that by one means or another they have availed themselves of the great majority of skills and attributes which we have discussed previously. These prosthetist-orthotists provide service on a high level of professional competency. The question then remains how can others be helped to attain similar accomplishments.

Development of the Four-Year Curriculum

Those of us interested in Prosthetics and Orthotics Education at New York University have considered these matters for a considerable time. As a matter of fact, it was as early as May 1954 that an initial conference was called by NYU to discuss what might be done to assist in solving some of the problems which have been described. It turned out that nothing more concrete could be done at that time except to talk and discuss possibilities. However, it was feasible to take a first step several years later, consisting of the inauguration of short-term courses in prosthetics which are now well known throughout the field. These courses have been discussed by Mr. Berger in a previous article in this issue. But clearly this type of short-term educational program was not the whole answer. This type of training is valuable to people already in the field, but does not really attack the problem at its roots. And there is no doubt that the roots of this problem lie at the point when people are just entering the prosthetic-orthotics field, not after they have been in it.

It is a characteristic of all professions that an individual is systematically taught the elements of his vocational field prior to being admitted to this practice, and most often this education and training is provided through a college or university. So it is with teaching, accounting, physical therapy, journalism or any other profession you might mention, and so it must be with prosthetics and orthotics. The necessary extensive training is taken prior to the individual's entering the field as a bonafide practitioner. As more and more prosthetist-orthotists accepted this principle the only question remaining was, "When was the profession and its associated groups ready to take the step?" The step referred to is the inauguration of a comprehensive four-year college level training program in prosthetics and orthotics that would offer the individual courses of instruction in all of the areas which he needs to provide a truly professional service.

Planning of a curriculum leading to a Bachelor of Science degree began at New York University more than two and a half years ago and, as has been announced, the freshman class in prosthetics and orthotics will begin its studies in September 1960 at the University's School of Education. We at New York University take pleasure in the fact that this program is the first of its kind and that it may serve as a guide for others to follow.

Taking into account many of the factors which we have discussed, a curriculum was devised to provide the student with a broad educational background, as well as thorough training in both prosthetics and orthotics, including instruction in English, speech, mathematics, physical and biological sciences, psychology, sociology, social studies, basic engineering subjects and shop methods. In addition to the foregoing, specialized, practical courses which cover upper and lower extremity prosthetics and orthotics, as well as spinal orthotics are included. These courses are supplemented by a clinical training program developed in cooperation with the American Orthotic and Prosthetic Association and a number of limb and brace facilities throughout the country. A detailed listing of the courses in the curriculum will be found in Appendix A to this article.

Specifically the student will learn the practical clinical aspects of this field in four steps:

a. Basic shop training in metal, wood and plastic
b. Specialized training in the application of these techniques to prosthetics and orthotics.

c. Laboratory courses in the fabrication and fitting of appliances for a variety of patients
d. Clinical internships at certified facilities

We anticipate that the graduate of the curriculum will be well qualified to enter any phase of the prosthetic and orthotic field. As such it is expected that these graduates would present themselves for certification at the appropriate time and upon successful completion of the examination earn their certification.

For admission to the four-year curriculum at New York University leading to the Bachelor of Science degree, the prospective student must have satisfactorily completed an accredited secondary school program and preferably should have followed a college preparatory course of at least 15 units of work, including 4 units of English, 1 unit of algebra and 1 unit of plane geometry. However, applicants will also be considered who have demonstrated a capacity to profit from college study through equivalent preparation or examinations.

Qualified undergraduate students in other colleges and universities may transfer to this curriculum at New York University, preferably sometime prior to the junior year. Such students should be careful that courses taken in the first two years are comparable to those required for the Bachelor of Science degree in Prosthetics and Orthotics at New York University. Specifically, courses in the freshman and sophomore years should be carefully selected so that the course requirements indicated in Appendix A are fully met.

Prospective students must be physically capable of performing the shop work associated with this field and have sufficient mechanical aptitude to profit from this phase of the instruction.

There is every likelihood that a number of traineeships will be made available for selected students in the junior and senior years of this curriculum by the Federal Office of Vocational Rehabilitation. It might properly be mentioned that this agency has been a source of considerable encouragement and support in the establishment of this educational program.

Conclusion

When the individual has finished his course of instruction we hope to have available a person with a well-rounded professional training who may decide to engage in one or more of the following activities in prosthetics and orthotics: a) clinical practice, b) teaching, c) research—these activities to be pursued in privately owned facilities, hospitals, rehabilitation centers, government agencies, or universities.

