

Spring 1958

Artificial Limbs

*A Review of
Current Developments*

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Artificial Limbs

VOLUME 4, 1957

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Washington 25, D. C.

Artificial Limbs is a publication of the Prosthetics Research Board, National Academy of Sciences—National Research Council, issued twice a year, in the spring and in the autumn, in partial fulfillment of Veterans Administration Contract VAm-21223, Office of Vocational Rehabilitation Contract SAV-1-58, and National Institutes of Health Grant RG-5057. Copyright 1958 by the National Academy of Sciences—National Research Council. Quoting and reprinting are freely permitted, providing appropriate credit is given. The opinions expressed by contributors are their own and are not necessarily those of the Prosthetics Research Board. Library of Congress Catalog Card No. 55-7710.

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Artificial Limbs

VOL. 5

SPRING 1958

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P R O S T H E T I C S R E S E A R C H B O A R D

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Evaluation Revalued

ROBERT E. STEWART, D.D.S.¹

In any sound program of research and development, whatever the intended goal, there must inevitably come a time when extensive evaluation of the product is indicated. Less than fifty years ago, systematic tests of new concepts were performed more or less routinely by private inventors dedicated to proper self-appraisal as occasion warranted. In a period less sophisticated technologically, this fashion in science served its purpose adequately and well. But with the growth in a more modern era of the large and vastly more complicated system of scientific inquiry, such as we know it today in government and industry alike, the requirement for periodic assessment of experimental results has led to the development of the independent testing laboratory, either as a part of the basic organization or as a separate contracting institution. So indispensable has this phase of technical investigation become that now large sums of money are spent annually in support of evaluation groups who themselves commonly engage at least in part in research aimed at improving their own methods and techniques.

With respect to these matters, the Artificial Limb Program has exhibited ostensibly no basic deviation from the general pattern now characteristic of other broad exploratory projects involving the cooperation of various specialists in otherwise distinct disciplines. But because of the peculiar nature of the amputee problem, the particular state of the art of limb prosthetics, especially in the upper extremity, and the demands of rather unusual external influences of one kind or another, the approach to systematic evaluation has in this case evolved out of a unique history and has, consequently, given rise to some valuable results in research and education of which the influence was not fully anticipated in the beginning.

Although in that portion of ALP devoted to the upper extremity much of the initial investigation was directed toward all-purpose, or "ideal," prostheses for selected levels of arm amputation, it was soon recognized that the desired objectives would be served more effectively were a variety of components made available for assembly into various combinations the better to provide for the particular needs of the individual patient. As these compo-

nents were developed, prototypes and, later, production units were subjected to systematic testing by the Prosthetic Devices Study, an organization established for this specific purpose within the Research Division of the College of Engineering of New York University.

At this point, evaluation generally furnished much needed data concerning the usefulness and reliability of individual units in direct comparison with previous similar parts but without regard for the influence of socket fit, type of harness and harness adjustment, type and extent of training, individual amputee preference, and other factors. Because methods suitable for the evaluation of techniques had yet to be introduced, early evaluations of components brought with them the subtle dangers of misinterpretation owing to the indirect effects of pre-existing errors in socket or harness, to say nothing of the possibility of the influence of one component upon the performance of another used in conjunction. In these circumstances, a great deal was left to be desired in reference to the over-all problem of upper-extremity prosthetics.

To fill the gap, there was initiated in 1950, in the Department of Engineering at the University of California at Los Angeles, the so-called "Case Study," with the purpose of bringing together all available information, of viewing systematically the results obtained by use of various combinations of devices and techniques, and thus of developing a set of general principles of management for the upper-extremity amputee. As the Case Study progressed, there arose an increasing awareness of the necessity for teamwork in the proper application of such knowledge as there was, and by 1952 the Prosthetic Devices Study was called upon to conduct an evaluation of the results of the UCLA Case Study.

It was obvious that, if such an evaluation were to be conclusive, large numbers of cases under varying geographical conditions would be needed for observation and that therefore the services of a number of clinic teams throughout the country would be required. Although the Prosthetic and Sensory Aids Service of the Veterans Administration, long the chief sponsor of the Artificial Limb Program, had already established some thirty prosthetic clinic teams, and although these groups were readily available for participation, it was patently mandatory that they be trained in the latest methods before any reliable program of evaluation could be initiated. Accordingly, short-term courses for clinic-team members—physicians, therapists, and prosthetists—were organized and conducted at UCLA beginning in 1953. The formation of new clinic teams outside the VA framework was encouraged, and these, along with a few private clinic teams already in existence, were invited to participate.

The education program leading to the Upper-Extremity Field Studies, the name applied to this part of the NYU evaluation work, proved to be a pioneering effort in its own right. While results of research were being made available to clinic teams for general use in a remarkably short time after the initiation of laboratory work, the continued association of clinic personnel

with the research program through participation in the Field Studies had a definite impact on those responsible for amputee care. Thus the Field Studies came to be a series of complex investigations designed not only to evaluate the usefulness of available upper-extremity prostheses but also to determine the effectiveness of the management procedures elucidated by the UCLA Case Study. Simultaneously, and almost unavoidably, the process of accumulating voluminous clinical data on one segment of the population led to a general upgrading of industry practices in amputee service and furnished the basis for further research into the needs, physical and mental, of the armless.

Because the NYU Field Studies represent the first, and thus far the only, attempt in the United States to appraise the status of upper-extremity prosthetics directly and on such a broad scale, and because the results present such a wealth of information not available elsewhere, this and the following issue of *ARTIFICIAL LIMBS* are given over to presentation of a series of summary articles divided into two parts—the first (this number) concerned with the educative aspects of the work, the second (Autumn 1958, Vol. 5, No. 2) with the research implications. For those who would undertake further study and interpretation in the interest of scholarship, the original data, far too detailed for thorough analysis by other than biostatisticians, are available in the College of Engineering of New York University, New York City.

In reviewing the material offered here, it is appropriate to keep in mind that the Field Studies constituted a new voyage into an area in which both subject matter and method of approach were uncharted and unexplored. Understandably beset by all the problems of design, organization, and execution typical of adventures into the unknown, they now reveal certain deficiencies most readily viewed with benefit of hindsight. In all probability, the true value of the Field Studies remains to be had—in the further application of the principles not only in the field of limb prosthetics but in other, more general areas of physical handicap as well.

Studies of the Upper-Extremity Amputee

I. Design and Scope

EDWARD PEIZER, Ph.D.¹

Man's increasing dominion over his natural environment has been ascribed to three specific characteristics—a highly developed brain, binocular vision, and an apposable thumb. Although not particularly specialized from a biological viewpoint, these three attributes have enabled him to adapt to a varied physical environment and, perhaps more important, to alter the physical environment to suit his needs. Loss of any one of them deprives him of fundamental human capacities and seriously inhibits his ability to compete, to interact, and to manipulate the objective world around him. Impaired brain function is usually irreversible, and in the case of vision loss heroic measures are often required to obtain even a modicum of functional restitution. But the situation is somewhat different today with respect to the loss of an upper extremity. New concepts and developments in the field of limb prosthetics have increased the potentialities of arm amputees. Not all the problems are solved. Far from it. But systematic and concerted efforts in medicine and engineering are being applied toward reducing the limitations attendant upon the loss of an arm. It is perhaps ironic that historically these constructive efforts have been stimulated by the destructive forces of war.

HISTORICAL DEVELOPMENT

In the aftermath of World War II, a grateful nation spared no effort to alleviate the condi-

tion of those who had been wounded or maimed in its defense. Among its many other services, the Veterans Administration undertook the task of providing prosthetic and rehabilitation services to all veteran amputees. In pursuit of this goal, it soon became clear that existing artificial limbs fell far short of meeting the needs and expectations of their users. Perhaps because of the greater dependence of the leg amputee upon adequate service, and because of the consequent emphasis on attention to his problems, the major needs were found among upper-extremity amputees. Arm prostheses were found to be heavy, uncosmetic and unsanitary, and possessed of very limited function (Figs. 1 and 2). Too often they were relegated to the closet. Generally accepted standards of prosthetic quality were lacking. Better materials, improved design, new prosthetic components, and improved fitting and fabrication techniques were clearly required.

Not generally recognized was the need for highly individualized training to develop proficiency in the use of an artificial arm so that vocational and other skills could be acquired. Without a common ground of experience, the physician rarely took part in the prescription and fitting of prostheses. Thus, even the most skilled prosthetist, faced with the task of providing his patient with a well-fitting, comfortable, and highly functional prosthesis, sometimes found himself in the unfamiliar role of psychologist, therapist, and/or vocational counselor. In short, sound, complete, systematic rehabilitation programs for amputees were lacking. Officials of the Army, the Navy, and the Veterans Administration wasted little time in hand-wringing. Authority was



Fig. 1. Typical below-elbow prosthesis, vintage World War II.

soon forthcoming, and funds were made available for a broad attack on these problems.

The resources of science, applied during the war years to destruction and demoralization, were now directed toward the restoration of human loss and the enrichment of human life. The first step was the establishment, in 1945, of the Committee on Prosthetic Devices of the National Academy of Sciences—National Research Council, which later became the Advisory Committee on Artificial Limbs and which is today the Prosthetics Research Board. This led to the inception of the Artificial Limb Program and to the establishment of research projects for the scientific study of the problems involved. At the University of California at Los Angeles fundamental studies were undertaken of the biomechanical principles

involved in normal prehension and of the problems of using artificial arms. At the same time, the industrial laboratories of Northrop Aircraft, as well as the Army Prosthetics Research Laboratory, were creating new materials, new devices, and new fabrication techniques, while New York University was assigned the task of evaluating these developments. The scientific facilities of both industry and government were thus employed to reduce the problem through efforts in basic and applied research.

The earliest results indicated that solving the problems and fulfilling the needs of the upper-extremity amputee was a task vastly greater than that of improving the mechanical aspects of fitting and fabricating prostheses. The finest artificial limb is of little value with-

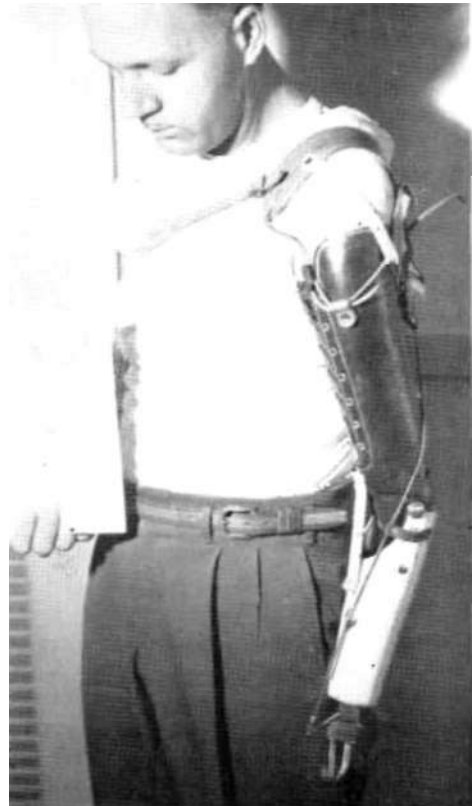


Fig. 2. Typical above-elbow prosthesis, vintage World War II.

out training in its use. Further, the loss of a limb was seen to create important disturbances in the personality as a result of functional loss and distortion of the self-concept. The amputee entertains doubts as to how he will appear to and be accepted by his family and friends. He wonders, often with misgivings, about his economic potential. He has what appear to him to be insuperable problems, and he needs help in restoring his self-confidence as well as his lost function. In order to meet these amputee needs, a complete and rational system of rehabilitation programming was required, and since 1945 considerable progress has been made in developing such an approach to this problem.

After several years of organized effort, a great deal of research information became the basis for an all-around approach to the treatment of upper-extremity amputees. Through the development of models, the testing of hypotheses, and the experimental treatment of a number of arm amputees of all types, it became possible to indicate with some confidence how certain types of patients should be fitted, how their arms should be constructed, and how they should be trained to use them. As an added result, it is becoming a commonplace that all the amputee's needs cannot be served by a single individual, regardless of his professional status or training. With recognition of individual needs and the variety of amputee problems, it became clear that successful rehabilitation of these patients demanded the highly qualified and specialized services of a number of disciplines. Prosthetists, therapists, and physicians each have vital contributions in this enterprise, as may also nurses, social workers, vocational counselors, and psychologists. The modern concept then became the "team approach," the team consisting minimally of the doctor, the prosthetist, and the trainer and including such other specialists as each case required.

In order to evaluate these findings, a series of studies, which came to be known as the "NYU Field Studies," was conceived in 1951 at the Prosthetic Devices Study at New York University.

GOALS OF THE UPPER-EXTREMITY FIELD STUDIES

The NYU Field Studies of upper-extremity prosthetics developed as the logical consequence of two main preconditions—the laboratory research program and the prosthetics education program (page 9). As for the first, out of the laboratories had come a whole series of new devices which, on the basis of preliminary testing on relatively small groups, gave promise of being significantly improved components. Before some of them could be considered "proved" items of a prosthetic armamentarium, more definitive testing on broader, more representative samples under varying conditions seemed essential. But more than gadget-testing was involved. New fabrication techniques employing plastics had also been developed, and although arms made according to these procedures seemed superior to older types, it remained to be seen if the procedures could be mastered by limbmakers all over the country and economically and conveniently applied to the production of all types of artificial arms.

The second factor to be considered in planning the studies was the matter of broad and speedy dissemination of the new knowledge and skills. It was clear that the new procedures could not be evaluated in clinics whose personnel were not completely familiar with their use. Moreover, considerable urgency prevailed about making new developments and improvements available to all amputees as soon as possible. To fulfill this requirement, a prosthetics education program was organized to train clinic-team personnel. But it was generally observed that additional assistance was required in significant numbers of clinics before they could begin to process patients effectively.

For all of these reasons, the NYU Field Studies were designed in 1953 with three main objectives in view:

and the confidence it inspires in its user are as important in prosthetic service as are structural and mechanical adequacy. Each of these areas was explored.

2. *To provide direction for future research in relation to practical field needs.* Field-study operations should provide access to large representative samples of upper-extremity amputees. Clinical contact with these patients would furnish a means for determining existing prosthetic problems and, even more important, for evaluating the importance of these problems to amputees themselves. With this information available to the developmental laboratories through a feedback arrangement, their efforts could be directed toward the problems of most immediacy and importance.

3. *To extend the educational process by rendering administrative and technical assistance to newly organized prosthetics clinics.* Shortly after graduation from the prosthetics courses at the University of California at Los Angeles, potential clinic teams were to be visited by NYU representatives, the purpose being to encourage and aid in the establishment of a clinic procedure along the lines taught in the courses. The expeditious organization of a clinic served two functions—amputees would have early access to modern treatment, and a clinic treating patients according to these procedures was a potential participant in the field studies and a source of research data.

Before these concepts could be tested in the crucible of clinic practice throughout the nation, several preliminary steps were necessary. First, meaningful and reliable methods had to be found for evaluating the effect of prosthetic treatment procedures. Second, a number of clinics had to be organized to participate in the studies if valid inferences about the general utility of the experimental procedures were to be drawn. Third, training in the new prosthetic techniques and procedures had to be given to those who dealt directly with amputees. Actually, all three of these steps were undertaken at approximately the same time.

INAUGURATION of THE UPPER-EXTREMITY FIELD STUDIES

The staff of the Prosthetic Devices Study of New York University had been engaged in developing on a generally theoretical basis a philosophy and methodology for evaluating the status of arm amputees. The problem was approached directly, attempts being made to determine the most important outcomes in prosthetic restoration and to measure the extent to which the newer management procedures provided them. Accordingly, proce-

dures and instruments were devised for determining the extent of residual function and the degree of adjustment to physical disability (Fig. 3). The status of the patient after treatment could thus be compared with his pretreatment condition as a basis for evaluation. But before these instruments could be applied on a broad scale it was necessary to

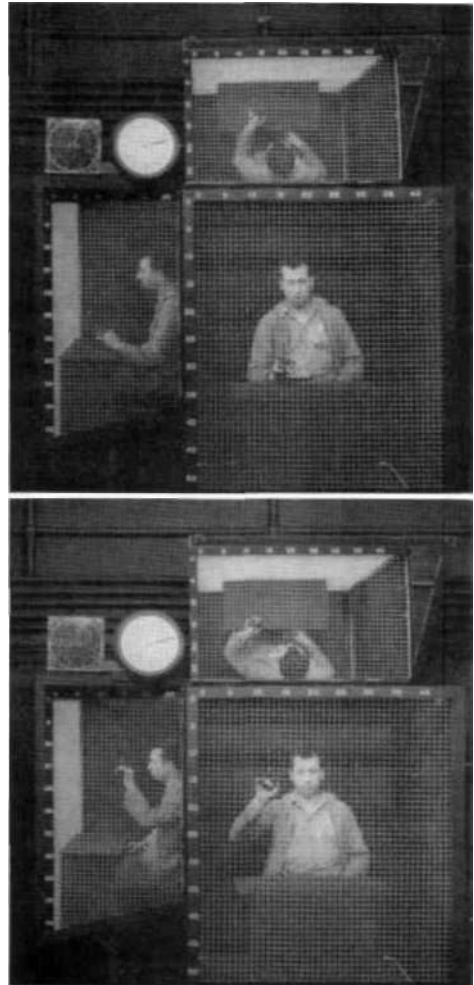


Fig. 3. Calibrated grid for measuring the arm movements required to perform certain common activities. Use of top and side mirrors provides information in three dimensions simultaneously. Clocks record time data.

test their reliability and administrative feasibility as well as to refine the procedures for their application. For this purpose, a preliminary "pilot" study was planned, and Chicago was selected as the test site.

THE CHICAGO "PILOT" STUDY

The pilot study carried out in 1952 called for a small number of surgeons, therapists, and prosthetists from the Chicago area to attend a special four-week course of instruction in upper-extremity prosthetics at the University of California at Los Angeles in order to familiarize the participants with the devices, fabrication techniques, and clinical procedures to be evaluated.² Upon their return to Chicago, they were joined by representatives of NYU's Prosthetic Devices Study, and the pilot study was launched.

This field trial of research instruments and procedures involved the screening of a number of amputees in the Chicago area and the selection of a group for treatment in the Veterans Administration clinic. To enable the clinic properly to prescribe the new prosthesis, each of the selected subjects was given a comprehensive evaluation prior to other treatment. In addition, research evaluations were conducted by NYU representatives to provide baseline data against which the effects of the rehabilitation procedures could be evaluated. The new arm for each participant was then prescribed in accordance with the prescription procedure taught in the UCLA course and was to be fabricated precisely as prescribed and according to the mechanical and cosmetic standards formulated. When the arm was complete, it was brought to the clinic for a checkout which consisted of a detailed examination by the clinic staff to assure themselves of the adequacy of the product. If revisions were required, they were made before the patient was given the arm; if none were needed, the clinic prescribed appropriate training treatments to be administered by the therapist.

After training was completed, the amputee was again seen by the clinic team; if the arm were still satisfactory and maximum results had been achieved through training, the patient was to wear the arm routinely in daily living. At the end of a two-month period of daily wear, the subjects were re-evaluated in a manner similar to the pretreatment evaluation.

As a result of the Chicago study, valuable experience was gained in the processing of patients. Research techniques were refined, clinic procedures were crystallized, methods for administering questionnaires and for taking measurements were standardized, and instruments were revised and augmented. With the end of the pilot phase, expansion of the upper-extremity field studies to national proportions began, an expansion made possible by the participation in the program of a number of widely distributed private clinics as well as Veterans Administration clinics.

ORGANIZATION OF PARTICIPATING CLINICS

The unprecedented nature of the projected field studies made the selection of a number of clinics a formidable task. It was first necessary to locate interested and qualified clinic personnel. Then it was necessary to orient them as to the nature of the program as well as to the need for special training. Steps for integrating the clinics into the field program required explanation, and specific operating procedures had to be worked out with individual groups. This task was undertaken by the Director of the Prosthetic Devices Study, Dr. Sidney Fishman.

After completion of the pilot study in Chicago early in 1953, and continuously for two years thereafter, Dr. Fishman and Dr. Miles H. Anderson, the Director of the Prosthetics Education Project at UCLA, visited many large population centers throughout the country in order to meet with medical and paramedical personnel interested in the treatment of arm amputees. On the basis of expressions of interest, and of an appraisal of the available facilities and potential case loads, a number of clinical facilities were invited to participate. During these discussions, research procedures were described, expected outcomes were explained, and the roles of the clinic

members and of the NYU research workers were defined. Arrangements were made for members of each clinic staff to attend the courses in upper-extremity prosthetics at UCLA (see below).

It was quickly realized that financial problems would be encountered both by private clinics and by participating limbshops. In the former, the newer training procedures called for increased services of therapists and doctors. In the latter, the employment of newer fabrication and fitting techniques required an initial investment on the part of the prosthetists in components, equipment, and materials. In addition, the checkout of an arm by the clinic team often resulted in revisions adding to initial fabrication costs. For these reasons, certain fiscal arrangements were indicated. Monies were made available to clinic teams to pay the training fees for amputee cases participating in the work. In order to spur the fabrication of the new-type arms and to permit participation in the program by the prosthetists, arrangements were made to purchase five experimental limbs from each shop participating in the studies. As a result of these efforts, 75 clinics representing 30 states and the District of Columbia (Fig. 4) participated in the field program. Each treatment center was directed and staffed by graduates of special upper-extremity prosthetics training courses. Of the total number of clinics involved, 28 were Veterans Administration installations and 47 were other public and private institutions.

PROSTHETICS EDUCATION PROGRAM

The new knowledge and techniques, organized into courses of instruction and revised after the pilot school, were offered in a series of 12 schools (Fig. 5) conducted at UCLA, the chief purpose being to familiarize doctors, therapists, and prosthetists with the new developments and to encourage the team approach to the prosthetic rehabilitation of the upper-extremity amputee. It thus became possible to teach to those with primary interest new concepts for the management of upper-extremity cases.

In effecting the transfer of information and skill to the primary amputee-treatment group

consisting of the doctor, the therapist, and the prosthetist, academic tradition was broken. It seemed plain that if the "team approach" were to be taught, the members of the team should go to school together. Accordingly, in a unique educational enterprise, orthopedic surgeons, specialists in physical medicine, physical and occupational therapists, and prosthetics craftsmen became classmates. The six-week course offered at UCLA began with a three-week session of instruction for prosthetists only. During this portion of the course, prosthetists were exposed to a highly concentrated educational dose of prosthetic design and construction principles, plastics technology, anatomy, and kinesiology. Then they tested their knowledge by fitting patients under the direct supervision of their instructors.

In the fourth week, the prosthetists were joined by the therapists. This group began with a concentrated portion of mechanics, biomechanics, and the characteristics of a wide variety of both newly developed and the older prosthetic components. Under the supervision of the instructors, they also received experience in training the patients previously fitted by the prosthetist students.

At the beginning of the sixth week, the prosthetists and therapists were joined by the physicians and surgeons, who were given several days in which to review and digest the course materials. Practice clinic teams, consisting of the doctor as clinic chief and of at least one therapist and one prosthetist, were then organized. The entire class then proceeded to operate as clinic teams until graduation, whereupon each of the individuals returned home, a potential participant in the soon-to-follow upper-extremity field studies. The new knowledge and skills were broadly disseminated by these educational efforts, but their utility and effectiveness on patients could not be clearly seen until large numbers of varying types of patients had been treated and evaluated.

The Prosthetic Devices Study, charged with the responsibility for following up the program concepts, designed studies to evaluate the modern treatment methods. The central questions to be answered were deceptively



Fig. 4. Location of the participating clinics See facing page.