In a sense, all of the varied prosthetic-orthotic activities at New York University which have been described in the previous articles have their logical culmination in the four-year college level training program. It is through this type of educational program, which has been designed to be consistent with a modern philosophy of professional education that we will be able to take the most important steps in placing prosthetics and orthotics on an appropriate social, economic and professional footing in our country. We have reached the point in our society where no important calling is open to young people without the experience of college level training. Prosthetics and orthotics has been an inexplicable exception to this rule in the past, but it will be so no longer as it joins the ranks of the stimulating, productive, and valued vocations associated with the healing arts.

APPENDIX A
CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN PROSTHETICS AND ORTHOTICS

School of Education—New York University

Course No.	*Course*	*Credits*	
English and Speech			
011.19-20	*Human Values in Literature and Composition	8	
021.1-2	*Fundamentals of Speech	4	
			12
Science and Mathematics			
014.53-54	*General Chemistry	4	
014.161-162	General Physics	6	
014.107-110	*General Biology	8	
114.427	Anatomy	4	
114.435-36	Physiology	4	
180.416	Kinesiology	2	
WS 13	General Mathematics	3	
WS 21	Analytic Geometry	3	
			34
Psychology			
035.1	*General Psychology	2	
135.21	*Developmental Psychology	2	
			4
Sociology and Anthropology			
020.1-2	*Introductory Sociology	4	
			4
Social Studies			
	Electives	8	
			8
Vocational			
031.101	General Woodworking	4	
031.105	General Metal	4	
031.107E or ED 11	Mechanical Drawing	2	
			10
Prosthetic and Orthotic Specialization			
180.901	**Descriptive Geometry	2	
180.903	***Mechanics	3	
180.905	***Strength of Materials	2	
180.907	***Prosthetic and Orthotic Shop Techniques	3	
	****Lower Extremity Prosthetics		
180.908	Above-Knee and Hip (lec-lab)	8	
180.909	Below-Knee, Syme's Partial Feet (lec-lab)	6	
180.917	Clinical Affiliation	1	
	****Lower Extremity Orthotics		
180.910	Long Leg, Short Leg, (lec-lab)	6	
180.920	Clinical Affiliation	1	

*School of Education requirements—other courses are departmental requirements.
**Will be offered beginning academic year 1961-1962.
***Will be offered beginning academic year 1962-1963.
****Will be offered beginning academic year 1963-1964.

	***Upper Extremity Prosthetics	
180.911	Shoulder, Above-Elbow, Below-Elbow, Hand (lec-lab)	7
180.910	Clinical Affiliation	1
180.912	****Upper Extremity Orthotics (lec-lab)	3
180.913	****Trunk Orthotics (lec-lab)	3
180.915	****Professional Problems in Prosthetics and Orthotics	2
		48
	Electives	10
		10
	Total Credits	130

PROSTHETIST-ORTHOTIST COURSES 1960-1961

This composite calendar of courses has been compiled by the AOPA Committee on Education.

Date	Course No.	Title	University
1960			
Sept. 5-23	X480	Below-Knee Prosthetics	UCLA
Sept. 26-Oct. 7	7414A	Below-Knee Prosthetics	NYU
Oct. 17-28	611	Below-Knee Prosthetics	NWU
Oct. 17-28	7416A	Upper-Extremity Prosthetics	NYU
Oct. 17-Nov. 4	X480	Below-Knee Prosthetics	UCLA
Nov. 7-18	7414B	Below-Knee Prosthetics	NYU
Nov. 28-Dec. 9	611	Below-Knee Prosthetics	NWU
Nov. 28-Dec. 16	X480	Below-Knee Prosthetics	UCLA
Nov. 28-Dec. 16	743X	Above-Knee Prosthetics	NYU
1961			
Jan. 9-27	X480	Below-Knee Prosthetics	UCLA
Jan. 9-Feb. 3	661	Upper Extremity Prosthetics	NWU
Jan. 16-Jan. 27	7414C	Below-Knee Prosthetics	NYU
Feb. 6-17	7416B	Upper-Extremity Prosthetics	NYU
Feb. 13-24	611	Below-Knee Prosthetics	NWU
Feb. 20-Mar. 10	X463	Above-Knee Prosthetics	UCLA
Mar. 6-24	743C	Above-Knee Prosthetics	NYU
Mar. 13-21	601	Above-Knee Prosthetics	NWU
Apr. 3-21	X468	Upper-Extremity Prosthetics	UCLA
Apr. 10-21	7414D	Below-Knee Prosthetics	NYU
Apr. 10-21	650	Fitting and Fabrication of Special Prostheses	NWU
May 1-26	746B	Upper-Extremity Prosthetics	NYU
May 15-26	611	Below-Knee Prosthetics	NWU
May 15-June 2	X476	Functional Bracing of the Upper Extremity	UCLA