ALABAMA	LOUISIANA	NEW YORK	RHODE ISLAND
Birmingham	New Orleans	Buffalo	Providence
1. Alabama Crippled Children's Commission	19. Tulane University School of Medicine, Rehabilitation Unit	39. University of Buffalo Chronic Disease Research Institute	59. Rhode Island General Hospital
CALIFORNIA	20. Veterans Administration Regional Office	40. Veterans Administration Regional Office	TENNESSEE
Los Angeles	MARYLAND	New York City	Chattanooga
2. California Rehabilitation Center	Baltimore	41. Bellevue Hospital	60. Erlanger Hospital
3. Orthopedic Hospital	21. Johns Hopkins Hospital	42. Veterans Administration Regional Office	Knoxville
4. Veterans Administration Regional Office	22. Kernan Hospital Clinic	NORTH CAROLINA	61. Dr. Walter J. Lee's Rehabilitation Center
San Francisco	MASSACHUSETTS	Durham	62. Campbell Clinic
5. Veterans Administration Regional Office	Boston	43. Duke University Hospital	Nashville
COLORADO	23. Bay State Rehabilitation Center	OHIO	63. Veterans Administration Regional Office
Denver	24. New England Medical Center	Cincinnati	TEXAS
6. Denver General Hospital	25. Veterans Administration Regional Office	44. Veterans Administration Regional Office	Dallas
7. Veterans Administration Regional Office	MICHIGAN	Cleveland	64. Veterans Administration Regional Office
DISTRICT OF COLUMBIA	Ann Arbor	45. University of Cleveland Hospital	El Paso
8. Veterans Administration Regional Office	26. University of Michigan Hospital	46. Veterans Administration Regional Office	65. Providence Memorial Hospital
FLORIDA	Detroit	Columbus	Houston
Orlando	27. Detroit Rehabilitation Center	47. Ohio State University Hospital	66. Methodist Hospital
9. Dr. Eugene L. Jewett's Clinic	28. Henry Ford Hospital	OKLAHOMA	San Antonio
Tampa	29. Veterans Administration Regional Office	Enid	67. Veterans Administration Regional Office
10. Dr. Albert A. Wilson's Clinic	Grand Rapids	48. Dr. E. Evans Chambers' Clinic	UTAH
GEORGIA	30. Michigan Crippled Children Commission	Oklahoma City	Salt Lake City
Atlanta	MINNESOTA	49. McBride Hospital	68. Dr. Robert H. Lamb's Clinic
11. Dr. Harriet E. Gillette's Clinic	Minneapolis	50. Oklahoma Commission for Crippled Children	69. Veterans Administration Regional Office
12. Veterans Administration Regional Office	31. Veterans Administration Regional Office	51. Veterans Administration Regional Office	VIRGINIA
ILLINOIS	MISSOURI	Okmulgee	Fishersville
Chicago	Kansas City	52. Okmulgee Rehabilitation Institute	70. Woodrow Wilson Rehabilitation Center
13. Rehabilitation Institute of Chicago	32. Kansas City Rehabilitation Center	OREGON	WASHINGTON
14. Veterans Administration Regional Office	33. Katherine Payne Rehabilitation Center	Portland	Seattle
IOWA	34. Veterans Administration Regional Office	53. Portland Rehabilitation Center	71. Children's Orthopedic Hospital
Des Moines	St. Louis	54. Veterans Administration Regional Office	72. Veterans Administration Regional Office
15. Veterans Administration Regional Office	35. Firmin DesLoges Hospital	PENNSYLVANIA	Walla Walla
KANSAS	36. Veterans Administration Regional Office	Philadelphia	73. Dr. C. Don Plattner's Clinic
Wichita	NEBRASKA	55. University of Pennsylvania Hospital	WISCONSIN
16. Wichita Clinic	Omaha	56. Veterans Administration Regional Office	Madison
KENTUCKY	37. University of Nebraska Hospital	Pittsburgh	74. University of Wisconsin Orthopedic Hospital
Louisville	NEW JERSEY	57. Dr. Murray B. Ferderber's Clinic	Milwaukee
17. Louisville Rehabilitation Center	Newark	58. Veterans Administration Regional Office	75. Columbia Hospital
18. Veterans Administration Regional Office	38. Veterans Administration Regional Office		

Fig. 4. Participating clinics, keyed to map on facing page.



Fig. 5. Students and instructors of one of the 13 courses in upper-extremity prosthetics offered at the University of California at Los Angeles. This particular course was held in the autumn of 1954.

simple: Are upper-extremity amputees better served by means of the program procedures? In what specific areas can improvement, detriment, or indifference be found?

AREAS of RESEARCH

In relatively unexplored fields, the formulation of meaningful research questions is often laborious, unsure, and time-consuming. Merely selecting the most scientifically promising problems from the many questions which arise is in itself an important research task. Many possible approaches to the field must be evaluated, and those selected for study must give promise of becoming part of and contributing to the solution of larger problem areas. The research plan developed at the Prosthetic Devices Study to achieve the objectives of the field-study program evolved in this way. It provided for three major interrelated study areas to be exploited concurrently.

The first of these, a census of amputees, called for interviewing large numbers of upper-extremity amputees in order to begin the organization of a broader body of knowledge concerning them and to provide a large population from which to select a sample for more detailed study. This was the "Survey Phase." Secondly, a segment of this population was selected for clinic treatment by means of the rehabilitation procedures under study. These efforts of the field operations, referred to as the "Clinical Studies," were designed to pro-

vide information about the feasibility of clinic procedures and prosthetic fabrication methods. The third study area provided for the pre- and post-treatment evaluation of a portion of the sample selected for clinic treatment. This approach, called "Evaluation Studies," was intended to elicit more detailed information about a smaller number of amputees than was possible in the survey and to provide a basis for evaluation of the methods and materials employed in the treatment procedure.

In its final form, the research plan provided for trips by NYU field representatives to attend the monthly meetings of each participating clinic. Consequently, a given member of the staff would be in the field approximately two weeks out of each month, and a routine field trip often took him to five or six cities, where he would visit perhaps six or eight clinics and observe 20 to 30 amputees under treatment. With 75 participating clinics to serve, a field staff of 10 representatives directed by two field supervisors was organized. Since clinic meeting dates and times were quite firmly fixed, and since the time required to be spent with each subject varied from fifteen minutes to four hours, depending upon the stage of treatment, the trips required considerable planning. To minimize loss of time, schedules were arranged by correspondence, and confirmed when possible, before each trip. Despite the difficulty of control, the attrition rate when the studies ended was low. Some-

what less than 10 percent of those initially selected failed to complete the full treatment course and follow-up studies.

The NYU representative served two main functions: he established liaison among the treatment centers in the field and between them and New York University, which resulted in interchange of information and coordination of effort, and he was responsible for the collection of the research information. These data were gathered in the field by means of interviews, questionnaires, tests, and measurements.

SURVEY STUDIES

Each arm amputee referred to a participating clinic was considered a prospective research subject, and each was given a screening interview, the purpose being to obtain pertinent information concerning the patient, his prosthesis, and his needs and aspirations. Initially, clinics screened only those amputees who were immediately in need of treatment. The information thus gleaned contributed to the survey to be made of the status of upper-extremity amputees in the United States and was also useful in the selection of subjects for more detailed study. On the basis of the screening data, two classes of subjects were selected. One group was to be treated only in the clinic by the prescribed procedures. The other, in addition to the clinic treatment, was to undergo a detailed pretreatment evaluation and a similar post-treatment procedure.

At the screening interview, the purposes and general procedures of the program were explained to the prospective participant, and information of an administrative and medical nature was collected. The common vital statistics dealing with age, height, weight, and marital and occupational status were recorded. In addition, the date, cause, and site of amputation were obtained, and the length, range of motion, shape, and condition of the stump were described. Detailed descriptions were compiled of prostheses worn by candidates, and their quality and the subjects' ability to use them were evaluated. The data contributed by each amputee were recorded on forms developed for this purpose (Appendices IA and IB).

The selection of amputees to be processed at the first and subsequent prescription meetings was made at the Prosthetic Devices Study on the bases of available information and the sampling requirements of the study. Factors taken into account in the selection of the subjects included type of amputation, general health and physical condition of stump, and motivation of patient (his interest and willingness to participate). The entire census included 1630 male upper-extremity amputees, of whom 826 were below-elbow cases, 668 had amputations above the elbow, 89 had disarticulations at the shoulder, and 47 were bilateral amputees of all types. The findings arising from these survey studies are described in the article by Berger (page 57).

CLINICAL STUDIES

The idea of the clinic team was the key concept of the newly developed management procedures. The clinic was viewed as a means and a method for focusing the special skills of all the necessary medical and ancillary specialists on the specific problems of providing the amputee with the best possible replacement for the lost member. The primary service group consisted of physicians and surgeons, therapists, and prosthetists. Other specialists, such as administrative personnel, vocational-rehabilitation counselors, social-service workers, or psychologists, were added according to the special needs of individual cases. The fundamental nature of the clinic was emphasized by the requirement that each of the basic members be present before an "official" meeting of the clinic could be opened. It was at these clinic meetings that the treatment concepts to be evaluated were applied. There were six basic steps in the clinic procedure—prescription, preprosthetic treatment, fabrication of the prosthesis, initial checkout, training, and final checkout. Of these, three—prescription, initial checkout, and final checkout—required meetings of the full clinic team.

Prescription

Prescription, during these studies, called for the selection of specific components from an armamentarium of tentatively approved devices for assembly into an individually

prescribed prosthesis. Most of these components were designed for specific types of cases or uses and were to be prescribed in accordance with their design purposes. The final prescription was to be the consensus of the clinic members as to the most applicable components in each case. In practice, however, the medical, surgical, and physical-therapy needs of each patient were considered, as were also personal and vocational indications for specific components and materials. Required was a written prescription specifying every component to be used, and all deviations from standard applications were avoided unless expressly written into the prescription. To standardize the type and quality of the information collected at these meetings, the prescription form in Appendix IIA was developed. This procedure not only was the first treatment step but it also permitted the collection of research data describing the specific devices fitted to the subjects. On the basis of subsequent acceptability and utility to the amputees, inferences could be drawn as to the worth of these components.

Preprosthetic Treatment

As part of the prescription process, the patient was examined for conditions which might produce difficulty in wearing or using an artificial arm. Particular efforts were made to institute treatment prior to fitting a limb and thereby to avoid the influence of these factors upon the acceptance and use of the prosthesis. Medical and surgical problems involving disease, infection, inflammation, redundancies, bone overgrowth, neuromata, and plastic alterations were referred to the physician for treatment. Muscular weakness and limitations in joint mobility considered amenable to treatment were referred to the therapist.

Fabrication of the Prosthesis

When the prescription was completed, instructions were given to one of the attending prosthetists to fabricate the arm. With strict adherence to the details of the prescription, the limbmaker produced the arm by use of the techniques of fitting taught by the program. He was encouraged to inspect the completed arm by means of a checklist embodying the structural, functional, and cosmetic standards

that his product would have to meet at the next clinic meeting.

Initial Checkout

When the arm had been fabricated, it was brought to the clinic prior to being worn by the subject. At this clinic meeting, called "initial checkout," the standards developed in the program were applied. The initial checkout included an objective and subjective appraisal to see that the device fulfilled the prescription requirements and that it met established standards of fit, comfort, function, and appearance (Fig. 6). The information thus obtained described the ranges of motion available with the arm, the forces required to operate it, and stability, fit, comfort, and weight. In addition, some 30 items dealing with details of fabrication, appearance, color, specific components, and general quality were checked. These standards were considered to represent minimal levels of prosthetic adequacy. All the appropriate measurements and checks were recorded on a form similar to that shown in Appendix IIB.

These data were used to control the quality of the arms in order to permit valid generalizations about their worth. In addition, when compared with the outcomes of the treatment procedure, these data provided the basis for evaluation of the standards themselves.

The checkout was performed at a regular meeting of all members of the clinic. If the arm failed checkout, it was referred to the prosthetist for appropriate revisions (Fig. 7). Consequently, it was sometimes necessary for the subject to appear at the clinic more than the minimum of three times. If the prosthesis met all the requirements, the amputee was permitted to wear the arm regularly and was scheduled for training by the therapist, the next step in the clinic procedure.

Training

The training given to each subject by the therapist was organized in two parts—controls training and use training.

Controls Training. In the preliminary step, the objective was to familiarize the amputee with the mechanics of his appliance and to develop his ability to control its movements.

First he was taught to operate the arm freely so as to learn by kinesthetic reaction the motions and forces required to control it. Then various objects with abstract forms and of varying consistencies were introduced to



Fig. 6. A typical clinic meeting.



Fig. 7. Checkout. Final harness adjustments are made on a new arm prosthesis.

develop prehension skill. When, in the opinion of both therapist and amputee, these control motions were adequately developed, the next training phase began.

Use Training. Once the basic operating techniques were learned, they were applied to performing the practical activities of daily living, including self-help, home tasks, and vocational and social activities (Fig. 8). The training objectives were now to give the amputee confidence in his ability to use the arm by exploring a variety of activities and to achieve proficiency in performing them. In this connection, it was necessary to recognize that the prosthesis cannot replace the lost member and that at best it becomes an auxiliary of the remaining arm.

By application of this fairly standardized sequence of activities, it was possible to collect research information relating to achievement levels and to the number of hours of training required to achieve satisfactory performance. When the amputee seemed capable of satisfactory performance with his prosthesis, the therapist arranged for him to reappear at the clinic for a final checkout.

Final Checkout

The final checkout concluded the process of providing the amputee with an arm. In a



Fig. 8. Use training. The therapist explains how to approach, grasp, and manipulate a variety of common objects.

fashion similar to the pretraining initial check-out, it was conducted at a regular meeting of the clinic, all members present. The purpose at this time was threefold—to recheck the mechanical and functional adequacy of the arm after use in training, to assure the clinic that satisfactory proficiency levels had been attained, and to be sure that nothing further in the way of service could be offered the patient if the first two conditions were met.

The objective and subjective appraisal was again accomplished by means of the standardized checkout procedure (Appendix IIB). The arm was carefully inspected for signs of wear, and evidence was presented that the amputee was adequately trained. If the condition of the arm and proficiency of the subject in its use were deemed satisfactory, he was discharged with instructions to use the arm in accordance with his daily needs.

Recapitulation

Altogether, the group treated in the clinics included 378 below-elbow, 321 above-elbow, 46 shoulder-disarticulation, and 24 bilateral am-

putees. Of the total of 769, 410 received no further treatment, while 359 were extensively studied prior to and after completion of the treatment procedures.

The complete procedures employed in these studies are rather too complex for convenient presentation here in more than outline form. The full description and explanation of the most recent modification of these procedures is the subject of short-term courses of instruction currently being offered at the University of California at Los Angeles and at New York University. The manuals used in these courses (1, 2) contain detailed descriptions of the procedures and may be referred to for further information.

The results of these clinic studies are presented in the article by Springer (page 73).

EVALUATION STUDIES

The prosthesis for an upper-extremity amputee is a necessarily limited means of providing those motions lost through amputation—prehension, pronation-supination, wrist flexion-extension, and, in the case of the above-elbow amputee, the additional function of flexion-extension of the forearm. The chief goals of the evaluation procedures were to determine the extent to which a prosthesis provided functional as well as cosmetic replacement. A corollary purpose was to discover additional parameters of prosthetic utility and acceptability by increasing our knowledge of why an amputee accepts and uses more readily and efficiently one prosthesis in preference to another.

The extent to which prosthetic restoration is successful is dependent upon what each subject brings to the appliance in terms of physical and mental characteristics and on what the appliance brings to him in terms of functional capabilities and qualities of comfort and cosmesis. Evaluation procedures were, therefore, aimed at the analysis and understanding of both the human and the mechanical variables that are involved in the successful use of an arm prosthesis. Although the potential significance of the pre-injury personality was recognized, it was not investigated because of the difficulty of obtaining such information in a field study of this nature.

Some of the significant evaluation factors lent themselves to objective measurement; others, of a more personal and subjective nature, could be obtained only from the amputee himself. For this reason, the evaluation procedures and instruments were designed to collect both objective measurements and more subjective data dealing with the reactions and responses of the amputee.

In this connection, the measurement rationale underlying the collection of data should be understood. Quantitative data are convenient for systematic analysis. But quantification can be meaningful only within well-developed and clearly defined evaluation areas. The appraisal, for example, of certain functional characteristics of an arm lends itself readily to objective or quantitative measurement, since the problem area is defined by the extent to which the prosthesis replaces certain lost motions. The problem here is clear; the ranges of motion and the forces applied can actually be measured. In much the same way, an evaluation of performance may be made by scoring such objective aspects as speed, errors, and even some types of quality. On the other hand, in dealing with those effects of treatment procedures relating to feelings, attitudes, emotions, comfort, and fit, the parameters to be measured are not at all clear. For this reason, in such obscurely defined areas qualitative data deriving from interviews and from both structured and unstructured responses of the subject tend to be more valuable in outlining and clarifying the areas of study. Once this is done, the particular factors may become amenable to quantitative measurement.

Actually, only three possible sources of data were available—objective measurements describing events, the expert opinions and judgments of qualified observers, and the reactions of the subjects. Each of these sources was exploited. Specific mechanical and biomechanical factors were measured by objective methods. Prosthetic quality and proficiency in performance with an arm were appraised by trained observers whose reliability was periodically checked and re-established. Finally, the amputee himself provided information relating to his reactions to the arm, its quality, and its usefulness to him. Within two broad

categories, the human and the mechanical, the following were studied:

Biomechanical Data

1. The strength and ranges of motion of the arm and shoulder girdle and the general physical condition of the amputee.
2. The ranges of motion permitted by the prosthesis, its efficiency, and the forces required to operate it.

Performance Patterns

1. Proficiency in accomplishing the basic activities of prehension, transportation, and release in various planes and at different levels.
2. Quality of performance of practical daily-life activities.
3. The range of activities in which prostheses are used and the extent of their importance.

Amputee Reactions

1. Importance and extent of use of prostheses in daily living.
2. Reactions to treatment procedures.
3. Appraisal of prostheses and components.

Psychological Reactions

1. Personal meanings of amputation and prosthetic restitution.
2. Social consequences of loss of limb and of prosthetic replacement.

Biomechanical Data

It is reasonable to assume that an upper-extremity prosthesis which affords the amputee a greater range of motion and which requires a minimal amount of energy or force for operation will be a more desirable appliance. While much more information is necessary before final judgment can be made, comparative data on these factors formed one of the bases for the evaluation of arm prostheses. This kind of data was obtained through direct measurement using such instruments as rulers, spring scales, and goniometers. They were used to measure pinch force between hook or hand fingers; efficiency of force transmission through the cable system; ranges of pronation, supination, and forearm flexion; socket displacement under axial load; and weight of the prosthesis. In the case of the above-elbow amputee, additional information was collected on force input required to flex the forearm, angular deflection of the humerus needed to produce given ranges of forearm flexion, and ranges of motion at the shoulder. These measures were recorded on the

instrument shown in Appendix IIIA. The outcome of these evaluations will be presented in an article in the next issue of ARTIFICIAL LIMBS (Autumn 1958; Vol. 5, No. 2).

Performance Patterns

The performance of the subjects in standardized, specially designed activities was observed and analyzed. This procedure was employed to provide information concerning the effectiveness and appearance of the performance patterns. Two approaches to the evaluation of performance were taken. Both abstract and practical function were evaluated. In the former, the ability accurately to grasp, transport, and release objects of varying sizes, shapes, weights, and consistencies was graded (Fig. 9). In the evaluation of practical function, amputees were graded on their performance of meaningful daily-life activities (Fig. 10). Proficiency scores and time-and-motion data were recorded on the forms appearing in Appendix IIIB, while activities were tabulated as shown in Appendix IIIC.



Fig. 9. Evaluation of abstract function.

Amputee Reactions

Analysis of Importance and Extent of Use of Prosthesis in Daily Living. In an attempt to appraise the importance of the prosthesis to the amputee, and to determine some of the specific ways in which prostheses were used,

the interview technique was utilized. The subjects were asked if they used their prostheses in specific activity areas, including work, home tasks, social life, dressing, and eating. If their



Fig. 10. Evaluation of practical function.

response was positive in any area, they were asked to specify the particular use they made of the arm. They also were asked to rate the importance they placed on their prostheses in each of the activity areas.

The extent to which a subject used his prosthesis to accomplish the tasks of daily life seemed to be a significant factor in appraising the degree of functional restoration afforded by the prosthesis. For this reason information was gathered about the frequency with which the prosthesis was used in ordinary two-handed activities. In order to make this more meaningful, additional information was collected concerning the frequency with which each activity was encountered in the course of the daily life of the particular amputee. Additional information about common activities which were *not* done and the reasons therefor also was gathered.

The following key questions were used:

1. How often does the occasion arise for the amputee to perform each of a number of typical two-handed activities?
2. How often does the amputee use his prosthesis in performing each activity?
3. If the need for an activity arises more often than the prosthesis is used in accomplishing the task, why does the amputee not use his prosthesis?

4. What is the relative importance of each of a number of activities?

These evaluations were made by means of the instrument shown in Appendix IIIC. The results of this study will appear in an article in the next issue of ARTIFICIAL LIMBS (Autumn 1958; Vol. 5, No. 2).

Reactions to Amputation and Prosthetic Experience. The subjective reaction of an amputee to his prosthesis was deemed an important factor in its evaluation. Apart from his feelings about the characteristics of the prosthesis, his experiences in securing it and wearing it are also contributing factors in his acceptance or rejection of the arm, and information in this regard may be important to an understanding of his status. This type of information was obtained through the use of interviews and questionnaires. By these means, data were gathered relating to:

1. Time lapse between amputation and first prosthesis.
2. Preprosthetic physical therapy.
3. Procedures in prosthetic prescription.
4. Services of prosthetist.
5. Procedures in initial checkout of prosthesis.
6. Training in the use of the prosthesis.

The article by Springer (page 73) describes the findings of this study.

Amputees' Appraisal of Prosthesis and Components. An evaluation of the prescribed components was an essential aspect of the studies. An armamentarium had been developed, and components had been prescribed on the basis of their design features. In order to appraise the relative value of these components, the amputees were asked to comment on specific characteristics of all the components of their prostheses and to describe the suitability or inconvenience of any device with which they were familiar. The following information was elicited:

1. The extent of his acquaintance with prosthetic components.
2. His appraisal of certain specific characteristics of each device with which he was familiar.
3. His expression of the suitability of prosthetic components for activities.
4. A comparison of currently and previously worn prostheses.

These opinions and experiences were recorded as shown in Appendix HID. The results and significance of this study will appear in an article in the next issue of ARTIFICIAL LIMBS (Autumn 1958; Vol. 5, No. 2).

Psychological Reactions

It is frequently observed that some amputees fail to wear or use a prosthesis which seems to be well fitted and functional. Others, with properly prescribed and well-fitted arms, and even those with inadequate prostheses, accept and use them extensively. These reactions were attributed to the varying, highly personal meanings of amputation and prosthetic restoration. For this reason, a psychological analysis by means of interviews and questionnaires was undertaken to explore the significance of these factors.

The instruments used included a 57-item multiple-choice questionnaire (Appendix HIE) developed by the Prosthetic Devices Study. Completed by the subject in the presence of an NYU representative, it was designed to provide information about the feelings and behavior of amputees relative to amputation and prosthetic restoration. The following reactions were elicited: feelings of functional adequacy, acceptance of loss, sensitivity about disability, ability to cope with social situations, feelings of independence, and attitudes toward prostheses.

Another questionnaire (Appendix IIIF) contained nine open-end questions. This provided an opportunity for the subject to express his feelings about the effects of his condition and treatment upon his personality and social activities. It supplemented the more highly structured 57-item questionnaire (Appendix IIIE).

The third instrument (Appendix IIIG) was a novel (experimental) application of a projective device. It consisted of nine cartoons depicting common social situations in which the fact of amputation might lead to awkwardness or embarrassment. It permitted the amputee to select one of a number of possible responses to each potentially embarrassing situation. By his reaction, the patient was expected to express his feelings of independence, the degree to which he faced reality, his

acceptance of the amputation, and his sense of security. Each response represented a gradation of possible reactions to each situation.

A fourth questionnaire (Appendix IIIH) was employed specifically to elicit information from subjects who had never previously worn prostheses. It consisted of 15 multiple-choice questions relating to the amputee's knowledge of prosthetic components and his expectations regarding the functional, cosmetic, and comfort qualities of artificial arms. A series of open-end questions was included to determine opinions of prosthetic usefulness and difficulties of prosthetic wear.

Upon execution of these procedures, the evaluation of an amputee was complete, but the entire process was performed twice. The first appraisal, conducted by the NYU representative prior to the prescription meeting, provided a detailed description of the pretreatment condition of the patient with respect to his physical condition, functional capacity, experience as an amputee, quality and usefulness of his prosthesis, and his emotional reaction to disability. Approximately three months after a satisfactory final checkout, or six to nine months after fitting, the previously evaluated subjects were again processed for a post-treatment evaluation, the procedures followed being essentially the same as in the pretreatment evaluation. The instruments used are given in Appendices IIIE, IIIF, IIIG, and IIIH.

These data are analyzed and discussed in an article to appear in the next issue of ARTIFICIAL LIMBS (Autumn 1958; Vol. 5, No. 2).

SUMMARY

Some of the problems involved in prosthetic service to amputees just after World War II, and the steps taken by governmental and private organizations toward their solution, have been described in this section. The development of the Artificial Limb Program has been traced briefly from its inception through

the initial studies in which problems were isolated and new methods and materials to solve them were developed. The dissemination of new knowledge through the organization of a prosthetics education program has been discussed, and the design and scope of the studies undertaken to evaluate the new developments have been described. "Survey Studies" were carried out to increase the available knowledge about amputees in this country. "Clinical Studies" were pursued to evaluate the effect of the newly developed treatment methods. And "Evaluation Studies" of the changes in amputees' conditions brought about by these treatments were planned and executed.

The evaluation instruments and techniques have been described briefly in this section in the interest of presenting a clear overview of the whole process. A total of 359 amputees were studied by means of these procedures. This group contained 168 below-elbow, 158 above-elbow, 23 shoulder-disarticulation, and 10 bilateral amputees.

The upper-extremity field studies represented a pioneering effort to apply special skills to special problems in a broad, only partially understood field. A multiplicity of interests, unique requirements, and a paucity of previous research combined to broaden the scope of the studies. The methods and instruments employed are considered a first step toward the establishment of more precise and valid methods for evaluating the condition of those with physical impairment. But despite the broadness of the field and the research requirements, service to the amputee was always a paramount consideration.

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Studies of the Upper-Extremity Amputee

II. The Population (1953-55)

NORMAN BERGER, M.S.¹

THE number of upper-extremity amputees examined during the "Survey Studies" conducted by New York University probably represents the largest sample of a single type of disabled individual any research group has thus far had the opportunity to study. The size of the sample (1630 cases) offered a unique opportunity for assessing the status of the upper-extremity amputee on a nationwide basis during the years 1953-55 just prior to the widespread introduction of the devices and techniques promulgated by the Artificial Limb Program. The information that will allow us to form a picture of the arm-amputee population during those years is presented in the following pages under the headings:

General characteristics. This section presents identifying data (such as age, height, weight, and educational level) as well as some general findings concerning causes of amputation, amputee types, and amputee vocations.

Stump characteristics. Here are found data concerning the strength and range of motion of various stump movements, characteristics basic to the control and use of a prosthesis.

Extent of use of prostheses. Under this heading is presented information dealing with the extent and type of prosthetic use in the common activities of daily living, data which permit inferences concerning the functional value of prostheses.

Prosthetic components. This section presents a description of the prostheses worn by arm amputees throughout the country.

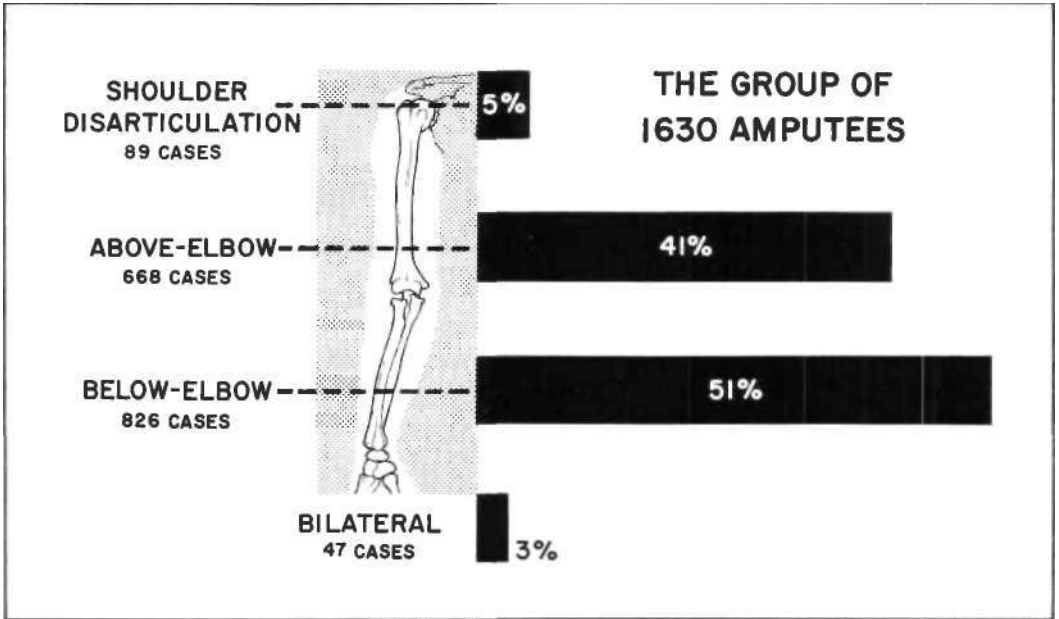
Within this outline, the data gathered are presented, where applicable, by amputee type, an arrangement which permits comparison of attributes between below-elbow, above-elbow, shoulder-disarticulation, and bilateral arm amputees.

One should note at the very outset that this entire study deals with *male* amputees only. No female patients are included anywhere. It will also be noted that the tables and graphs which present the data contain a varying number of cases. Owing to such limitations as the fact that some amputees were not wearing their prostheses or could not remember details about their prosthetic experience, full information was not available for each case. Accordingly, the totals approximate, but are usually somewhat less than, 1630.

GENERAL CHARACTERISTICS

Below-elbow amputees only slightly outnumber above-elbow amputees in the general population. This observation may be somewhat surprising in view of the widespread belief that below-elbow amputations occur much more frequently than do other types. Apparently, the latter is not the case, and it would therefore be unwise to direct research and development toward the one area at the expense of the other. The relative infrequency of shoulder disarticulations and of bilateral arm amputations also is noteworthy.

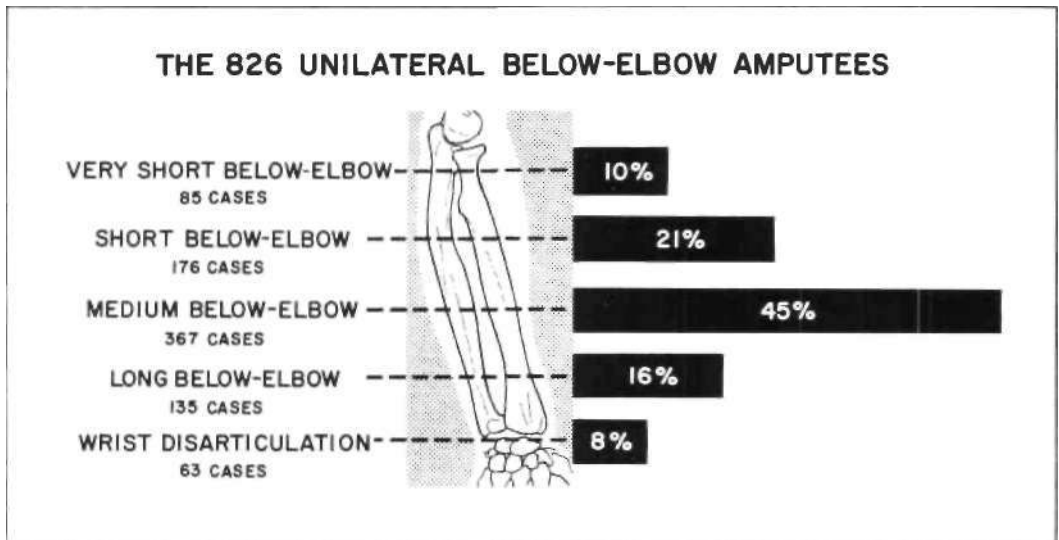
Classification of arm amputees is based on stump length expressed as a percentage of the length of the same arm segment on the sound side. For example, a below-elbow amputee whose stump measures 6 in. from medial

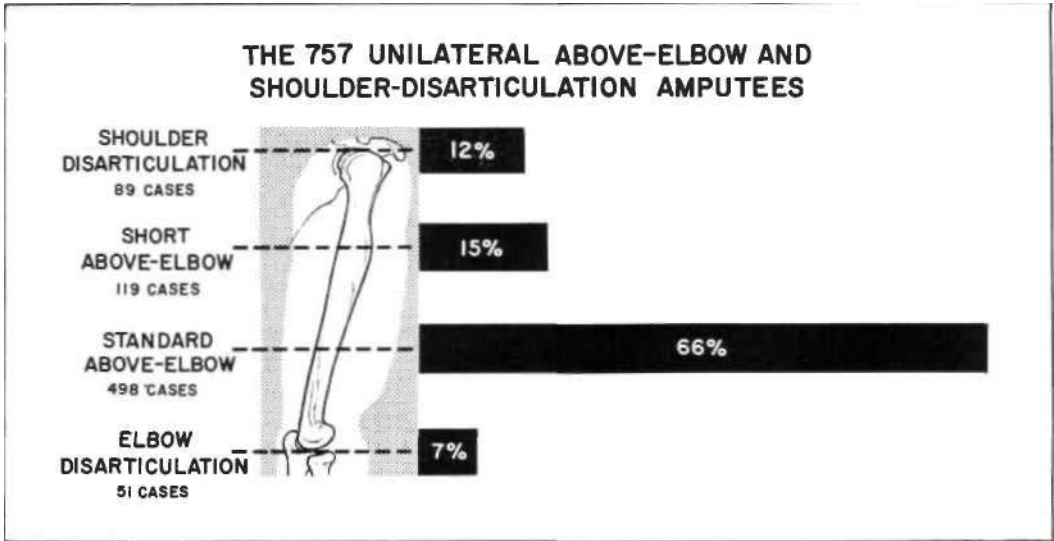


epicondyle to end and whose sound forearm measures 12 in. from medial epicondyle to ulnar styloid has a remaining stump length of 50 percent. The system of classifying arm amputees is thus based on percentage categories, each category indicating a progressively greater amount of loss of function. Because the remaining percentage of the length of the

corresponding normal arm segment is an indication of the amount of functional loss occasioned by the amputation, the figure is an important one.

In the NYU survey, the number of amputees in each category was as indicated in the accompanying charts. Nearly half (45 percent) of all below-elbow amputations fall in the

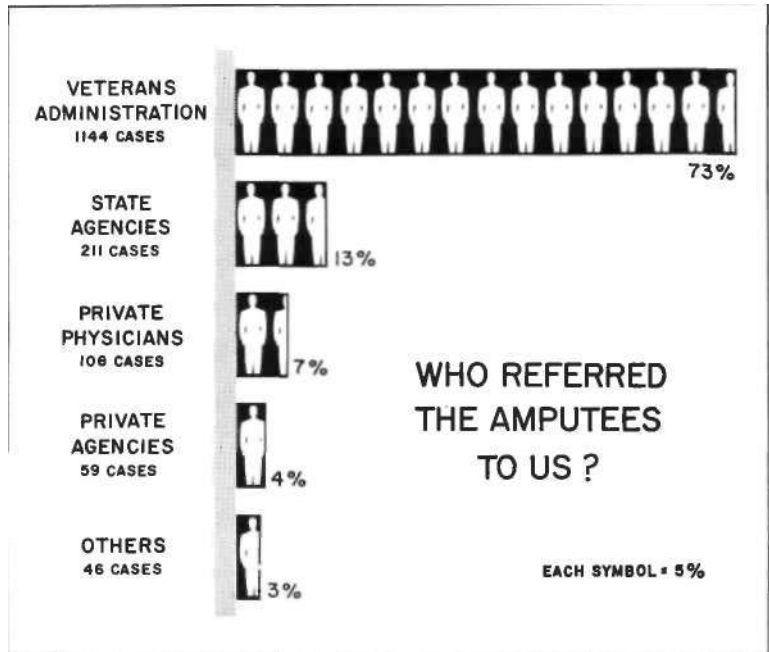




medium below-elbow range, while more than half of the above-elbow cases (66 percent) fall in the standard above-elbow category. Extremely short stumps tend to outnumber extremely long types in both above- and below-elbow cases. Of the below-elbow stumps, 10 percent are very short as compared to 8 percent that are wrist disarticulations; in the above-elbow group, 12 percent are shoulder disarticulations as compared to 7 percent that are elbow disarticulations.

A very substantial portion of the amputees contacted during the survey studies were veterans whose amputations were service-connected and who were receiving prosthetic treatment through the Veterans Administration. This preponderance of veteran amputees should be borne in mind, since it may tend to affect the data in some respects.

With the large number of veterans in the sample, it is not surprising that over half of the amputations were caused by combat injuries. Aside from wartime casualties, most upper-extremity amputations result from trauma, less than 5 percent being either of congenital origin or due to disease.



The average age of the group (Table 1) is 36 years, but in view of the large number of veterans in the sample it is difficult to say whether this age distribution is representative of the entire amputee population. It is likely that significant numbers of cases in the older age groups are not included in these data.

Tables 2 and 3 give respectively the heights and weights of the subjects studied. Table 4 gives the residence of the subjects by state.

Almost four out of five of the amputees in the survey group were married (Table 5). There has been speculation about a possible relationship between the extent of handicap and marital status. In this regard, the following breakdown may be of interest:

	Below-Elbow	Above-Elbow	Shoulder Disarticulation	Bilateral
Percentage that were single	19	21	32	26

While there is some indication of a trend in these figures, their significance must await additional data bearing on this point.

Table 6 presents the educational level of the subjects, but here again the data may be biased by the fact that a large portion of the group was eligible for educational benefits through the Veterans Administration or State Vocational Rehabilitation Divisions. The effect of these influences on the data cannot be assessed without further study.

Table 1
AGE OF THE SUBJECTS

No. of Cases	Age (years)	Percent of Total
69	15-19	4
406	20-29	25
734	30-39	45
253	40-49	16
106	50-59	6
46	60-69	3
8	70 and over	1
Total 1622		

Amputation in the upper extremity apparently results in a definite occupational shift primarily away from agricultural and other forms of manual labor at all levels of skills and toward managerial, clerical, sales, and office work. Prior to amputation, professional-managerial, clerical, and sales jobs accounted for 14 percent of the sample's vocations, while agricultural, skilled, semi-skilled, and unskilled jobs accounted for 64 percent. In contrast, the former groups of jobs include 41 percent of the postamputation occupations (an increase of 27 percentage points), and the latter groups include 27 percent (a decrease of 37 percentage points).

Another marked shift occurs in the rate of unemployment. Whereas only 1 percent of the group was unemployed prior to the loss of an arm, 19 percent were not gainfully employed when seen at amputee clinics.

Table 2
HEIGHT OF THE SUBJECTS

No. Cases	Height	Percent of Total
35	Under 5'4"	2
80	5'4" but less than 5'6"	5
276	5'6" but less than 5'8"	17
393	5'8" but less than 5'10"	25
469	5'10" but less than 6'0"	29
257	6'0" but less than 6'2"	16
92	6'2" and over	6
Total 1602		

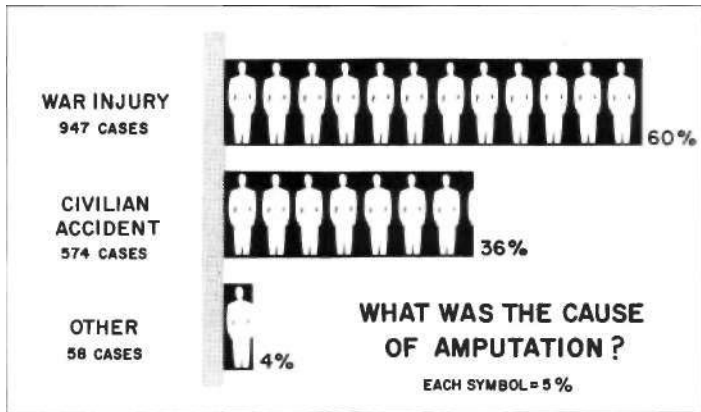
Table 3
WEIGHT OF THE SUBJECTS

No. Cases	Weight (lb.)	Percent of Total
23	Under 120	2
176	120-139	11
443	140-159	28
522	160-179	32
289	180-199	18
95	200-220	6
54	Over 220	3
Total 1602		

It is interesting to note that those amputees who were employed were occupied in a wide variety of jobs including agricultural and skilled vocations. This fact leads us to speculate as to the reasons for these occupational shifts. Are these trends actually caused by the physical inability of the amputee to perform and compete, or are there perhaps other social or psychological reasons for the occupational shift? Doubtless, a combination of factors is operative, but the relative importance of each is still unknown.

STUMP CHARACTERISTICS

The stump characteristics with which we are concerned in this section are strength and



range of motion. Information about these characteristics was obtained through goniometric measurements and standard muscle-testing techniques.

In general, the below-elbow amputee retains somewhat more range of pronation than of supination (Table 7). The average amount of residual pronation in the entire sample is

Table 4
RESIDENCE OF THE SUBJECTS BY STATE

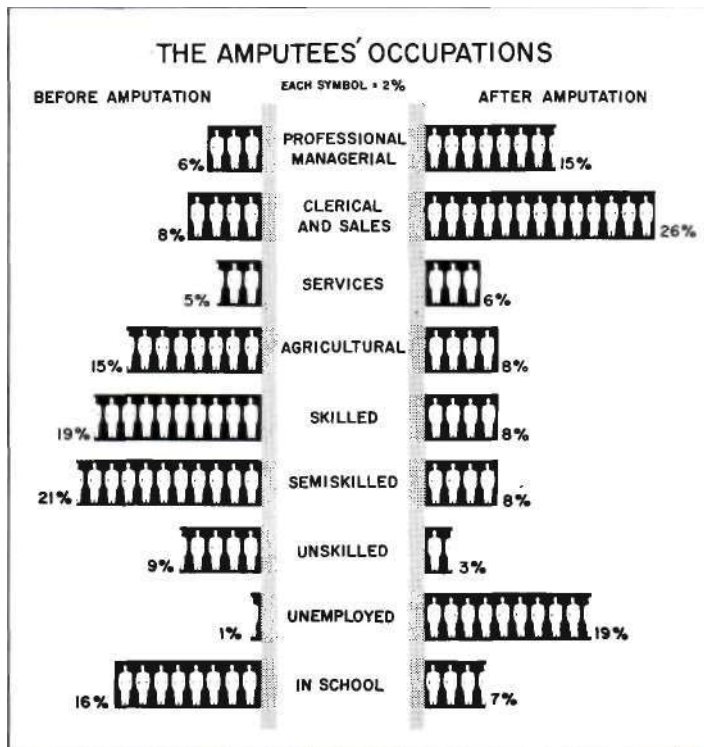
Alabama	24	Nebraska	16
Arizona	0	Nevada	0
Arkansas	3	New Hampshire	0
California	157	New Jersey	65
Colorado	38	New Mexico	3
Connecticut	1	New York	70
Delaware	1	North Carolina	13
District of Columbia	12	North Dakota	0
Florida	27	Ohio	120
Georgia	38	Oklahoma	61
Idaho	0	Oregon	25
Illinois	24	Pennsylvania	163
Indiana	1	Rhode Island	10
Iowa	32	South Carolina	0
Kansas	24	South Dakota	0
Kentucky	41	Tennessee	61
Louisiana	39	Texas	79
Maine	3	Utah	25
Maryland	29	Vermont	0
Massachusetts	73	Virginia	27
Michigan	129	Washington	33
Minnesota	48	West Virginia	3
Mississippi	7	Wisconsin	16
Missouri	86	Wyoming	3
Montana	0	Total	1630

Table 5
MARITAL STATUS OF THE SUBJECTS

No. Cases	Status	Percent of Total
320	Single	21
1199	Married	79
Total 1519		

Table 6
EDUCATIONAL LEVEL OF THE SUBJECTS

No. Cases	Education	Percent of Total
461	Attended or completed grade school	28
737	Attended or completed high school	45
336	Attended or completed college	21
88	Performed graduate work	6
Total 1622		



38 deg., the average amount of supination being 33 deg.

Besides retaining somewhat more range of motion in pronation than in supination, the below-elbow amputee tends to have somewhat greater strength of pronation (Table 8). The strength of pronation was rated good or

excellent in 57 percent of the cases while 51 percent were rated good or excellent in supination.

Of the total group, 75 percent were able to flex their elbows actively to an angle of 130 deg. or more (Table 9). Among below-elbow amputees, then, approximately three out of four cases retain a normal amount of elbow flexion on the side of the amputation. On the other end of the scale, however, it should be noted that a significant number of amputees have a restricted range of motion and require special prosthetic or medical attention in order to achieve a more normal flexion angle.

Whereas somewhat more than 50 percent of the cases had good or excellent strength in pronation and supination, 90 percent had

equivalent strength ratings in elbow flexion (Table 10), as would be expected since amputation through the forearm interferes less with the muscles and joints related to elbow flexion than with those related to pronation and supination.

When wearing a prosthesis, the above-elbow amputee rarely has occasion to move his

Table 7
RANGE OF PRONATION-SUPINATION

Pronation		Range (deg.)	Supination	
No. Cases	Percent of Total		No. Cases	Percent of Total
262	32	Below 10	276	34
102	13	10-29	155	19
172	21	30-49	178	22
127	15	50-69	98	12
80	10	70-89	49	6
70	9	90 or more	57	7
Total 813			813	

Table 8
STRENGTH OF PRONATION-SUPINATION

Pronation		Strength	Supination	
No. Cases	Percent of Total		No. Cases	Percent of Total
215	28	Excellent	194	25
224	29	Good	199	26
103	13	Fair	132	17
19	3	Poor	21	3
209	27	Trace or none	224	29
Total 770			770	

stump beyond an angle of 80 deg. either in elbow flexion or in abduction of the humeral stump. On this basis, the majority of above-elbow amputees have more than adequate range of motion for present conventional prostheses. The data indicate that 94 percent of the cases had 80 deg. or more of flexion; 91 percent had 80 deg. or more of abduction (Table 11).

The motion of extension at the shoulder joint is used primarily in locking and un-locking the prosthetic elbow. To perform this operation, an extension range of 40 deg. is more than adequate. In our sample, 82 percent of the cases could achieve an extension angle of 40 deg. or more.

The majority of above-elbow amputees have no significant problem with regard to the strength of motions at the shoulder joint. In the total group, 90 percent of the cases had good or excellent strength in flexion, 81 percent had good or excellent strength in extension, and 90 percent had good or excellent strength in abduction (Table 12).

EXTENT OF USE OF PROSTHESES

In assessing the extent of prosthetic use, information was obtained as to the length of time the prosthesis was worn, if at all, and as to the specific activities for which it was used in dressing, eating, work, and recreation. These data permit inferences to be made concerning the usefulness of the prosthesis in everyday life.

A surprisingly large portion (62 percent) of the amputees indicated that they were

Table 10
STRENGTH OF ELBOW FLEXION

No. Cases	Strength	Percent of Total
393	Excellent	50
308	Good	40
60	Fair	8
14	Poor	2
4	Trace or none	Negligible
Total 779		

Table 11
RANGE OF HUMERAL FLEXION, EXTENSION, AND ABDUCTION IN ABOVE-ELBOW CASE

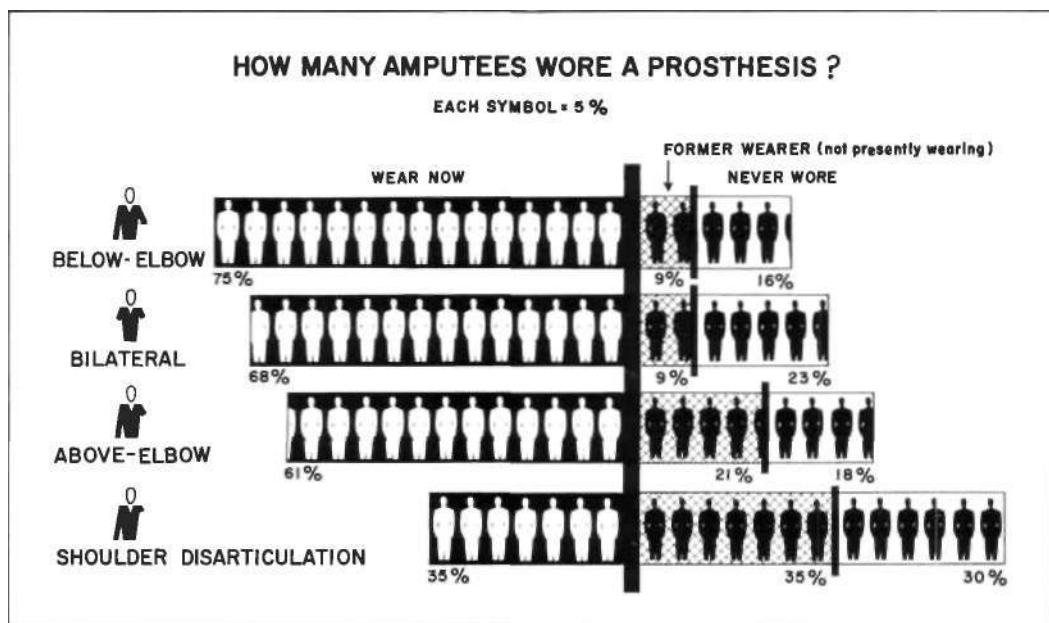
Flexion		Extension		Range (deg.)	Abduction	
No. Cases	Percent of Total	No. Cases	Percent of Total		No. Cases	Percent of Total
9	1	31	5	Under 20	13	2
2	1	86	13	20-39	8	1
11	2	286	42	40-59	18	3
11	2	201	30	60-79	19	3
35	5	69	10	80-99	83	13
54	8	—	—	100-120	107	16
530	81	—	—	Over 120	404	62
Total 652		673			652	

Table 12
STRENGTH OF HUMERAL FLEXION, EXTENSION, AND ABDUCTION IN ABOVE-ELBOW CASE

Flexion		Extension		Range (deg.)	Abduction	
No. Cases	Percent of Total	No. Cases	Percent of Total		No. Cases	Percent of Total
307	48	227	39	Excellent	290	46
769	42	246	42	Good	276	44
44	7	87	15	Fair	52	8
6	1	11	2	Poor	4	1
8	2	12	2	Trace or none	10	1
Total 634		583			632	

Table 9
RANGE OF ELBOW FLEXION

No. Cases	Range (deg.)	Percent of Total
58	Under 90	7
21	90-99	2.5
21	100-109	2.5
39	110-119	5
62	120-129	8
297	130-140	36
318	Over 140	39
Total 816		



prosthesis wearers at the time of the survey, but this figure may be deceptively high because of the large number of veterans in the sample. Moreover, the term "present wearer," while it indicates daily wear, does not indicate the actual *amount of time* the prosthesis is worn. Some of these "present wearers" may use the prosthesis only a short time each day. Further information bearing on this point is to be found in the accompanying chart dealing with the number of hours per week the prosthesis was worn.

It is perhaps more informative to notice how the wear status varies with increasing severity of loss. While 75 percent of the below-elbow amputees were classified as present wearers, this figure drops to 61 percent for the above-elbow amputees and to 35 percent for the shoulder-disarticulation cases. Clearly there are considerably fewer unilateral arm amputees wearing prostheses as the level of amputation moves proximally.

The same trend is found among amputees who had worn prostheses before but who had given them up and were nonwearers at the time of the survey. Among the below-elbow amputees, 9 percent were nonwearers although

they had had previous prosthetic experience. Among the above-elbow amputees, this figure rises to 21 percent and reaches 35 percent among the shoulder-disarticulation cases.

From these data, the inference is inescapable that, while the below-elbow prosthesis was a fairly widely worn device, the prosthetic replacement for the above-elbow case and that for shoulder disarticulation left more to be desired.

A significant portion of those amputees who wear prostheses apparently use them full-time, *i.e.*, 80 or more hours per week, which is about the equivalent of 12 hours a day, every day. In this respect there are, however, significant differences among the several amputee categories. For example, 71 percent of the below-elbow amputees were full-time wearers. But for the above-elbow and shoulder-disarticulation groups, this figure drops to 53 percent and 54 percent, respectively. Among bilaterals the figure rises to 88 percent; the bilateral is obviously more dependent on his prosthesis than is the corresponding unilateral amputee.

The conclusion that the amount of wear decreases significantly as the level of unilateral

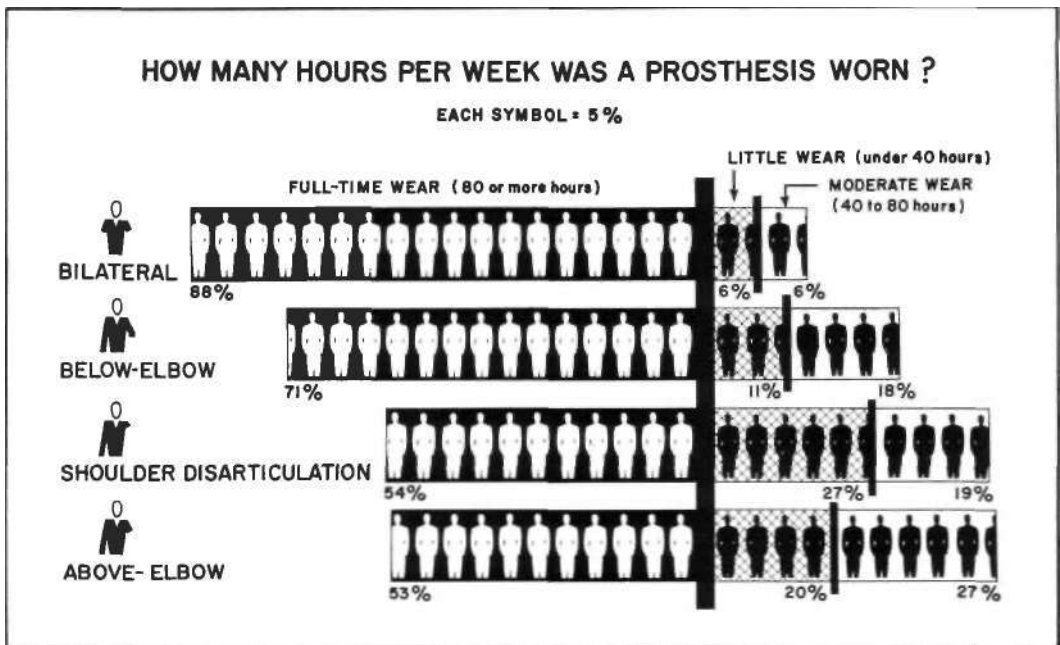
amputation becomes higher is reinforced by the data pertaining to the percentage of amputees who wear their prostheses for relatively short periods each week. A wearing time of less than 40 hours per week was reported by 11 percent of the below-elbow group, 20 percent of the above-elbow group, 27 percent of the shoulder-disarticulation group, and 6 percent of the bilaterals. Judging from these data, individuals with amputations above the elbow do not receive sufficient value from their prostheses to wear them consistently.

We come now to a consideration of the degree of actual use to which arm prostheses are put by those who wear them. The activities listed in the four accompanying charts have two important characteristics. First, they are extremely common, being performed several times daily by almost every active individual. They are an inescapable and integral part of normal daily life. Secondly, they are bimanual in nature, either requiring two hands directly or else necessitating the use of one hand while the other is occupied in an auxiliary role. For these reasons, the use or nonuse of the

prosthesis in these activities can properly be considered an indicator of the value of the replacement.

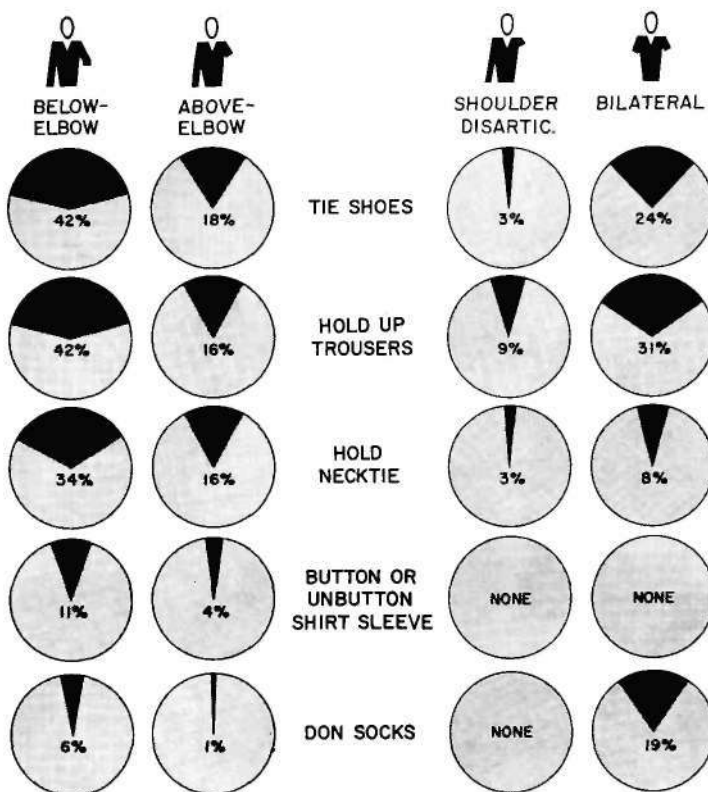
We have already seen that some amputees had never worn a prosthesis and that others had given one up after some trial period. While the situation is quite complex, these facts point out that, at least for a certain number of amputees, the prosthesis did not offer sufficient functional advantage to compensate for any inconvenience or discomfort involved in its use. But what of those amputees who did wear their appliance? Did they use their artificial arms to assist in the accomplishment of these common activities?

In the activities of dressing, we find that 42 percent of the below-elbow amputees *did* use their prostheses in tying shoe laces and in holding up the trousers while the sound hand adjusted buttons, zippers, or belts. This figure, however, is considerably reduced in the case of the above-elbow amputee and is even smaller for the shoulder-disarticulation cases. The information can be summarized by saying that, first, significantly less than half of those amputees who wear arm prostheses



USE OF PROSTHESIS IN DRESSING

(Percentage of Wearers)



use them in dressing activities and, second, that use of an arm prosthesis in dressing decreases markedly the more proximal the level of amputation.

Although it is customary for the normal person to use a knife and fork in cutting food, apparently most arm amputees adopt some other method. It should be recalled that the use of two hands for eating activities is mandatory in only a few instances, such as in cutting tough meat or in buttering bread. The amputee can try to avoid these situations, can receive help from another person, or can use a special tool such as a combination knife-fork. At any rate, it seems clear that, in the area of eating, the prosthesis was not of great functional value to the sample group. The highest rate of use was only 23 percent (among the below-

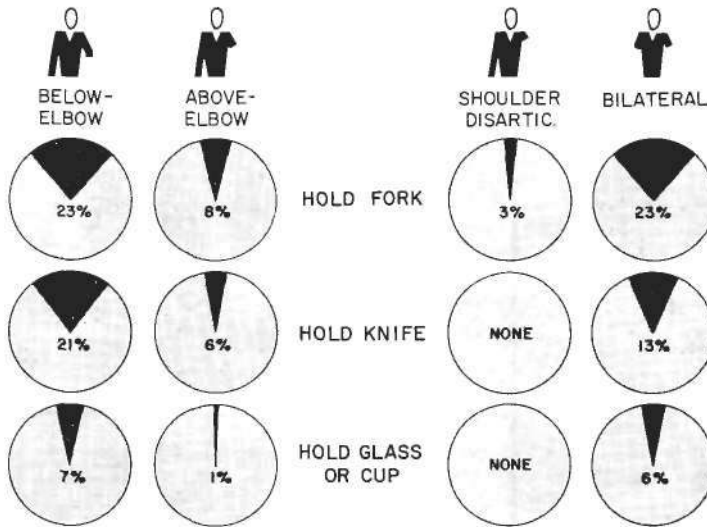
elbow and the bilateral subjects, who reported holding a fork in the prosthesis).

Light grasp is differentiated from heavy grasp not only by the weight of the object but also in that precision is the essential feature of the former while strength of grip is paramount in the latter. Holding papers and writing implements are examples of light grasp; handling tools exemplifies heavy grasp. The word "support" is here used to indicate holding an object up, as in carrying a topcoat, not by grasping but by placing a terminal device or prosthetic forearm underneath it. "Weight" implies holding an object down in the fashion of a paperweight, again without grasping.

As regards work activities, the data on use of an arm prosthesis present much the same

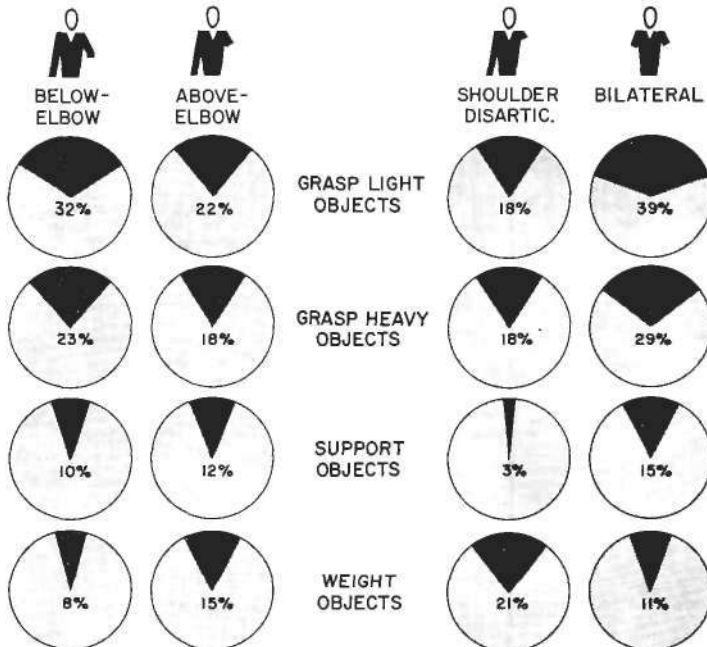
USE OF PROSTHESIS IN EATING

(Percentage of Wearers)



USE OF PROSTHESIS AT WORK

(Percentage of Wearers)



picture as we have seen in connection with dressing and eating. The majority of the group still report no use of their prostheses, and again the amount of use at work declines at the higher amputation levels. It is interesting to note, however, that in this area there is much less decrease in use among above-elbow and shoulder-disarticulation amputees than is the case in the other two areas (dressing and eating). That is to say, the above-elbow and shoulder-disarticulation prosthesis was used more often for work tasks than for eating or dressing. This may be accounted for by the social and competitive pressures in job situations, or perhaps by the fact that work tasks are extremely varied as compared to the restricted number and type of activities in dressing and eating.

As for activities involved in recreation, the number of amputees reporting use of the prosthesis for grasp of heavy objects is more than double the number reporting light grasp. This reversal of the data dealing with use of

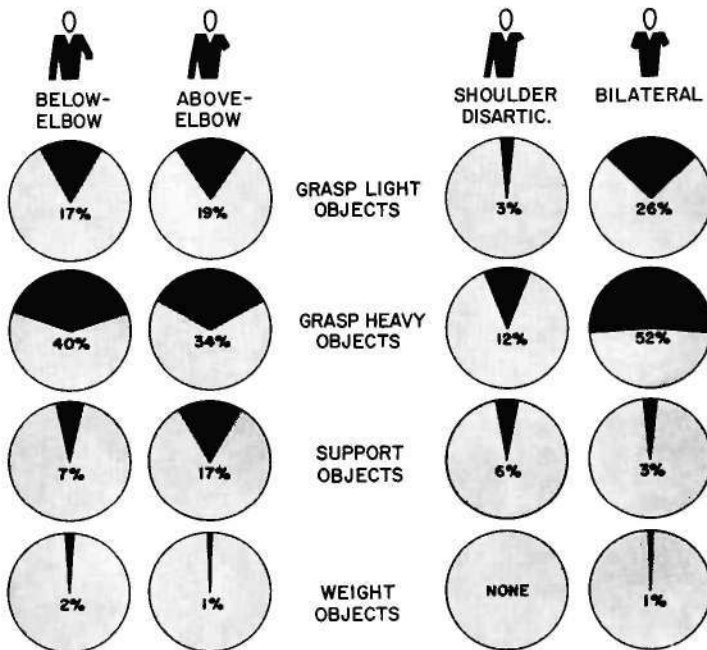
the prosthesis at work raises a number of questions. Does the amputee find himself placed in jobs whose demands are quite light physically? And, if so, is this a real or an imagined limitation, since apparently the amputee is able to and tends to do heavier activities for his own recreation than he does on the job? It may be that there is an existent prejudice, not in accord with the facts, concerning the kind of activity that an arm amputee can perform. Such a misconception, on the part either of the amputee or of other persons such as vocational counselors, could lead to placement in jobs requiring activity levels lower than those which the amputee is capable of producing.

PROSTHETIC COMPONENTS

In this section we are concerned primarily with the types of prosthetic equipment worn by arm amputees throughout the country just prior to the research studies. For convenience, we shall deal first with those pro-

USE OF PROSTHESIS FOR RECREATION

(Percentage of Wearers)



thetic components that are common to all prostheses and then proceed to components that are specific to below-elbow and to above-elbow arms.

At the time of this survey of upper-extremity amputees, the voluntary-opening Dorrance No. 5 was by far the most widely used hook. Over 32 percent of the group wore it. In all, the Dorrance hooks, of which there are numerous types, were worn by 70 percent of the subjects, the No. 8 and the No. 7 following behind the No. 5 in popularity. Other hooks that had a fairly widespread use were the APRL voluntary-closing hook (10 percent of all the amputees) and the Trautman hook (9 percent).

The three hands that had been most widely dispensed were the Miracle (31 percent of the group), the APRL (24 percent), and the Becker (21 percent). In addition to the relative numbers of the various types of hands, it is interesting to note that 84 percent of the sample used active hands as compared to 16 percent who wore passive hands. Also, as one would expect, the total number of hands

worn (728), while quite high, is substantially less than the total number of hooks (1010). Many amputees owned both a hand and a hook.

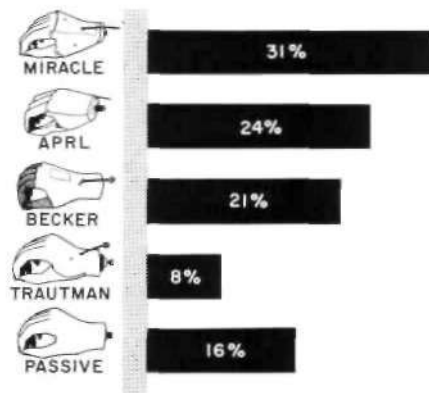
It is clear that at the time of the survey the great bulk of arm amputees (70 percent) used friction wrist units. The positive-locking type of wrist unit was worn by 20 percent of the group, and approximately three out of four of these units were of the Hosmer WD-400 type. The proportion of positive-locking wrists remained fairly constant in all groups except that of the bilaterals, who would be expected to have difficulty in operating this unit. Among the arms worn by bilaterals, only two were equipped with positive-locking wrists.

The remaining 10 percent of the sample wore the quick-change Dorrance "Butterfly" type of wrist, which is essentially a friction unit with provision for quick interchange of terminal devices.

Considering the group as a whole, plastic sockets were used most extensively. Forty-three percent of the subjects wore this type as compared to 37 percent who wore sockets made of leather, 12 percent whose sockets were made of wood, and 9 percent with fiber sockets. Since plastic is the standard socket material today, it is interesting to note that

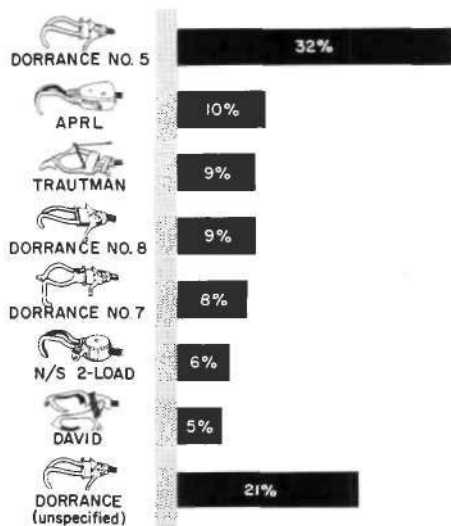
HANDS USED

(In Percent of a Total of 728 Amputees)



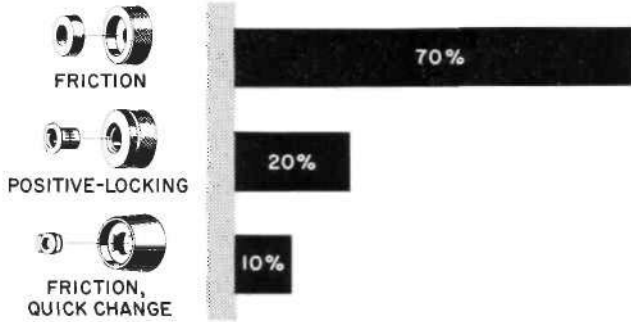
HOOKS USED

(In Percent of a Total of 1010 Amputees)



WRIST UNITS USED

(In Percent of a Total of 1156 Amputees)



57 percent of the entire group did not wear plastic sockets at the time of the survey.

There was, however, considerable variation among the below-elbow, above-elbow, and shoulder-disarticulation groups. The leather socket was used by a substantial portion of the below-elbow population (47 percent) but by smaller segments of the above-elbow and shoulder-disarticulation groups (23 percent and 35 percent respectively). Approximately half of this latter group (above-elbow and shoulder disarticulation) wore plastic sockets.

It is interesting to note that at the time of the survey there was still fairly prevalent use of wood for the above-elbow socket (19 percent of the cases) and of molded leather for the shoulder-disarticulation socket (35 percent of the cases). The data also indicate that over 79 percent of the below-elbow and over 86 percent of the above-elbow sockets were of single-wall construction. Double-wall sockets, which have many functional and cosmetic advantages, were not in general use.

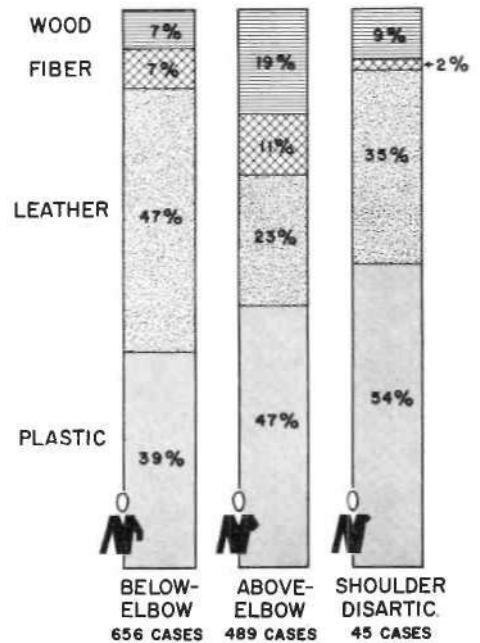
The harnesses worn by arm amputees at the time of the survey present quite different pictures in the below-elbow and above-elbow groups. The bulk of the below-elbow population (63 percent) used standard figure-eight harnesses, and an additional large group (25 percent) wore a single axilla loop. These two types of harnesses differ only in that the

axilla loop does not contain the front suspension strap (commonly in the form of an inverted F) of the figure-eight harness. The other major style of below-elbow harnessing is the chest strap and shoulder saddle, which was worn by 12 percent of the sample.

Turning to the above-elbow population, we find the situation reversed. Fifty percent of this group wore a shoulder saddle and chest strap, while another 24 percent wore the same harness *plus* an axilla loop to which

the control cable was attached. Thus, three quarters of the above-elbow sample had shoulder saddles and chest straps as their

SOCKET MATERIALS USED



basic suspensory harness. The remaining one quarter of all above-elbow amputees wore figure-eight harnesses, either with or without the over-the-shoulder strap.

The most universally used elbow joint was the polycentric rigid joint. It was found in 57 percent of the below-elbow arms (Table 13). If we add to this figure the three other types of rigid hinges listed in the accompanying table, we find that 70 percent of the below-elbow sample wore rigid elbow joints. The remaining 30 percent wore flexible or semiflexible joints.

Beginning with the triceps pad, a relatively small section of leather located on the posterior side of the humerus, each type of upper-arm cuff is progressively larger. The half cuff covers approximately half of the upper-arm circumference, the full cuff completely encircles the arm, and the three-quarter cuff is between these two in size.

A principle generally agreed upon is that the less cuffing used the more comfortable and

HARNESS TYPES USED

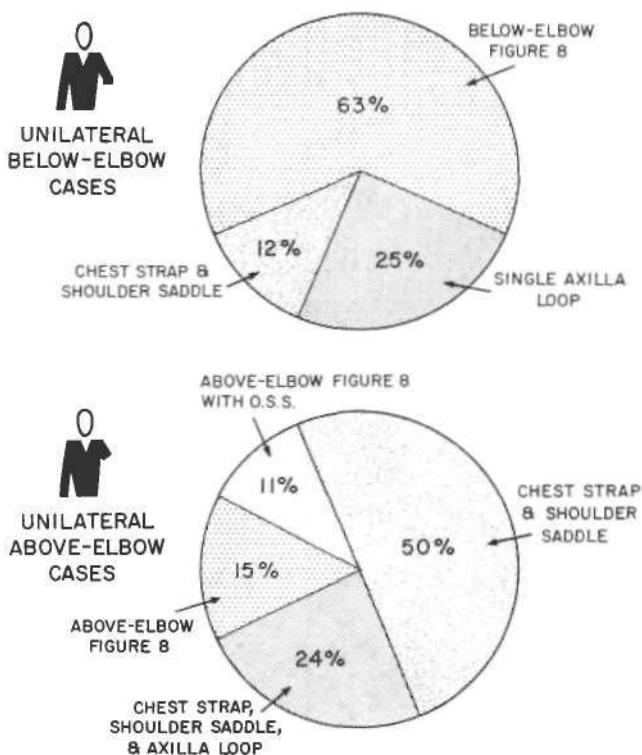


Table 13
ELBOW HINGES USED

No. Cases	Joint	Percent of Total
385	Polycentric rigid	57
120	Flexible	18
80	Semiflexible (insert)	12
55	Rigid, type unspecified	8
16	Step-up	2
14	Single-axis rigid	2
4	Locking rigid	1
Total 674		

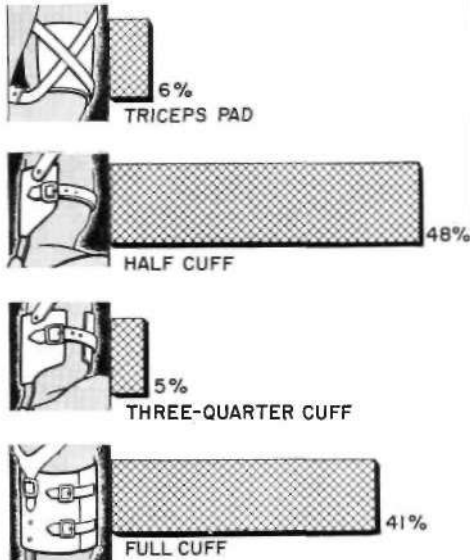
convenient is the prosthesis, provided that stability and control are not impaired. It is noteworthy, therefore, that the smallest cuff, the triceps pad, was worn by only six percent of the cases. The half and full cuffs were worn almost exclusively (48 and 41 percent of the sample, respectively).

Almost all of the half and full cuffs were worn with one or two billets. One of the factors accounting for the large number of full cuffs and supportive billets, which contrasts markedly with present practice, may have been the previously noted prevalence of the axilla-loop harness, which has no front suspension strap.

Slightly more than half of all above-elbow amputees did not use automatic, harness-

CUFFS USED BY BELOW-ELBOW AMPUTEES

AMONG 653 AMPUTEES



controlled elbow units, which are considered standard equipment today. Of this group, 42 percent were manual locks operated by the remaining sound hand, while the remainder (12 percent) wore Fitch-type elbows, which do not contain a locking mechanism.

Of the slightly less than half who did wear harness-operated elbow-locking units, 25 percent used Hosmer units (primarily the E-300 elbow) and 21 percent used Sierra units (the Model C elbow).

SUMMARY

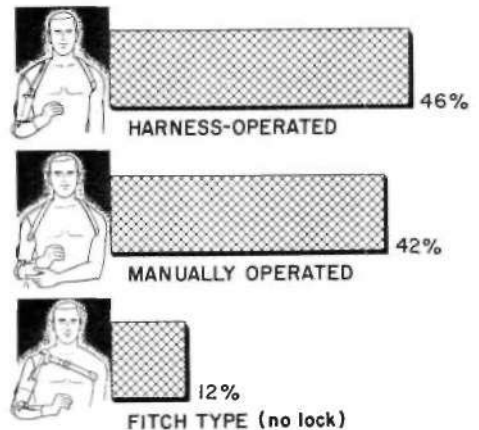
The past five years have witnessed a rapid change in the field of upper-extremity prosthetics, partly as a result of the education program and of the studies reported in this issue of ARTIFICIAL LIMBS. AS a step in the measurement of the progress that has been and will be made, the survey studies were designed to provide a baseline describing the state of upper-extremity prosthetics prior to

the introduction of new techniques, devices, and concepts of amputee management.

To establish this baseline, information has been presented about a sample of 1630 amputees observed during the years 1953-55. The character and status of the entire upper-extremity amputee population in 1953-55 can reasonably be inferred from these data. The extremely large number of all types of male amputees who participated, the nationwide scope of the survey, the inclusion of wearers and nonwearers, and the wide variety of occupations represented make for confidence

ELBOWS USED BY UNILATERAL A/E AND S/D AMPUTEES

AMONG 492 AMPUTEES



in the accuracy with which the state of the art has been depicted.

The primary limiting factor in these data is the large number of veterans among the group, which undoubtedly influences the results. In addition, the data tend to characterize those amputees who reside in urban areas or within a 100-mile radius of the major metropolitan centers where the participating clinics were located. Hence it is likely that the rural resident is not fully represented.

Studies of the Upper-Extremity Amputee

III. The Treatment Process

WARREN P. SPRINGER, M.A.¹

THE amputees who took part in the NYU Upper-Extremity Field Studies obtained their new prostheses through a treatment process characterized by seven clear-cut steps. These were preprescription examination, prescription, preprosthetic therapy (if indicated), fabrication of the prosthesis, initial checkout, training, and final checkout.

The preprescription examination was conducted at the beginning of the treatment process in order to obtain information that would be useful in formulating the prescription and planning the entire treatment program for the patient.

As for prescription, the research and educational program strongly encouraged the clinician team approach, wherein the physician, as clinic chief, involved the prosthetist, the therapist, the patient, and frequently other individuals, such as the social worker or the vocational counselor, in the prescription process. The resulting prescription not only covered the strictly medicosurgical aspects of management but also specified the type of prosthesis and components that were to be used and the training the patient was to receive.

The preprosthetic phase of treatment, when indicated, was directed toward providing the patient with the necessary strength and range of motion to operate his prosthesis and toward conditioning his stump for wearing it.

In the fabrication process, the prosthetist, working with the patient, carried out the con-

struction and fitting of the prosthesis in accordance with the specifications of the prescription.

Initial checkout, which was done on a team basis, consisted of a systematic inspection and evaluation of the prosthesis to ensure that accepted standards of construction and function were achieved. This step was accomplished before the amputee received training and before he was permitted to wear his prosthesis for any extended period.

Training consisted essentially of two parts—controls training and use training. The purpose of controls training was to develop the ability to open and close the terminal device, control prehension force, operate the wrist unit, interchange terminal devices, and, in the above-elbow cases, flex the prosthetic elbow and operate the elbow lock. Use training was designed to develop the ability to utilize the prosthesis in practical tasks related to daily-living activities and to occupational requirements.

Final checkout was performed after the completion of training or after an initial period of wear. It paralleled initial checkout in that many biomechanical evaluation procedures were repeated to determine if wear had given rise to any difficulties or deficiencies. But in addition to the evaluation of the prosthesis itself final checkout also included an evaluation of training and of the amputee's ability to use the prosthesis at a practical level.

This paper is primarily an account of the experiences and opinions pertaining to the treatment process as obtained from interviews with 359 adult, male amputees both at the beginning and at the end of their participation

in the studies. The information concerning checkout and training is supplemented by clinical data from records of an additional 410 amputees who participated in clinical aspects of the study.

The general characteristics of the research group of 359 amputees closely parallel those of the 1630 amputees in the survey group (Section II). Between the two groups there were no significant differences with respect to age, height, weight, marital status, cause of amputation, or strength and range of motion on the side of the amputation, although there were slight differences in educational level, in experience with arm prostheses, and in the relative frequency of below- and above-elbow types. These data are presented in Appendix I (page 85).

In interpreting the data in this section, certain considerations should be kept in mind. First of all, a considerable portion of the information is based on the amputees' recollections of past events. The differences that may exist between the recollection of events and the events as they actually happened constitute a possible source of error. A second consideration has to do with the amputees' interpretations of the questions asked during the interviews, especially at the beginning of the study. Terms such as "clinic," "prescription," "checkout," "physical therapy," and "training" may have had widely varying meanings for different subjects. For example, a subject might have said that the prosthesis he was wearing at the beginning of the study had been subjected to a checkout when in reality it had been given only a cursory inspection instead of the systematic examination and evaluation that constituted a "checkout" in our meaning of the term.

A third factor has to do with the number of amputees who were able to give meaningful responses to these questions. In some instances and for various reasons usable responses were not obtained from the entire group. In some cases questions were not answered. In most instances, however, classifiable responses were obtained from at least 80 percent of the group, and it seems reasonable that these responses are representative of the attitudes of the entire group.

On the positive side, there is good reason to assign a considerable degree of importance to the opinions and reactions expressed by the subjects, since, in the last analysis, the amputee is the final judge of his prosthesis. The extent to which he accepts and approves of the process through which he obtains his prosthesis may have considerable bearing on the extent to which he accepts and uses the device.

PRESCRIPTION

Prior to their participation in the research studies, only 17 percent of the amputees had ever received an arm that was prescribed by a clinic team (physician, limbfitter, and therapist). In the great majority of cases, decisions as to the type of limb and components had been made either on an individual basis by the limbfitter or the amputee or jointly by both limbfitter and amputee. Fifty-six percent of the amputees approved of this procedure, the most frequent reason (21 percent) given for approval being that they were consulted concerning their choice.

In the group (44 percent) that did not approve of the preprogram procedure through which they had received a limb, 14 percent reacted negatively to the fact that they were not consulted. It was somewhat surprising to find that an additional 18 percent expressed the opinion that the amputee should *not* be consulted. Of the total group, 12 percent felt that the doctor should prescribe the prosthesis. Apparently a significant number of amputees prefer to trust the judgment of others in the matter of prosthetic replacement. Others (and the number probably increases with their prosthetic experience) prefer to become personally involved in the selection of components best suited to their needs.

Since all of the prescriptions for the new prostheses and related treatments were arrived at on a clinic-team basis, the amputees were asked the following question to obtain their reactions to the team method of prescription: *Do you think that prescription of a new arm by a clinic consisting of a doctor, limbfitter, and therapist is a good procedure?* Ninety-four percent of the amputees answered in the affirmative. Compared to the mixed reactions concerning the preprogram procedures, the

figure of 94 percent clearly indicates that the amputees preferred the new procedure. By far the most frequent reason given for this response was that the combined experience which could be obtained through the clinic procedure was useful. Typical comments were:

- "... more heads are better than one."
- "... experience of several people is helpful."
- "... no aspect is overlooked."

Other reasons that were mentioned relatively frequently can be classified under these headings:

- "... prevents errors."
- "... team members act as a check on each other."
- "... amputee becomes involved in the prescription."

Among the 6 percent who did not approve of the procedure, the most common reason offered was that:

"An old wearer knows what he needs."

To obtain information on the parts the various clinic members played in prescription, the amputees were asked: *Who was most influential in deciding the kind of arm you should have?* The replies are summarized in the accompanying chart.

TERMINAL DEVICES

The next two charts show the relative frequency with which the various types of terminal devices were prescribed in the research study. For purposes of comparison, data on the hands and hooks that were being worn at the

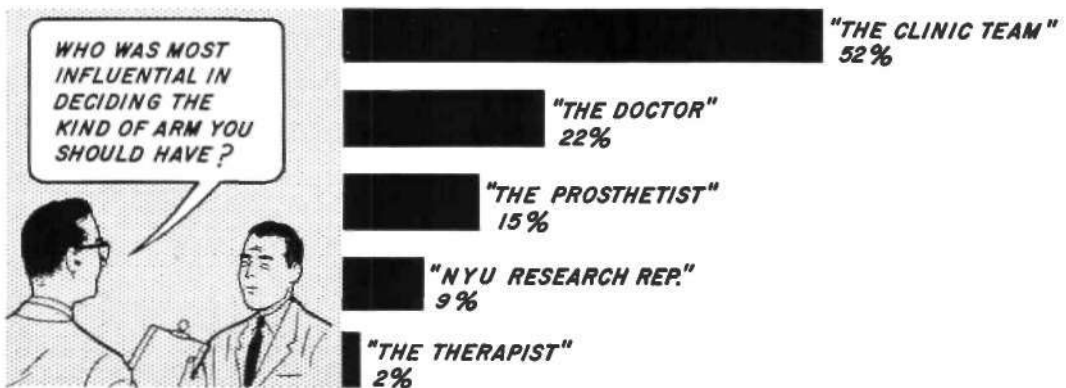
beginning of the study are included under the heading "Old Prosthesis."

In interpreting the prescription data on hands and hooks, consideration should be given to the fact that it was a policy of the research program to encourage the prescription of APRL hands and hooks in order to obtain additional data for evaluation of these devices. This accounts for part, but by no means all, of the changes in terminal components of the old and the new prostheses. Other factors involved in the changes were related to an increasing tendency on the part of clinic groups to prescribe aluminum hooks and hooks with rubber or neoprene facings and to a natural interest in the possibilities of voluntary-closing terminal devices with their wide range of grasp forces. In the case of the APRL hand, the wide range of grasp forces was combined with improved appearance. This natural curiosity and interest in new devices is reflected in the increased use of the Sierra two-load hook also.

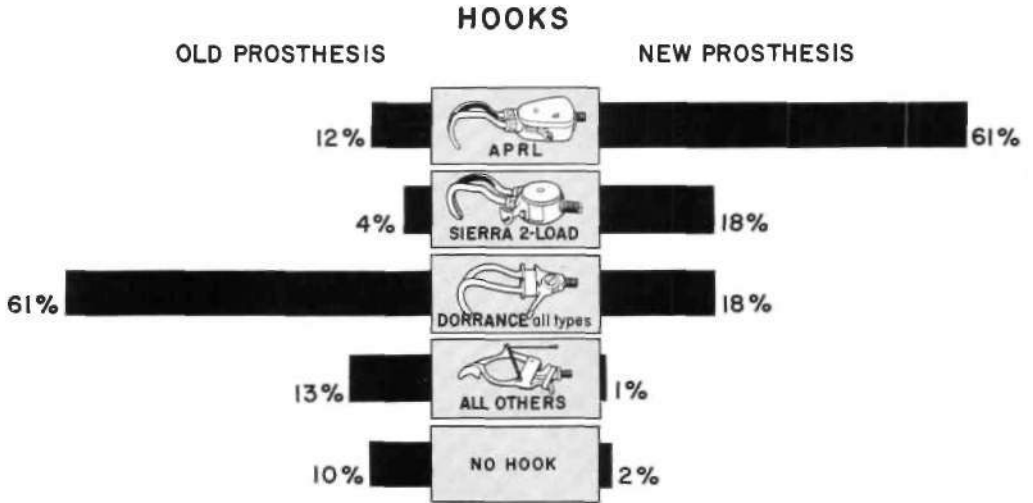
WRIST UNITS

The new prostheses showed a marked increase in the prescription of positive-locking wrist units with the "quick-change" disconnect. The chief reasons for this increase related to:

1. Specific vocational or avocational indications for a positive lock to control rotation.
2. Prescription of both hand and hook for approximately four out of five subjects. A substantial majority of these cases required a wrist unit with a "quick-change" feature to facilitate interchange of hand and hook.



TERMINAL DEVICES PRESCRIBED
(In Percent of All Amputees)

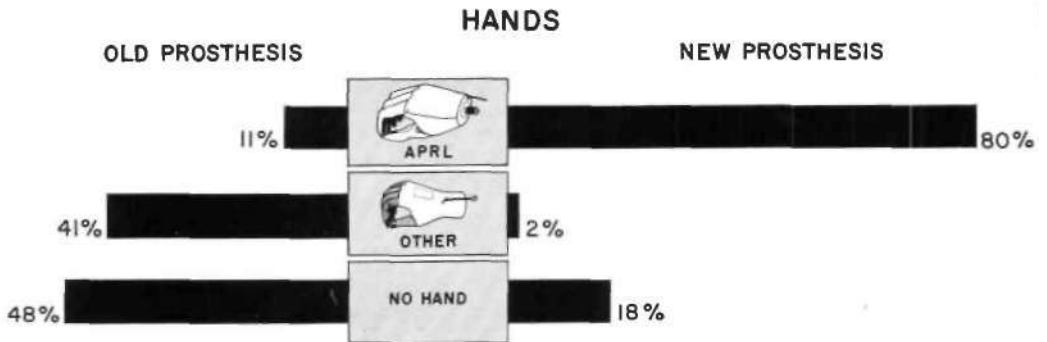


WRIST-FLEXION UNITS

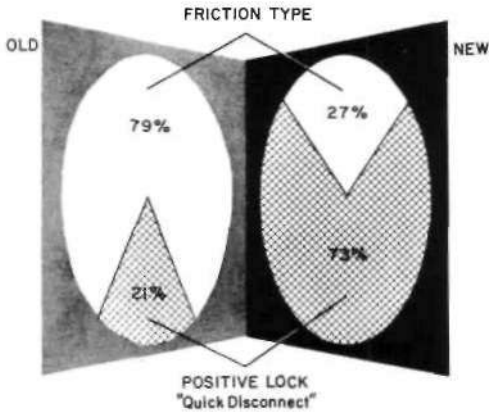
There were only two wrist-flexion units on the old prostheses. Both cases were bilateral amputees. Twenty-two wrist-flexion units were

prescribed in the research group. Ten were for bilateral amputees; six were for above-elbow, four for shoulder-disarticulation, and two for below-elbow amputees.

TERMINAL DEVICES PRESCRIBED
(In Percent of All Amputees)



WRIST UNITS PRESCRIBED
(In Percent of All Amputees)



BELOW-ELBOW HINGES

A marked increase in the number of flexible hinges prescribed reflects the increased awareness of the value of utilizing residual rotation of the forearm stump whenever possible so that the need for pre-positioning the terminal device with the sound hand can be reduced or eliminated entirely. An additional advantage of flexible hinges is that they are less likely to damage the sleeves of the wearer's clothes.

BELOW-ELBOW CUFFS

Prescription for below-elbow cuffs showed a marked change toward smaller cuffs and elimination of straps. This change is a result of increased recognition of the desirability of providing a cuff large enough to give adequate stability and suspension but which would also have minimum bulk, would restrict motion as little as possible, and would give greater comfort.

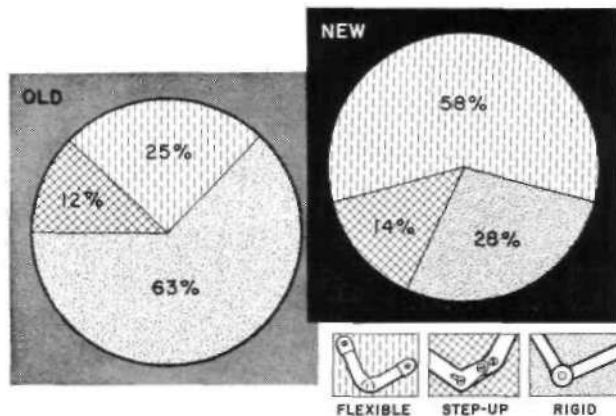
ELBOW UNITS

A guiding principle in the prescription of prosthetic elbow units for above-elbow and shoulder-disarticulation prostheses was that locking should be accomplished independently by controls attached to the harness, without recourse to operation of controls by the sound hand. The extent to which this principle was applied can be seen from the data, which show that all elbow units prescribed were harness-operated. This is a highly significant change from the data relating to the old prosthesis, which show that only 46 percent of the old elbow units were harness-operated.

SOCKETS

Practically all of the prescriptions for the new prostheses specified plastic laminate as the material to be used in fabricating the socket. The data on the socket material used in the old prostheses show that 37 percent were made of plastic, 28 percent were made of leather with a steel frame, and the remainder were made of fiber and metal, wood, or leather. Approximately four out of five of the new prostheses had double-wall sockets, as compared to less than one out of five of the old prostheses. Twelve percent of the old and 14 percent of the new below-elbow sockets were

BELOW-ELBOW HINGES PRESCRIBED
(In Percent of Below-Elbow Amputees)



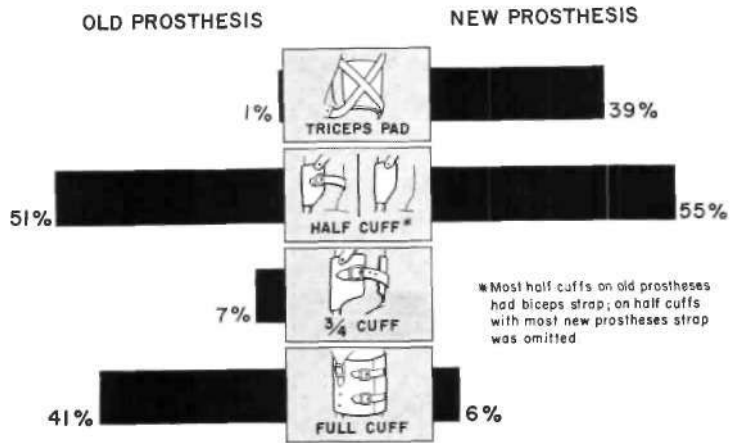
of the split-socket, step-up type in both the old and the new prostheses.

HARNESSES

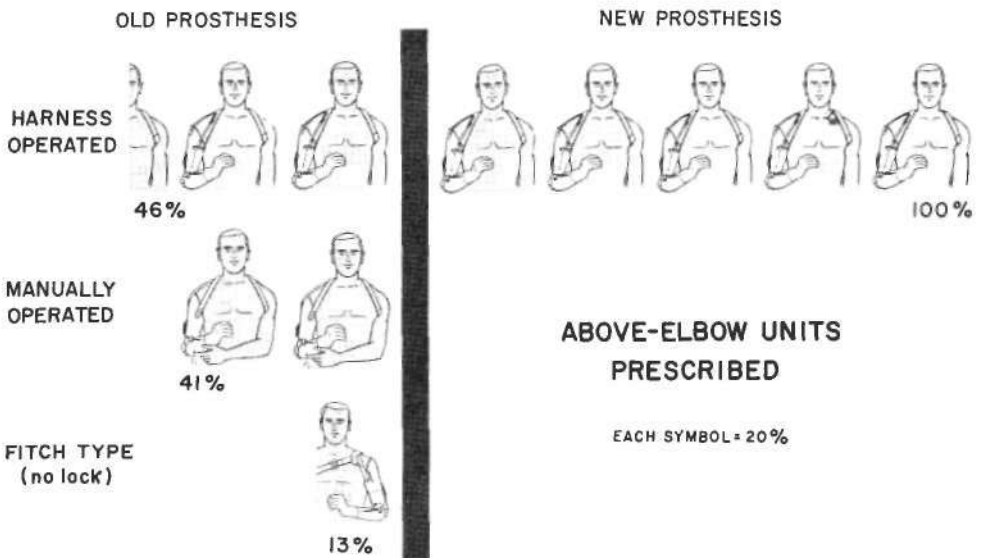
The data on harnesses show a highly significant increase in the number of figure-eight harnesses prescribed for below-elbow and above-elbow cases with the new prostheses as compared with the old. The reasons for this increase are related to the favorable attitude of the program toward this simple type of harnessing, except for cases wherein heavy lifting was expected. Practically all of the shoulder-disarticulation amputees had chest-strap harnesses on both the old and the new prostheses.

BELOW-ELBOW CUFFS PRESCRIBED

(In Percent of Below-Elbow Amputees)



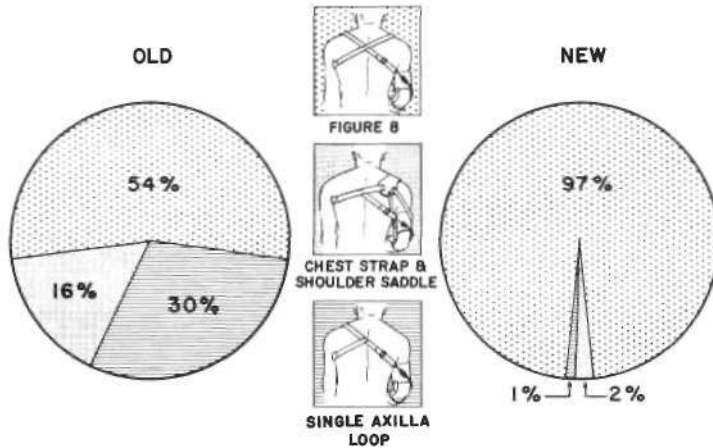
Vinyon tape was specified in 96 percent of the prescriptions for new prostheses, and cotton webbing or nylon or dacron tape were prescribed in the remaining 4 percent.



PREPROSTHETIC
THERAPY

BELOW-ELBOW HARNESSES PRESCRIBED

(In Percent of Below-Elbow Amputees)



In the old prostheses, 83 percent of the harnesses were made of cotton webbing, 8 percent were of leather, and the remaining 9 percent were made of vinyon or nylon tape. The marked shift to the use of vinyon tape was due primarily to the presumably superior characteristics attributed to vinyon with respect to dimensional stability, washability, fraying, and resistance to bacteria and fungi.

Four out of ten subjects said they had received treatment by some form of exercise or other physical therapy prior to their entrance into the study. The same proportion of the group indicated that their stumps had been bandaged to bring about shrinkage.

In response to the question, *Do you think these [preprosthetic] treatments were helpful?*, 79 percent replied in the affirmative and offered the following reasons (in order of decreasing frequency): increased strength, increased range of motion, helped stump shrinkage, reduced pain, improved function, reduced flabbiness.

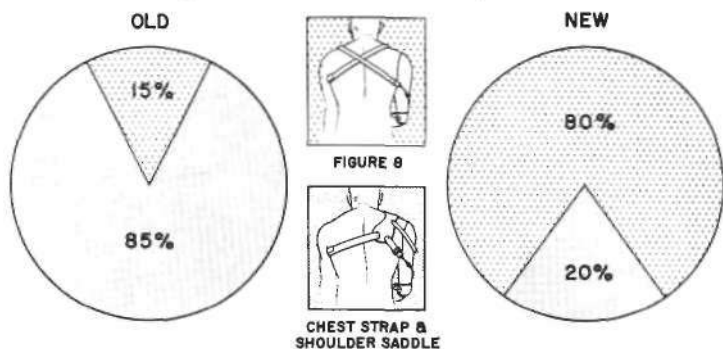
During the course of the research studies, preprosthetic exercise or other physical therapy was prescribed for 13 percent of the amputees treated. That only a relatively small proportion of the subjects received preprosthetic

CONTROL SYSTEMS

All of the prescriptions for new prostheses called for the use of the Bowden cable in the control system. In the old prostheses, 58 percent utilized Bowden cable; the remainder utilized nylon cord, leather, or steel cable without a housing. The change to Bowden cable was effected to take advantage of its higher efficiency in transmitting forces.

ABOVE-ELBOW HARNESSES PRESCRIBED

(In Percent of Above-Elbow Amputees)



treatment is accounted for by the fact that most of the amputations occurred quite some time before the amputees participated in the program. In most cases, treatment consisted primarily of exercise to increase strength and range of motion of the stump. Other physical-therapy measures, such as diathermy, massage, and hydrotherapy, accounted for a relatively small proportion of treatments. Almost all of the subjects indicated that treatment was received daily.

Seven percent of the amputees had their stumps bandaged to cause shrinkage. About two thirds of this small group indicated that bandaging had been continued over a period of 4 to 12 weeks; the remainder of the group said that bandaging had been continued for more than 12 weeks.

Of those who did receive preprosthetic treatment, 88 percent considered the treatments helpful. The reason given most frequently was that the treatments increased strength and range of motion. About one out of five subjects mentioned stump shrinkage as the chief beneficial effect.

INITIAL CHECKOUT

With reference to arms worn prior to entrance into the program, the subjects were

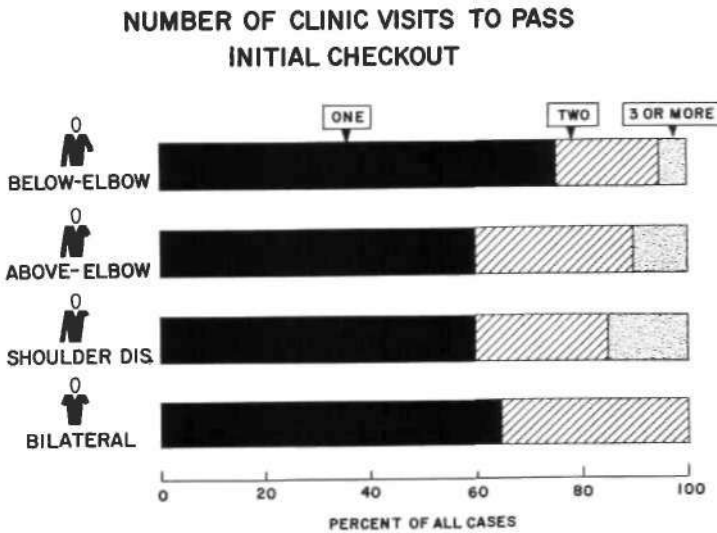
asked: *Was your arm checked for fit, comfort, and function before it was delivered to you?* Four out of five indicated that their prostheses had been subjected to some form of initial checkout or evaluation, even though this was not done on a formal basis. One third of this group said that the limbfitter had made the check. Thirteen percent designated the physician as having made the check, and 9 percent said the check was made at the hospital. The others did not provide specific information as to who performed the checkout or evaluation.

A basic principle guiding operations in the Field Studies was that the amputee would not be permitted to wear his new prosthesis or proceed to training until initial checkout had been passed successfully. If deficiencies were encountered that would interfere with wear or training, recommendations for correction were made, and the amputee was scheduled to appear again so that initial checkout could be completed.

Several factors serve to explain why a relatively large proportion of amputees had to appear before the clinic two or more times in order to pass initial checkout. One is that the checkout procedure proved to be highly effective in directing attention to the necessary corrections and adjustments in individual

components and to the prosthesis as a whole. A second related to the relatively high and rigid standards established by the checkout procedure. A period of time was generally required before the prosthetic experience necessary to meet these standards was gained.

The relatively greater frequency with which above-elbow and shoulder-disarticulation amputees failed to pass initial checkout on the first appearance, as compared to below-elbow amputees, was for the most part due



to difficulties in harnessing. In addition, the relatively small number of shoulder disarticulations seen meant that it took correspondingly longer to obtain substantial experience in their fitting and harnessing.

While a majority of prostheses passed initial checkout on the first presentation, this does not mean that no deficiencies were found at initial checkout in these cases. More often than not, a number of minor deficiencies were found, which resulted in a "provisional pass" rather than a "pass." When a provisional pass was given, recommendations were made for correction of the minor deficiencies found. When the amputee reported for his first training period, a check was made to see that the recommended changes had been effected.

Among the below-elbow subjects, the most frequent deficiencies found at initial checkout were in connection with sockets. With above-elbow amputees, the deficiencies found most frequently were in connection with harnessing. The fewest deficiencies were encountered with wrist units. The charts show the order in which the various components ranked according to the number of deficiencies found.

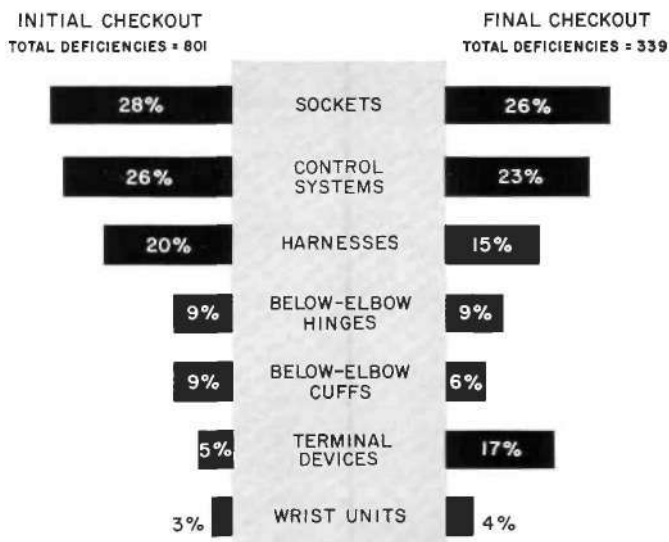
The amputees taking part in the study were asked: *Do you think it was worth while that the new arm was checked for fit, comfort, and function before it was delivered to you?* Ninety-four percent of the replies were *yes*. The most common reasons given for these replies were:

- " . . . to correct and prevent problems."
- " . . . provides a check on fit."
- " . . . provides a check on comfort."
- " . . . provides a check on prescription."

SOURCES OF DEFICIENCIES

Below-Elbow Prostheses

(In Percent of Total Deficiencies)



Some of the comments of those few who did not think it was a good procedure were:

- " . . . made no necessary changes to arm."
- " . . . am intelligent enough to decide for myself if it is comfortable."
- " . . . could be checked out at limbshop."
- " . . . had to wear it first to see if anything was wrong."

TRAINING

The data pertaining to previous training showed that 42 percent of the amputees had received prosthetic training sometime prior to the beginning of the study. Eighty-nine percent of this group expressed the opinion that this training was helpful. Three fourths of the amputees who received no previous training said they thought training would have been helpful, while the remaining fourth thought it would have been of no use.

Data obtained from the clinical studies showed that 81 percent of the subjects received

training, that 14 percent received no training, and that owing to incomplete records the training status was indefinite for the remaining 5 percent. Among the amputees who received no training, the most common reasons offered were: the amputee had worn a prosthesis before and previous training was considered adequate; the amputee passed the prosthetic-use test without training; the amputee declined training.

In response to a query concerning the value of prosthetic training, four out of five amputees replied in the affirmative. Among the most frequent reasons given for the affirmative answer were:

"... training gives an idea of what can be done with the prosthesis."

"... learned mechanical operation of components."

"... expedited use of arm."

Of the group who did not believe that training was valuable, there were proportionately twice as many below-elbow as above-elbow amputees. They offered such comments as:

"... using an arm is easy."

"... training was not well organized."

"... I would rather learn my own way."

"... amputee was left on his own too much."

"... training helped very little."

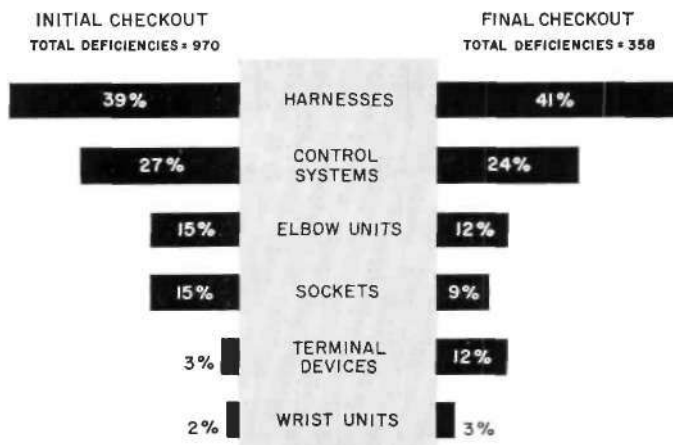
"... training was not long enough "

In response to the question, *Do you believe the training you were given in the use of your new prosthesis could be improved?*, 41 percent answered in the affirmative. About one fourth of those who answered in the affirmative expressed the opinion that there should be more training in activities of daily living. An equal number thought that more time was needed. Among the group that expressed the opinion

SOURCES OF DEFICIENCIES

Above-Elbow Prostheses

(In Percent of Total Deficiencies)



that more time was needed there were more than three times as many above-elbow amputees as there were below-elbow amputees.

Other suggestions for improvement of training were:

"... there should be more enforced training."

"... provide a training manual which would allow the amputee to practice at home."

"... adapt training to occupational needs."

"... there is not enough supervision of training."

The total training time for an individual amputee ranged from half an hour to 99 hours, but more than nine out of every ten amputees received less than 20 hours of training. Except for bilateral amputees, more than eight out of every ten amputees received 10 hours or less of training. The average number of hours of training for each amputee type is based on the great majority of amputees (94 percent) who required less than 20 hours of training. Of the small remaining group of amputees (6 percent), one half received from 21 to 30 hours of training; the other half received from 30 to 99 hours. It must, however, be emphasized again that the larger part of this group had had previous prosthetic experience.

The average length of individual training sessions for the amputees in the clinical studies was one hour and forty minutes. There was no significant difference in the figures for below-elbow, above-elbow, shoulder-disarticulation, and bilateral amputees. For almost 50 percent of the amputees, the length of the individual sessions was one hour.

In reply to the question, *Did any difficulties arise in connection with the operation or comfort of your new prosthesis during training or the initial period of use?*, 54 percent of the amputees replied in the affirmative. Among the below-elbow subjects, the socket was the most frequent source of difficulties relating to fit and comfort, while among the above-elbow group the harness constituted the major source of trouble. With respect to function, operation of terminal devices and the control system were the most troublesome. The control system was the most common source of difficulty with respect to maintenance.

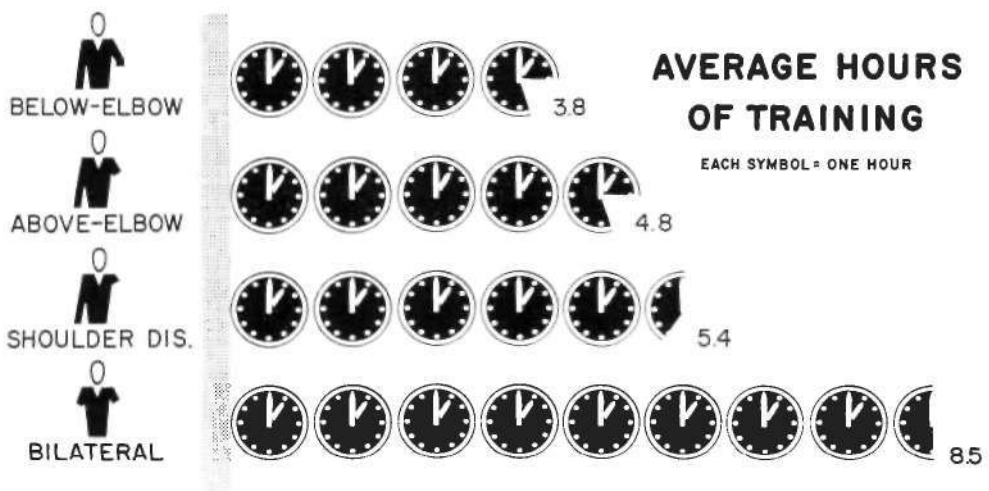
FINAL CHECKOUT

Prior to participation in the Field Studies, less than 30 percent of the amputees had had their prostheses rechecked for fit, comfort, and function after the period of initial wear or training. In accordance with the procedures

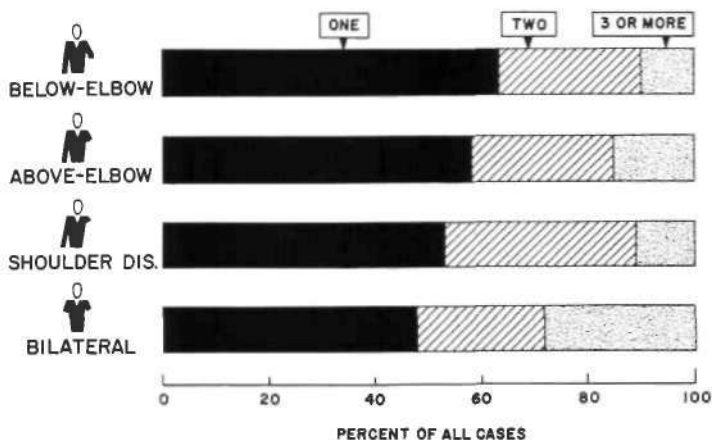
described in Section I, *all* prostheses in the Field Studies were subjected to final checkout after the completion of training or the initial period of wear. At this time not only was the prosthesis given a systematic and thorough inspection and evaluation but, in addition, an appraisal was made of the patient's ability to use the prosthesis, and a careful examination was made to see if there were any medical or surgical problems that might interfere with successful wear and use. Clinics considered that an amputee had "passed" final checkout only when there were no further surgical, medical, or prosthetic problems of any kind that required attention.

Sixty percent of the prostheses passed final checkout on first presentation, 26 percent passed on second presentation, and 14 percent required more than two appearances to pass final checkout. This compares with 69 percent, 24 percent, and 7 percent, respectively, for initial checkout.

The decrease in the number of prostheses that passed final checkout on first presentation, as compared with initial checkout, was due chiefly to the results of wear of the prosthesis, the emphasis on the amputee's ability to use the prosthesis, the apparent need for additional training, and the need for modifications which



NUMBER OF CLINIC VISITS TO PASS FINAL CHECKOUT



had been overlooked at the initial checkout or on which judgment had been withheld until the effect of wear could be determined. The actual number of deficiencies found at final checkout was, however, smaller by far than the number at initial checkout. Among the below-elbow amputees, the total number of deficiencies recorded at final checkout was only 339 as compared with 801 at initial checkout. The corresponding figures for above-elbow amputees were 358 at final checkout and 970 at initial checkout. These figures show clearly that the prostheses were far better at final checkout than they were at initial checkout, even though it took a little longer to get through the checkout procedure.

As was the case at initial checkout, the difficulties found most frequently at final checkout were related to socket fit for the below-elbow amputee and to harnessing for the above-elbow amputee. The fewest difficulties were encountered in relation to wrist units. The order in which various components ranked according to the number of deficiencies found is to be seen in the combined data for initial and final checkout.

The effects of wear and use were to be seen in the continued difficulties with fit and comfort of the below-elbow socket at final checkout

with other factors such as adjustment of the harness and control attachments that activate the elbow lock.

In response to the question, *Do you think it was worth while that your arm was rechecked for fit, comfort, and function after training and initial period of wear?*, 90 percent of the replies were in the affirmative. The most frequent reason for this reply was that the recheck permitted problems to be corrected. Typical comments were:

"... gives an opportunity to correct problems after wear."

"... experts can see difficulties better."

"... it is important to find out if arm still functions properly."

"... it provides a general check."

SUMMARY

The amputees' experience in the field-studies program differed quite markedly from their previous prosthetic experience with respect to prescription and final checkout. Prior to their participation in the study, less than one out of five had ever had a prosthesis that was prescribed by a clinic team, and less than one third had had their previous prostheses subjected to a final comprehensive checkout.

and also in the relative increase in deficiencies encountered with terminal devices. The more common deficiencies in the latter case were related to malfunctions of hand or hook, staining or damage to the cosmetic glove, and excessive backlash with voluntary-closing devices.

At both checkouts, deficiencies of the elbow unit rank fairly high on the list. Analysis indicates, however, that most of these difficulties were not with the internal mechanism but rather

The differences with respect to preprosthetic treatment, initial checkout, and training were less marked. Relatively fewer amputees received preprosthetic treatment in connection with the new prostheses than was the case in connection with the prostheses that were being worn at the beginning of the study. This, of course, can be accounted for by the lessened need for these services with increased prosthetic wear.

Although a substantial majority of the amputees said that their previous prostheses had been subjected to some form of initial checkout or evaluation, these had not been done on any formal or systematic basis and had in general not involved the application of standards of acceptance.

Forty-two percent of the amputees who had worn a prosthesis *prior* to the beginning of the study had received training in its use, although the nature or extent of this training is not clear from the data. More than eight out of ten subjects received training with the prostheses obtained in the research program.

Amputee opinion pertaining to the treatment process, as indicated by the data gathered, was for the most part strongly in favor

of the new procedures. Ninety-four percent of the amputees approved of the team method of prescription. Eighty-eight percent of those who received preprosthetic treatment said the treatments were helpful. Ninety-four percent were of the opinion that initial checkout was worth while.

Four out of five amputees were of the opinion that the training they received in the use of their prostheses was valuable. But 41 percent of the group thought that training could be improved. The most frequent suggestions for improvement were to increase the amount of training time and the amount of training in meaningful activities of daily living.

The final checkout to which all of the prostheses in the research studies were subjected was particularly comprehensive and designed to uncover any medicosurgical, prosthetic, training, or other factors that might interfere with successful wear and use. Nine out of ten amputees were of the opinion that this procedure was worth while.

All in all, the treatment process inaugurated as part of the studies was considered valuable and achieved a high degree of amputee acceptance.

Studies of the Upper-Extremity Amputee

IV. Educative Implications

SIDNEY FISHMAN, Ph.D.¹

FROM the foregoing discussions, it will be apparent that one of the major purposes of the Upper-Extremity Field Studies was to introduce certain influences into the professional activities of the several groups (physicians, therapists, prosthetists) concerned with the care of the amputee and his reintegration into society. It was anticipated that changes in methods of patient care arising from these influences would in turn affect the welfare of the amputee group. In this sense, therefore, a major aspect of the Field Studies was the educative process involved in the attempt to change the operational patterns of those responsible for amputee care by strengthening the philosophies, attitudes, and skills which had been taught during the short-term courses of instruction. Continued encouragement, assistance, and guidance were required to habituate these groups to the procedures proposed during the instructional courses.

The second phase of the Field Studies, the results of which will be discussed in the next issue of ARTIFICIAL LIMBS (Autumn 1958, Vol. 5, No. 2), is most properly considered a research activity. The purpose in this phase of the program was to attempt to evaluate the effects of these efforts on the over-all status of the amputee through the use of objective and subjective measurements. To accomplish this second phase, detailed studies were made of the

status of the group of amputees prior to their treatment by the prosthetic clinic and again at a time after the completion of treatment.

In approaching the task of estimating the effectiveness, or lack of effectiveness, of a two-pronged (research and education) program of this type, a number of problems arise. In this particular case, fortunately, we have the opportunity of deferring evaluation of the second phase, the research activities, until after those results are presented in a second installment.

The results of the educative effort are perhaps best considered in terms of Jesus' parable of the sower, as set forth in *The Gospel According to St. Matthew* (Chapter 13):

3 ... Behold, a sower went forth to sow;

4 And when he sowed, some *seeds* fell by the way side, and the fowls came and devoured them up:

5 Some fell upon stony places, where they had not much earth: and forthwith they sprung up, because they had no deepness of earth:

6 And when the sun was up, they were scorched; and because they had no root, they withered away.

7 And some fell among thorns; and the thorns sprung up, and choked them:

8 But other fell into good ground, and brought forth fruit, some an hundredfold, some sixtyfold, some thirtyfold.

9 Who hath ears to hear, let him hear.

In some few places and among some persons, no effects are to be noted. Among others minor temporary changes evolved, and in still other instances important permanent improvements were brought about. We may consider these effects under three broad categories—impact on the medical management of the amputee, impact on public and private rehabilitation agencies, and impact on social attitudes.

IMPACT ON THE MEDICAL MANAGEMENT of THE AMPUTEE

It has been emphasized consistently throughout the foregoing sections that a "prosthetic-clinic approach" to the problem of the amputee was a basic tenet of the field-studies program. In this approach, the fundamental decisions relating to the rehabilitation of the patient were made in concert by a group consisting minimally of a physician or surgeon, a physical and/or occupational therapist, and a prosthetist. Whenever possible, vocational counselors and other personnel trained in the psychosocial aspects of rehabilitation also were included.

The second aspect of the prosthetic-clinic approach involved an attempt at considerable standardization of the process of patient care and usually included eight more or less formal treatment steps—prescription examination, prescription, preprosthetic therapy, prosthetic fabrication, initial checkout, prosthetic training, final checkout, and follow-up. As a consequence of these efforts, three major changes occurred in the medical care of amputees—introduction of prosthetic-clinic procedures, staff and patient education, and upgrading of existing services.

INTRODUCTION OF PROSTHETIC-CLINIC PRO- CEDURES

Although similar clinical procedures have been developed and practiced in the treatment of other disabilities, and even occasionally in prosthetics, the attempt at systematic introduction of such procedures on a broad basis was a novel one. In addition, experimental exploration and validation of the essential adequacy of such procedures is hardly ever available. As a major outcome of the Field Studies, however, the basic validity of the clinical procedures in the field of upper-extremity prosthetics has been established. In addition to these accomplishments, certain other changes occurred with respect to the patient-care activities of each of the specific professions—the physician and surgeon, the physical and occupational therapist, and the prosthetist—concerned with the handling of the upper-extremity amputee.

The Physician and Surgeon

As a result of the principles and procedures instituted under the program, the period during which the amputee is considered a patient under medical management was extended significantly. Formerly an amputee was a patient during surgery and through a limited period of postoperative care. Today, the period of medical supervision continues through the entire process of limb prescription, fabrication, training, and evaluation.

As an additional outgrowth, a subspecialty within the fields of orthopedic surgery and physical medicine has been developed. A limited number of physicians have become expert in the field of limb prosthetics. Since the amputee represents a relatively small portion of the total population requiring medical service, it is not feasible for large numbers of physicians to specialize in this field. But in order to provide competent service for amputees it was essential that a few physicians in each major population center be thoroughly equipped to provide the care required. Physician specialization in the very restricted field of prosthetic restoration has come about as a direct result of the program.

Through the program the physician has learned much concerning the technical specifics of prosthetic restoration. As a result of this education, his respect for the contributions made by the skill and experience of the therapist and prosthetist in the process of amputee rehabilitation has increased. The interdisciplinary approach to the problem of amputation and prosthesis has become accepted and appreciated as a significant forward step in the medical management of the amputee. As a general consequence, the physician has been able to acquaint himself with, adapt, and then apply modern—and gradually higher—standards of prosthetic care for his patients. Knowing, perhaps for the first time, what constitutes and what is involved in providing a good prosthesis, the physician is now able to require a standard of service not previously possible.

The Physical and Occupational Therapist

For the therapist, the short-term courses in upper-extremity prosthetics filled a gap left

by the usual curricula in schools of occupational and physical therapy. Perhaps for the first time, a systematic approach to the amputee problem was taught and practiced. As a result, the therapist has been able to carry out the major responsibility of amputee training with a background of general technical knowledge directly relating to artificial limbs. In addition, closer professional liaison developed between the therapist, the physician, and the prosthetist with regard to the amputee. As a result, in most instances upper-extremity amputees are now routinely referred to the therapist for instruction in the use of the artificial limb, whereas in the preprogram days the number of therapists qualified to give this service and the number of amputees availing themselves of it were both insignificant.

The Prosthetist

The program sought and helped to provide a proper professional role for the prosthetist. As a group, prosthetists were for the first time exposed to formal university instruction and to closer relations with medical, paramedical, and psychosocial disciplines. Thus the prosthetist has been helped toward a redefinition of his status on a higher professional level.

This progress in the direction of a more professional role was aided in no small measure by the acquisition of a new technology involving the use of biomechanical principles, plastics fabrication, and principles of harnessing and controlling artificial limbs. This improved knowledge has resulted in improved service, increased status, and greater interprofessional satisfactions.

One cannot say at this early stage in the evolution of this field just what the ultimate or proper interrelations may be between the professions concerned. Certainly the appropriate relationships will tend to vary from location to location, depending upon personnel and situational considerations. There can, however, be no gainsaying the facts that a period of growth has been stimulated, that the adequacy of the present treatment situation far surpasses that of the old, and that there has been developed a climate which gives every indication of providing additional professional status for the prosthetist.

STAFF AND PATIENT EDUCATION

A second value provided by the studies relates to the matter of staff and patient education. It is as true in limb prosthetics as in the other healing arts that there are no standard procedures which will apply with equal effectiveness to every patient. Moreover, limb prosthetics is still a field in which the contributions of each of the specialists are but partially understood by the others. Consequently, there is an important need for a cross-fertilization of ideas and a distillation of the best thinking for a given patient by the process of group activity. In this sense, an important achievement of the prosthetic clinic may be considered the intraclinic education of the team members.

Equally important is the role that the clinic must play in the education of the patient. Most amputees, when arriving for prosthetic care, are subject to wide and varied misunderstandings and misinterpretations as to the procurement and ultimate use and value of a prosthetic device. Clinic personnel have become more effective in educating the patient concerning realistic goals and anticipations, in addition to providing him with the best type of prosthesis for his particular needs.

UPGRADING OF EXISTING SERVICES

In the process of applying and studying clinic procedures experimentally, the last important result evolved—that of an upgrading of existing services, as well as the establishment of services where none had existed previously. In this respect, the major contribution apparently has grown out of the introduction of a coordinated pattern of treatment.

Previously, it had not been uncommon for a prosthetist, physician, and vocational counselor, for example, to proceed with the care of an amputee independently of one another. This procedure was often adopted in spite of the fact that in any situation where an individual is receiving treatment from more than one specialist, and where the anxieties are such as to provoke some degree of patient discontent, there is a noticeable tendency for some patients to distort the intentions and contributions of each profession in relation to the others. Such problems are further aggravated in those instances where the patient himself is called

upon to act as the means of communication between the professions involved, since we may be sure that there will always be a certain degree of distortion of the patient's perceptions of the treatment processes. The clinic procedures were especially effective in reducing this troublesome method of communication between the specialists.

We may also anticipate that the behavior and demeanor of the patient toward the prosthetist will differ from that he exhibits toward the physician, therapist, or counselor. These differences in overt behavior patterns may easily and logically suggest different patterns of treatment to each of the individual professions. Yet it should be clear that these varying behaviors on the part of the patient are transitory and that the real solution lies in a uniform treatment plan rather than in a number of discrete ones. It therefore becomes clear that, in order to provide amputees with the best available medical and prosthetic service, the contribution of each of the professional specialties is best coordinated and amalgamated with that of each of the others. The prosthetic-clinic procedures, introduced through the studies, permitted a more uniform evaluation of the patient and assisted in circumventing the problems inherent in uncoordinated care.

IMPACT ON PUBLIC AND PRIVATE REHABILITATION AGENCIES

Many groups who have as their adopted or assigned mission the reintegration of the handicapped individual as a productive member of society have long been aware of the significance of the process of prosthetic restoration as a link in the over-all process of rehabilitation. As a direct consequence of this awareness, and as a necessary outgrowth of their over-all responsibilities in the rehabilitation field, federal agencies such as the Veterans Administration, the Armed Forces, and the Department of Health, Education, and Welfare, the state divisions of vocational rehabilitation, workmen's compensation, and health and public welfare, and such nongovernmental agencies as the state societies for crippled children and adults, rehabilitation centers, insurance companies, and a number of other

private agencies have become the largest purchasers of prosthetic services in the United States.

Through the NYU Field Studies these groups have been made increasingly aware of the potentialities of prosthetic restoration and have responded by raising their standards in the field of upper-extremity prosthetics. Having been provided with professionally competent avenues for the processing of their beneficiaries through prosthetic prescription, fabrication, training, and evaluation, these agencies have begun to insist that their clients be treated by special amputation teams headed by physicians who are experts in the field. Since these agencies may be considered "consumers" in the sense that they most frequently pay for the prosthetic services provided, they have been instrumental in raising the standards by rejecting prostheses and services that do not meet the minimum standards first set up through the program.

A by-product is that the groups mentioned tend more and more to order prostheses from those prosthetists who have fully qualified themselves by virtue of training and experience. In a good many instances, these agencies have shown themselves willing to spend the additional monies required to obtain services of the highest quality. In some instances the program has been instrumental in stimulating the inauguration of local services to avoid the necessity for these rehabilitation agencies to contract for prosthetic services from distant sources. The widespread introduction of the clinic-team concept to the field of limb prosthetics provided the means for greater liaison between rehabilitation agencies and those persons medically responsible for the process of prosthetic restoration. Since the clinic-team meetings ordinarily involve a conference of all of the participants in a given case, the agency itself is frequently represented at such conferences by a professional staff member. This, of course, makes for considerable improvement in the continuity of the rehabilitation process.

IMPACT ON SOCIAL ATTITUDES

Beyond their influence on the medical and rehabilitation agencies, the effects of the

Upper-Extremity Field Studies also permeated through other facets of our social structure, although as one departs further and further from the professional groups directly responsible for the care of the amputee the impact of the effort becomes more diffused and less specific. Nonetheless, a number of significant effects remain to be noted. They may be viewed as influencing the attitudes and thinking of sponsoring agencies, scientists concerned with physical disability, other groups of disabled, and society at large.

SPONSORING AGENCIES

Perhaps one of the most important contributions was the demonstration that within a relatively brief period of time research and development can be accomplished and the benefits therefrom made available to the average patient with a disability. It should be recalled that the entire upper-extremity research program did not get under way until several years after the close of World War II and that the major prosthetic design improvements depended upon several years of fundamental biomechanical research. Thus the entire concept and technology of the care of the upper-extremity amputee has been revolutionized within a remarkably brief period of six or seven years.

Such demonstrable progress is of inestimable value to those whose prerogatives require that they decide where substantial private or public monies should be spent in medical or rehabilitation research. Although it is always important to verify or evaluate the results of a broad program of research, this is not always possible. Yet this is precisely what the Upper-Extremity Field Studies have done.

In the first instance, scientific evidence has been provided concerning the over-all value and contribution of the six or seven years of research and development. Secondly, and from a more technical point of view, information was brought forth concerning those aspects of the care of the upper-extremity amputee which had progressed most satisfactorily and those phases which require continuous improvement and attention.

SCIENTISTS CONCERNED WITH PHYSICAL DISABILITY

The program of research and education also assisted in the general growth of scientific thinking on problems of human disability. Some detailed discussion of these research considerations will be included in the next issue of *ARTIFICIAL LIMBS* (Autumn 1958, Vol. 5, No. 2), which will deal with the research aspects of the studies. The discussion of the educative aspects of the Upper-Extremity Field Studies would be incomplete without note being taken of the progress that has occurred in the attitudes and thinking of researchers in the field of physical disabilities. These advances have been summarized at the recent conference on the *Contributions of the Physical, Biological, and Psychological Sciences in Human Disability* sponsored by the New York Academy of Sciences (page 125).

OTHER GROUPS OF DISABLED

It is clear that a special service was performed for those individuals who have incurred disabilities related to, but not identical with, amputation. These groups are perhaps best typified by those disabilities which require functional restoration by use of braces or other orthopedic appliances.

Until the time of these studies, there was very little overt expression of the need for progress in the field of bracing. The prevailing situation was one that had remained static for decades. With limited exceptions, personal unvalidated opinion, professional and otherwise, pervaded and still characterizes the entire field.

Partially as a consequence of the broad educative aspects of the Upper-Extremity Field Studies, a spontaneous development of interest and desire for systematic progress arose in this related field, which is often served by the same doctors, therapists, and prosthetists-orthotists. People who were suffering from these types of disabilities and those who cared for them generated a new feeling of hope and enterprise. The results of these changes in attitudes are just now being translated into planning for active research and education.

SOCIETY AT LARGE

Further evidence was provided that the systematic treatment of the disabled is a fundamentally effective and socially desirable process. The "collective concern" which society experiences concerning the physically handicapped tends to be reduced with the knowledge

that constructive things can be done, and have been done, for this group in an orderly, scientific manner. Associated with this growth in knowledge is a reduction in anxiety and prejudice concerning the physically handicapped and a corresponding increase in their acceptance by society.

Staff Participation

IN THE planning, operation, and reporting of the NYU Upper-Extremity Field Studies (1953-56), a number of members of the professional staff of the Prosthetic Devices Study fulfilled certain specific supervisory responsibilities, although they participated, on one occasion or another, in all phases of the program. Listed with their particular areas of major interest, they were:

SIDNEY FISHMAN, Project Direction
EDWARD R. FORD, Technical Coordination
NORMAN BERGER, Instrument Development
HECTOR W. KAY, Data Collection
EDWARD PEIZER, Data Collection
EARL A. LEWIS, Data Reduction

The following additional members of the staff participated in the development of instruments, collection of research data, analysis of data, or preparation of reports:

HAROLD BERKOWITZ	THEODORE MARTON
GAVIN CARTER	SANFORD SHER
BARBARA DUNSKY	JEROME SILLER
WALTER GOODMAN	WARREN P. SPRINGER
MARSHAL A. GRAHAM	SIDNEY TOABE
MORRIS KRANSDORF	PIERRE VENTUR
SIMON LEVIN	BRENNAN C. WOOD
BERTRAM A. LITT	

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3. Klopsteg, Paul E., Philip D. Wilson, *et al.*, *Human limbs and their substitutes*, McGraw-Hill, New York, 1954.
4. New York University, Prosthetics Education Project, Post-Graduate Medical School, *Prosthetic clinic procedures*, 1956.
5. University of California (Los Angeles), Department of Engineering, *Manual of upper extremity prosthetics*, 2nd ed., W. R. Santschi and Marian P. Winston, eds., in press 1958.

Technical Notes from the Artificial Limb Program

This section of ARTIFICIAL LIMBS is intended as an outlet for new developments in limb prosthetics which, though not deserving of a long feature article, nevertheless ought to be brought to the attention of the readers of this journal. Notes may vary in length from a single paragraph to several pages of manuscript, as appropriate. Illustrations also are acceptable.

Reinforcement of Wooden Prostheses

The Phase II Subcommittee of the Committee on Prosthetics Research and Development recently requested that the VA Prosthetics Center conduct studies of the Fiberglas technique developed at the University of California at Berkeley for the reinforcement of wooden prostheses (ARTIFICIAL LIMBS, Spring 1957, p. 103). Some months ago an exhaustive study was initiated to involve both clinical observations and laboratory testing. A VAPC method of finishing wooden prostheses was introduced into the evaluation program. This method, instead of using Fiberglas as a reinforcing material, employs nylon stockinet. VAPC hypothesized at the time that both plastic-laminate methods would probably be superior to rawhide but that the Berkeley technique would be apt to provide better structural reinforcement for a wooden prosthesis. Amputees were issued prostheses finished in both ways. Follow-up periods ranged from one and a half to three months. No plastic failures or structural failures of the wood occurred.

Simultaneously, VAPC tested hollow cylindrical wood specimens finished by the Berkeley and by the VAPC plastic techniques as well as by the rawhide type of reinforcement. Another group of wood specimens was left unfinished as a control. All specimens were tested for impact resistance to determine the relative structural advantages of the various reinforcing materials. Before the test

was conducted, careful control over the ambient humidity and the moisture content of the wood was exercised. As a result of these tests, it was demonstrated that both plastic finishes provided the wood with a higher impact resistance than did rawhide. The Berkeley technique gave the highest resistance, but the difference between the Berkeley and the VAPC techniques was not as great as originally anticipated. Average values of impact resistance were only about 6 percent apart. Surprisingly enough, the rawhide specimens improved the impact resistance of the unfinished wood only about 5 percent, whereas the Berkeley method, for example, improved the impact resistance about 25 percent. VAPC also noted that all wood specimens, finished and unfinished, when tested at a moisture content of 12 percent (by weight) had higher impact resistances than specimens containing higher (20-percent) and lower (6-percent) moisture contents. The 6-percent moisture content produced the weakest (in impact resistance) specimens of all. Thus it would seem that excessively dry wood is not desirable. Preferably, moisture content should be about 12 percent by weight.

The one disadvantage of the plastic finishing techniques (both Berkeley and VAPC) is in weight gain. On small specimens (the hollow cylinders mentioned above) the plastic finish caused a weight increase of about 30 percent, whereas rawhide increased the weight by about only 10 percent. However, the patients who were given prostheses finished with the plastics voiced no complaints about weight gain. Advantages of the plastic finishes include improved appearance, improved durability of the finish itself, ready cleaning of the prosthesis with a damp cloth, and higher impact resistance of the whole prosthesis and thus the prevention of wood cracking due to inadvertent dropping. VAPC noticed also that an *extremely* damp environment did not affect the wood specimens finished with plastic as much as it affected those finished with rawhide. Only among the unfinished and the rawhide specimens were distortions of the wood noted. Delamination of the finish was common among the rawhide specimens only.

Recently, VAPC issued a manual on its own method of finishing wooden prostheses (p. 101).

—Anthony Staros

Case Analysis at RIC

During the last four years, over 400 amputees were admitted to the Rehabilitation Institute of Chicago. An indication of the representative value of this series of cases is to be found in a summary of the patient source. Seventy-five percent live in the Chicago area, and nearly all of the remainder come from Illinois. Sixty-four percent of the patients were referred by the Division of Vocational Rehabilitation of the State of Illinois; the remainder were referred by community agencies, private physicians, industry, insurance companies, limbshops, and the United States Public Health Service.

Because of the large number of nontraumatic cases in this series, a study of the cause of amputation as related to the site became a matter of interest to the Prosthetics Re-

search Center of Northwestern University. The resulting data are given in the accompanying table.

About half of the amputations were the result of trauma; the rest were due largely to vascular insufficiencies, such as those accompanying diabetes mellitus and arteriosclerosis obliterans. Ninety-one percent of the vascular cases involved the lower extremity, two thirds resulting in amputation above the knee. About 40 percent of these vascular cases were between the ages of 51 and 60 (inclusive) at the time of amputation and were therefore, from a rehabilitation standpoint, subjects for weight-bearing prostheses. The effect of pressure on the circulation in such cases becomes a matter of significant importance. This problem is being observed closely by the Prosthetics Research Center.

—Colin A. McLaurin

SITE OF AMPUTATION AS RELATED TO CAUSE OF AMPUTATION
(433 Cases Seen at the Rehabilitation Institute of Chicago, 1953-57)

Cause of Amputation	Site of Amputation																	
	Upper Extremity									Lower Extremity								
	Partial Hand	Wrist Dis-articulation	Below-Elbow	Short Below-Elbow	Elbow Dis-articulation	Above-Elbow	Short Above-Elbow	Shoulder Dis-articulation	Forequarter	Total	Partial Foot	Syme	Below-Knee	Knee-Bearing	Above-Knee	Hip Dis-articulation	Hemi-pelvectomy	Total
Aneurysm														2				2
Arteriosclerosis Obliterans											3	10		52				65
Buerger's Disease												3		6				9
Burns			1						1	2				1				2
Carcinoma									1	1				2				5
Charcot's Disease														1				2
Chronic Ulcer														1				1
Congenital Absence		2	1	5		4	2			14				2				5
Diabetes Mellitus											1	15	2	45				63
Gas Gangrene			1							1				1				1
Hemangioma													1					1
Neuromuscular Disorder													1					1
Osteomyelitis			1							1			2		8			10
Sarcoma														6	2			8
Septicemia														1				1
Synovioma														1				1
Thrombus														11				12
Trauma	14	6	24	9	1	26	8		1	89	6	2	42		84			134
Tuberculosis														2				2
Total	14	8	28	14	1	30	10		3	108	10	2	81	2	228	2		325

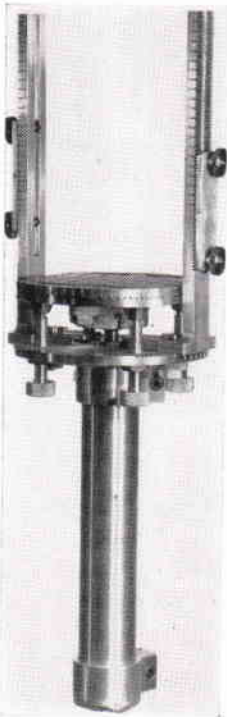
Below-Knee Prosthetics

In cooperation with the Prosthetics Research Board, the VA Prosthetics Center, New York City, has been performing developmental work on the design, fabrication, and alignment of below-knee prostheses. Working closely with the lower-extremity project at the University of California at Berkeley, VAPC has several aspects of the below-knee problem under attack.

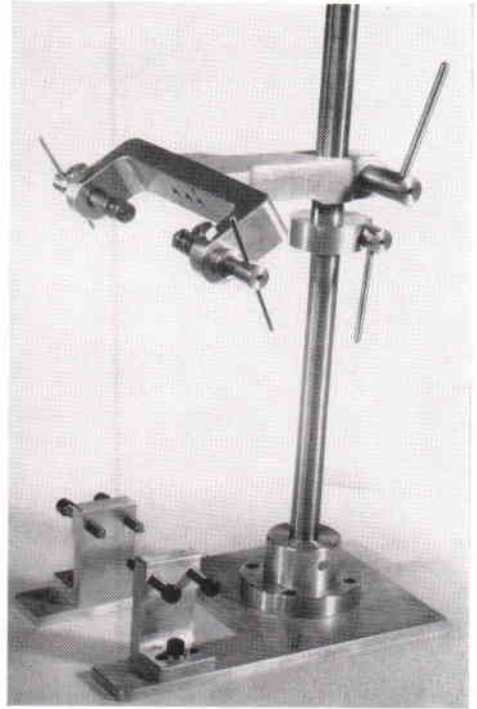
An adjustable leg and an alignment-duplication jig (see cuts) for use in below-knee prosthetics were designed by engineers and prosthetists of the VA group. A polyester-laminate socket fabricated for the amputee is mounted on the adjustable leg, and thigh corset and sidebars are placed in rough alignment. Walking trials are used to determine proper alignment of joints, socket, and thigh corset in a procedure similar to that used with the above-knee adjustable leg (ARTIFICIAL LIMBS, May 1954, p. 24). The jig is used to "set" the alignment made during walking. The foot, socket, and sidebars are fixed in the jig, and the adjustable leg is removed. Then

the foot is assembled to the socket by plastic-laminate construction of the below-knee shank in the jig. The sidebars are laminated into the shank during this same operation.

The VAPC adjustable leg and the alignment-duplication jig, as well as the procedure for making the socket and shank, are under



BELOW-KNEE ADJUSTABLE LEG—This device, developed by the Veterans Administration Prosthetics Center, is used to determine proper alignment of below-knee prostheses.



BELOW-KNEE ALIGNMENT-DUPLICATION JIG—Designed at the Veterans Administration Prosthetics Center, this device is used to duplicate proper alignment in the finished below-knee prosthesis.

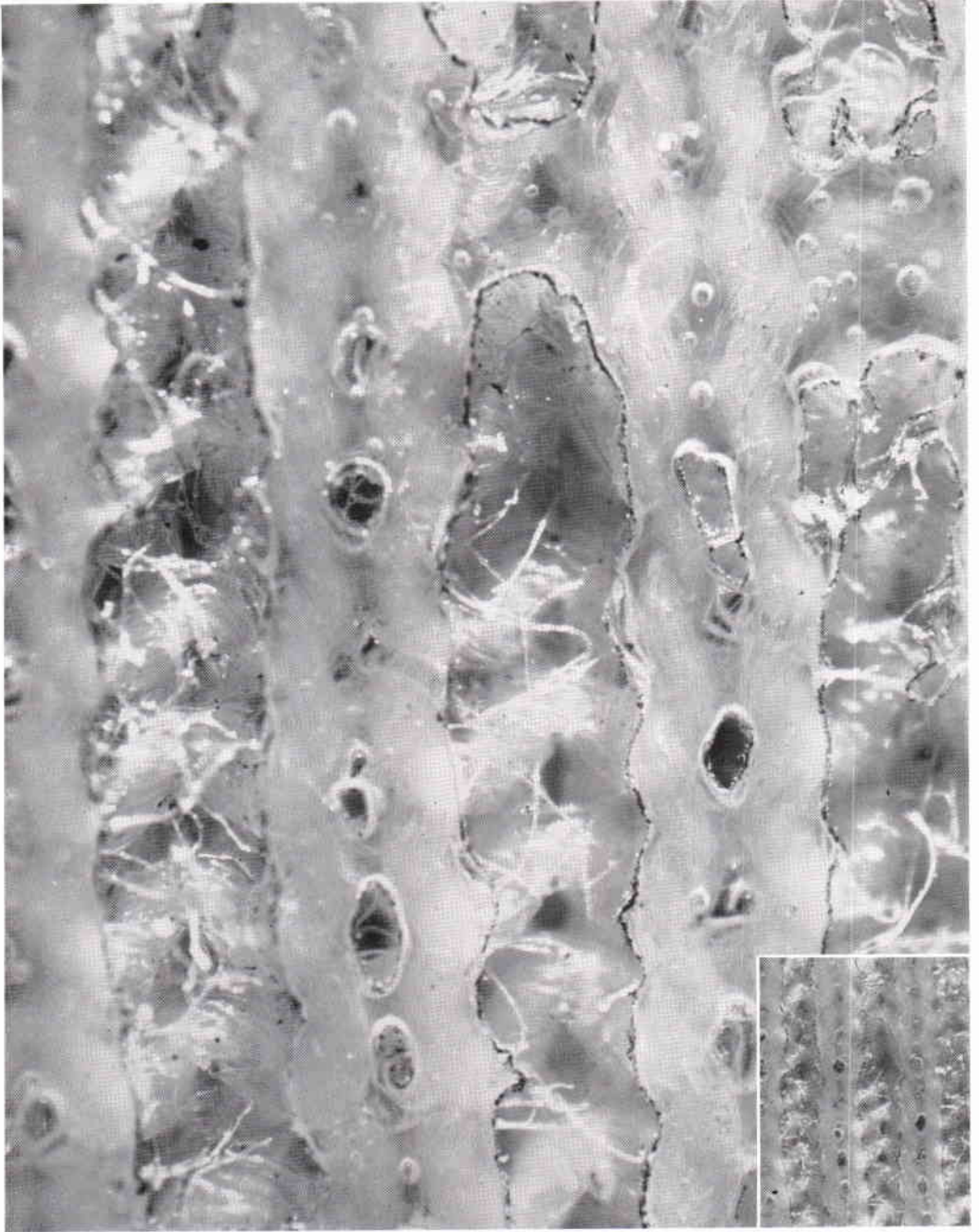
study by the Berkeley group. The VAPC techniques will soon be described in a report prepared by VA technicians.

—Anthony Staros

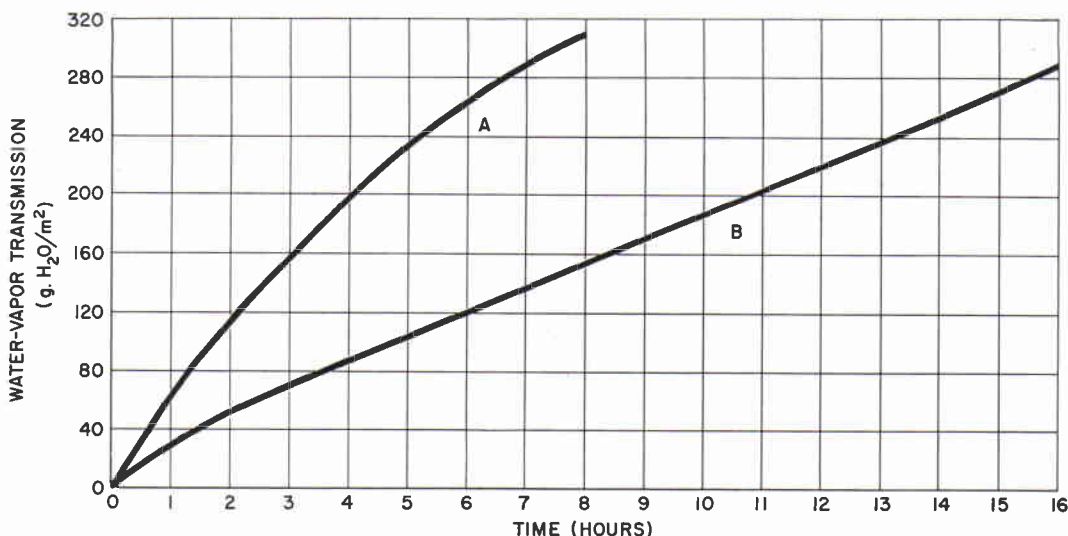
Porous Laminates for Upper-Extremity Prostheses

The hypothesis that plastic arm sockets which permit evaporation of sweat would provide greater comfort to the amputee led the U. S. Army Prosthetics Research Laboratory to undertake research toward the development of porous laminates. The procedure devised does not differ markedly from the technique used for preparing non-porous laminates.

Starting with the plaster-of-Paris model of the stump, a layup using several (three or four) layers of nylon stockinet and a polyvinyl alcohol (PVA) bag is made in the usual



SURFACE OF A POROUS PLASTIC LAMINATE—The large area is a photomicrograph (about 21 \times) of the area shown in the insert. Insert is, in turn, a photomicrograph (about 5 \times) of the original sample. *Courtesy Anthony Staros, Veterans Administration Prosthetics Center, New York City.*



POROUS PLASTIC LAMINATES—Water-vapor permeability of a double-walled below-elbow socket (curve *B*) compared with a control (curve *A*).

manner. A resin system consisting of 4 parts of ERL-2795 and 1 part of ERL-2793 (Bakelite Chem. Co.) diluted with $\frac{1}{2}$ part of solvent mixture (equal parts of xylene, methyl isobutyl ketone, and cellosolve) is mixed and poured into the PVA bag. The bag is pulled down tightly over the stockinet and the resin "strung" to ensure complete impregnation of the stockinet layers. The laminate is then placed in a circulating-air oven at 200° F. After five to ten minutes the laminate is taken from the oven, and the PVA bag is cut and removed. Removal of the bag at this point permits a slight expansion of the laminate, and it is believed that such expansion prevents bridging of the pores in the stockinet by resin, so that the pores of the stockinet remain open.

The laminate is now returned to the oven and left there until the resin has completely cured, usually about two hours. After the cast has cooled, a second PVA bag is pulled over the inner laminate and tied with a string at the distal end. Then a wax buildup is made over the end of the cast, and either a wrist unit or an elbow laminating ring, as appropriate, is positioned in place. Three to four layers of nylon stockinet are stretched over the setup, and the stockinet is impregnated with the same resin mixture and in the same manner as already described. The

resin is permitted to set for one to two hours at room temperature, after which time the PVA bag is removed. The laminate is wiped with a wet paper towel to smooth down the outer fibers, and curing is allowed to continue at room temperature for two to two and a half hours. The layup is then heated for half an hour at 100° F, half an hour at 150° F, and half an hour at 200° F and then permitted to cool.

Excess laminate is cut off and the plaster of Paris chipped out. The inner and outer laminates may now easily be separated and the wax and PVA bag removed. The laminates are now ready for final trimming, gluing at the edges, and riveting. This technique results in a very porous laminate that allows a relatively high rate of water-vapor transmission.

Representative data on water-vapor permeability of the product are summarized in the accompanying chart. Curve *A* represents the water absorbed per unit of surface area by a drying agent (Drierite) in an open-mouthed jar contained in a humidity cabinet at 50 percent R.H. and 77° F. Curve *B* represents the water absorbed per unit of surface area by the same drying agent in a double-walled socket contained in the same humidity cabinet. Comparison of curve *A* with curve *B* indicates that over an 8-hour

period the drying agent in the laminate absorbed approximately half the amount of water absorbed by the Drierite in the open jar. Further examination of curve *B* indicates that the average rate of water-vapor transmission through the laminate is 18 g. of water vapor per square meter per hour at a partial-pressure difference of approximately 12 mm.

Hg. This may be compared to the hourly water loss from the human body of 11 to 14 g. per square meter insensible perspiration under a driving force of approximately 50 mm. Hg [J. P. Bull, J. R. Squire, and E. Topley, *Lancet*, 213 (Aug. 7, 1948)].

—*Egbert DeVries and J. T. Hill*

Abstracts of Current Literature

This section of ARTIFICIAL LIMBS is intended to summarize the current literature of limb prosthetics, especially the less accessible reports literature arising from the several research groups participating in the Artificial Limb Program. Authors are invited to submit, for review, copies of any such material, including papers published in scientific journals.

External Finishing of Wood Prostheses with a Nylon Stockinette-Polyester Laminate, A Fabrication Manual, Gennaro Labate and Thomas Pirrello, Veterans Administration Prosthetics Center, New York City, October 22, 1957. 27 pp., illus. Free.

For almost two years the VA Prosthetics Center has been using a plastic-laminating technique for external finishing of wood prostheses. The VA method (page 95) differs from a previously described technique (UC-Berkeley; see ARTIFICIAL LIMBS, Autumn 1956, p. 66; Spring 1957, p. 103) in that nylon stockinet rather than Fiberglas sheeting is used as the plastic reinforcement.

This manual outlines, step by step, the method of finishing with the nylon-polyester laminates. Finishing techniques for socket, shank, and foot are described by word and drawing, and there is included a list of materials required, together with the names and addresses of suppliers. Although the description given is specifically for the above-knee prosthesis, the principles involved are equally applicable to the finishing of below-knee legs.

It is reported that the VA Prosthetics Center has experienced many benefits from using the finishing method described in this manual. Prime costs are said to be lower than with rawhide or Fiberglas laminates. As with other plastic finishing methods, cosmesis, structural durability, and moisture resistance are enhanced.

Studies of Circulation and Surface Temperature of Amputation Stumps, Ellen Brown, Series 11, Issue 32, Lower-Extremity Amputee Research Project, Institute of Engineering Research, University of California, Department of Engineering (Berkeley) and the School of Medicine (San Francisco), [Report to the] Prosthetics Research Board, National Research Council, June 1957. viii plus 94 pp. plus 61 unnumbered pp. of charts and diagrams. Free.

Because it was thought that circulatory problems, vascular disorders, vasomotor disturbances, or dysfunction of the autonomic nervous system might be responsible for pain, real or phantom, in amputation stumps, a series of experiments was undertaken with 44 volunteer amputee subjects, most of whom had been referred to the Lower-Extremity Amputee Research Project at the University of California for treatment of painful conditions. Eight of these patients had undergone amputation for reasons of vascular disease. In the remaining 36, amputation had been necessitated by trauma or infection. This report presents the results of six kinds of tests performed in relation to the stumps and contralateral extremities of the subjects: the cutaneous reaction to the local injection of histamine; the effect of arterial occlusion by means of pneumatic cuffs; measurements of skin temperatures on exposure to cold, with subsequent warming and vasodilatation induced by means of an electric blanket and the administration of whisky; experimental or therapeutic blockade of the autonomic nervous system by intravenous administration of chemical blocking agents, by injections of procaine in the vicinity of sympathetic ganglia, or by surgical sympathectomy; oscillometric recordings of pulsatile blood flow; and visualization of the vascular pattern in stumps by means of contrast angiography.

Although in the temperature tests the stumps of the subjects tended to remain colder than did the contralateral limbs, there was little evidence of circulatory disorder in any of the subjects examined, including even those in whom amputation had been the result of vascular disease. Ischemia of both superficial and deep tissues was ruled out, and convincing evidence of vasomotor dis-

turbance was an uncommon finding. Although reduced oscillometric pulsations occurred in the stumps, as compared with the contralateral sound limbs, perspiration appeared for the most part to be normal, organic arterial insufficiency was almost completely excluded, and vasomotor disorder was found to be at best only a contributory factor in the temperature phenomena.

A concluding section of this report gives recommendations for future study.

An Experimental Assessment of Amputee Performance with Voluntary Opening and Voluntary Closing Terminal Devices, Hilde Groth and John Lyman, Artificial Limb Research, Department of Engineering, University of California (Los Angeles), Special Technical Report No. 23, February 1957. iv plus 25 pp., illus. Free.

In current prosthetics practice, terminal devices for artificial arms are of one of two basic types, voluntary-opening (in which the voluntary control motion opens the device, closing being effected by springs or rubber bands) or voluntary-closing (in which the voluntary control motion closes the device, opening being effected by springs or other means of storing energy). Since for the amputee the perceptual-motor task involved in operating the one type of device is just the reverse of that involved in operating the other, the question arises as to which, if either, of the two systems is to be preferred in terms of actual amputee performance. Is the difference of such fundamental importance as to constitute a dominant design factor in terminal-device development? Although the existing literature contributes little to the subject, the opinion has been rather widely expressed that only the voluntary-closing mechanism is compatible with normal neuromuscular patterns and that only with the voluntary-closing mechanism is graded prehension possible. Is this true?

In an attempt to establish experimentally the relative merits of voluntary-opening versus voluntary-closing mechanisms in terminal devices, and also to evaluate the influence, if any, of the mode of terminal-device control upon amputee performance, two series of tests were undertaken with amputees recruited from the files of the UCLA Artificial Limbs

Project. In both, the criterion for determining the preference of one system over the other was the "efficiency of performance" of light manipulatory tasks taken, in the first series, with respect to time, in the second with respect to prehension forces.

Selected for the tests were two commercially available types of terminal devices, nearly identical except for their operating characteristics, the voluntary-opening principle being represented by Northrop-Sierra two-load hooks and hands and the voluntary-closing principle by APRL (Army Prosthetics Research Laboratory) hooks and hands. In order to validate direct comparison of the two operational patterns, the locking mechanism on some of the APRL hooks was placed in the "free-wheeling" position (lock inoperable).

In the first experiment, three simple manipulation tests (the Minnesota Rate of Manipulation Placing Test, the Table Setting Test, and the Cup Test), requiring only the motion elements of grasp, transport, and release of objects, were administered individually to each of 10 unilateral below-elbow amputees, 5 unilateral above-elbow amputees, and 2 bilateral above-elbow amputees fitted in turn with a voluntary-opening hook, a voluntary-opening hand, a voluntary-closing hook with lock, a voluntary-closing hook without lock, and a voluntary-closing hand. One terminal device was tested each week during the series, and two postural conditions were investigated in order to evaluate the effect of the relative height of the work surface. In addition to the laboratory performance, each amputee filled out a questionnaire giving device preferences for each of 25 daily-living manipulations.

In the second experiment, involving 10 regular wearers of voluntary-opening devices and 10 regular wearers of voluntary-closing devices, half of the subjects in each group were fitted with Northrop-Sierra two-load hooks and the other half with APRL hooks with the locking mechanism removed. Instrumentation was provided by mounting Baldwin-Lima SR4 strain gauges on the fixed finger of each device, and the prehension force in various manipulations was recorded with a Brush oscillograph.

The results indicated that the underlying

principle of operation of a terminal device has no practical influence upon performance when judged by the criteria of manipulation time and prehension force. No evidence for preference of one type over the other was found. Moreover, the principle of operation was seen to exert no influence on the amputee's ability to adjust prehension forces as necessitated by a given task. Wearers of either type of device were able to manipulate fragile objects (paper cups and straws) without damaging them. As expressed in the questionnaire, amputee preferences were predominantly in favor of the voluntary-opening device. All agreed that the potentially wider range of forces available in the voluntary-closing device was of no real benefit because, in practice, manipulatory activities are confined to a limited range of low-level forces. The amount of tension available in the voluntary-opening devices appeared to be quite satisfactory.

The present form of the locking mechanism in the voluntary-closing devices was found to be more of a handicap than a help in manipulatory activities. Locking and unlocking were difficult and time-consuming and required too much of the amputee's attention. The attention factor was, indeed, found to be an important one in terminal-device acceptance.

Lack of a practical difference in performance with the two types of terminal devices suggests that the proper criteria for improvement lie in simplicity, durability, and reliability rather than in the basic type of operating mechanism.

Field Check of the Navy Above-Knee Prosthesis, Production Model A, Prosthetic Devices Study, Research Division, College of Engineering, New York University, Report No. 115.22, Prepared for the Prosthetic and Sensory Aids Service, Veterans Administration, May 1957. iv plus 26 pp., 2 inserts, 15 tables, 4-p. appendix. Free.

After a successful shakedown test in 1951 and a similarly successful field test in 1953, arrangements were made for the commercial production of the so-called "Navy variable-cadence above-knee leg," which incorporates a variable-friction knee mechanism (ARTIFICIAL LIMBS, May 1954, p. 16), a plastic shank designed for strength and lightness, and the so-called "Navy functional ankle"

(ARTIFICIAL LIMBS, May 1954, p. 17). In order to introduce the unit to clinic teams throughout the country, to identify problems that might be encountered by prosthetists, to determine amputee acceptance, and to evaluate maintenance requirements, the first production models were subjected to a field check by the Prosthetic Devices Study of New York University.

From 131 male above-knee amputees interviewed and examined there were selected as test wearers 58 otherwise healthy patients with various stump lengths, occupations, and levels of physical activity, ranging in age from 15 to 58 years, and residing in 25 states and the District of Columbia. Each of these subjects, all of whom had theretofore been active wearers of above-knee limbs, was fitted with a production model of the Navy prosthesis, delivery of the leg being made in the presence of a clinic team consisting minimally of a physician, a therapist, and a prosthetist. Patient and prosthesis were first examined to ensure proper fit, alignment, and comfort, and each subject was then scheduled for two subsequent examinations by the clinic team at one-month intervals, at which times the reactions of both patient and the members of the clinic team were obtained by the NYU research representative. In addition, records were maintained of the frequency of friction adjustments and of the type and extent of maintenance required.

The resulting data indicated clearly that the functions of the knee and ankle were felt by the majority of the subjects to represent a decided improvement over their previous prostheses. The amputees said that the knee mechanism improved their gait patterns, enabling a smoother, more natural walk with less effort. The additional motion of the ankle, particularly on rough or uneven ground, as well as the cushioning effect, was also well liked. The reactions of the 36 clinic teams involved in the study paralleled those of the amputee wearers with regard to the general improvement in gait effected by the new leg.

Although the functional characteristics of the Navy leg were favorably received, significant criticisms were directed at the maintenance requirements. In particular, the friction brakes were unsatisfactory since adjustments were required too frequently. Other major maintenance requirements re-

lated to the extension-stop bumpers, which had to be replaced in 36 cases; the durability of the plastic shank, which had to be replaced or reinforced in 14 cases; and the excessive wear of the ankle block, which had to be replaced in 13 cases.

Because of these difficulties, the final recommendation was that, despite the general functional acceptability of the Navy leg, no further distribution should be undertaken until the deficiencies have been corrected.

Surveys of Child Amputees at the Mary Free Bed Hospital, Grand Rapids, Michigan, Prosthetic Devices Study, Research Division, College of Engineering, New York University, Report No. 115.21, Prepared for the Prosthetics Research Board, National Research Council, May 1957. viii plus 162 pp. Free.

In cooperation with the Michigan Crippled Children Commission, the Prosthetic Devices Study of New York University inaugurated in 1953 at the Mary Free Bed Hospital in Grand Rapids, Mich., a program of investigation in the field of child prosthetics. From the case roster of MCCC there were selected for detailed study two samples of amputee children (23 upper-extremity child amputees, 38 children with amputations in the lower extremity) representing both sexes, a wide range of ages, virtually all amputation levels and combinations of levels, and the two possible sources of amputation (congenital and traumatic), the primary purpose of the survey being to develop a comprehensive body of knowledge about the child amputee (as distinct from the adult amputee), his particular needs, and the extent to which his needs were being met by an agency experienced in this field.

In the study of the upper-extremity amputees, information was gathered about background, physical condition, experience with amputation and prostheses, quality of prostheses, and ability in prosthetic use. Through interviews with parents and by means of psychological instruments, studies were made of parental acceptance of amputee children, social sensitivity, general adjustment, and specific reactions to disability. The findings indicated that children use their prostheses in at least as wide a range of activities as do

adults, that they often display higher levels of performance than is ordinarily associated with adults, and that they integrate the prosthesis into their body image to a degree rarely found among adults. Many prostheses were described as well constructed and fitted and of good workmanship, but there was a decided lack of prosthetic components and hardware specially designed for children. Although most upper-extremity amputee children generally liked the functional advantages of their existing prostheses, a widespread interest in and desire for a hand was noted among both boys and girls of all ages. Laminated plastic sockets and forearms were clearly preferred to those of leather or metal.

Studies of the lower-extremity amputees were based on records of personal history and prosthetic experience, biomechanical evaluation of the strength and range of motion of the stump, evaluation of the prostheses, and an evaluation of gait and other activities. It was concluded that the lower-extremity congenital amputee is far more frequently burdened with multiple anomalies than is the congenital upper-extremity amputee, and some children with congenital leg deformities not involving amputation were fitted with unconventional prostheses. With these exceptions, however, the juvenile leg amputee presents a less complicated stump than do corresponding adults. Early fitting with prostheses was a principle applied to all lower-extremity amputee children, congenital cases being fitted at approximately $1\frac{1}{2}$ years of age, or when the normal child begins to walk, traumatic cases being fitted as soon as the postoperative condition permitted. The child leg amputee seemed to be more dependent upon his prosthesis than was the child arm amputee, as indicated by continuous and extensive wear of leg prostheses. Although children were found to employ leg prostheses far more extensively than adults as regards both the number and frequency of activities, they appeared to be less concerned with the appearance of their gait.

In the psychological assessment of juvenile amputees, use was made of interviews and tests. A case study of each child was made by means of the Blacky Test, a parental-attitude questionnaire, and an intensive clinical interview of child and parent, and

the results were used to evaluate reactions to disability, general adjustment, social sensitivity, and parental acceptance. The findings indicated that the most frequent reactions to amputation are denial of handicap, attempts to compensate for functional loss and social disadvantage, and strong strivings for independence. Withdrawal techniques, inferiority feelings, dependence, and depression were frequently noted. The general adjustment of 60 percent of the sample was found to be adequate or superior, but 40 percent showed inadequate adjustment. Although some 32 percent were enjoying satisfactory parental acceptance, in another 41 percent parental acceptance seemed inadequate. Generally, the subjects seemed quite sensitive about their physical appearance, the inadequately adjusted children being more sensitive than those well adjusted. Congenital amputees seemed to make better adjustments than traumatics. Little significant difference was noted in the reactions to disability of the congenital and the traumatic groups, but more of the traumatic amputees had depressive reactions and feelings of inferiority.

An interesting dichotomy based upon specific reactions to disability categorized most of the observed reactions as being concerned either with restitution of the loss or with avoidance of its implications. Those who had strong desires for restitution engaged in behavior resulting in desirable achievements and satisfaction and were more frequently well adjusted than those with avoidant reactions.

Notes on the Diagnosis and Treatment of Above-Knee Fitting Problems, William E. Hitchcock, Prosthetics Education, Post-Graduate Medical School, New York University, August 1957. iii plus 37 pp., illus. \$1.50. Medical Book Store, 550 First Ave., New York 16, N. Y.

During the past two years, the ischial-bearing, quadrilateral socket with its characteristically narrow anteroposterior dimension, its typical bulge in the area of Scarpa's triangle, and its high anterior and lateral walls has been fitted to above-knee amputees in increasing numbers throughout the country. Most above-knee amputees have been able to wear such a limb successfully. From time to time, however, certain problems, arising after

a short period of use, have caused considerable trouble. To take appropriate corrective measures it is important to be able to analyze any given problem.

This report describes and discusses, by text and drawing, a series of 25 common problems that have been encountered in the use of the above-knee quadrilateral socket, either at initial fitting or after a period of use, and offers the means of eliminating the symptoms. It consists of five principal sections entitled, respectively: *Anterior Wall*, *Lateral Wall*, *Posterior Wall*, *Medial Wall*, and *Sitting Problems*. Each of these is broken down into the types of problems to be anticipated. To analyze a given problem with a quadrilateral socket, one need only to select the reported symptoms from the table of contents and turn to the page indicated. This document may therefore be looked upon as a prosthetist's "modification manual" for dealing with the type of above-knee socket now widely recommended. And consequently it should be in the shop of every limbmaker who has occasion to construct above-knee prostheses, either suction socket or with auxiliary suspension.

Well written and well illustrated, this publication was made possible by a training grant from the Office of Vocational Rehabilitation, U. S. Department of Health, Education, and Welfare. It is used as one of the teaching aids in the courses in above-knee prosthetics (page 117).

Notes on the Management of the Above-Knee Amputee, Prosthetics Education, Post-Graduate Medical School, New York University, August 1957. ii plus 130 pp., illus. \$4.00. Medical Book Store, 550 First Ave., New York 16, N. Y.

This document, consisting of six more or less independent sections (*Prosthetic Clinic Procedures*, *Prescription of Above-Knee Prostheses*, *Gait Analysis*, *Checkout of Above-Knee Prostheses*, *Revised Notes on Above-Knee Gait Training*, and *Revised Notes on Activities Training*), presents, largely in outline form, the procedures recommended for prescription of above-knee prostheses, the problems commonly encountered in checkout of above-knee limbs, together with the usual causes of these difficulties, and the techniques found suitable for the above-knee amputee in level walking as well as in the performance of a

number of other essential functions (sitting in and rising from chairs, ascending and descending stairs and ramps, picking up objects from the floor, kneeling and arising from the kneeling position, and so on). As such, it forms a sort of companion piece for the report by Hitchcock (see above). The materials were developed jointly by the staffs of the Prosthetics Education Program of the NYU Post-Graduate Medical School and the Prosthetic Devices Study of the NYU College of Engineering using research results and practical experience accumulated by the Prosthetic Devices Research Project of the University of California at Berkeley (now the Berkeley Section of the UC Biomechanics Laboratory) and by the Prosthetic Devices Study at NYU.

Except for the first section, which is a narrative account of the development and method of operation of the prosthetics clinic team, this report takes the form of a manual of instructions for the prescription and check-out of the above-knee prosthesis and for the training of the above-knee amputee in the proper use of the limb. Apparently because the text was gleaned from various teaching aids used in the NYU courses in above-knee prosthetics (page 117), there is a certain lack of continuity from section to section. But this circumstance is of no serious consequence because each section is essentially self-supporting.

Like the report by Hitchcock, this publication was made possible by a training grant from the Office of Vocational Rehabilitation, U. S. Department of Health, Education, and Welfare.

Lower Extremity Prosthetic Devices for Children, Michigan Crippled Children Commission (Carleton Dean, M.D., *Director*), Lansing, Mich., [1958]. ii plus 68 pp., illus. Free.

This report, patterned along the same lines as the earlier report from the same source on upper extremities (*ARTIFICIAL LIMBS*, Autumn 1957, p. 77), presents the frequency distribution of child amputees of all types (231 with upper-extremity amputations, 196 with amputations in the lower extremity) recorded in the Michigan State Register of Crippled Children as of June 30, 1957, together with a

statistical analysis of prosthetic services provided for 31 congenital and 78 traumatic unilateral lower-extremity amputees in Michigan as of July 1, 1957. Of the 109 cases cited, some 30, covering ages from the toddler to the adult (21 years), are presented graphically with detailed data on equipment and services furnished and on the cost of such equipment and services.

It is pointed out that, because it is the inherent desire of all children eventually to rise and walk erect, acceptance of a leg prosthesis, both on the part of the child and of its parents, is more readily forthcoming than is the case with artificial arms. Emphasis is placed on the importance of fitting the congenital leg amputee the moment he shows signs of trying to rise and walk.

Second Annual Report, Child Amputee Prosthetics Project, Lewis G. Wilson and G. Franklin Harland, Department of Pediatrics, School of Medicine, University of California at Los Angeles, December 1956. iii plus 50 pp. plus 30 pp. of data forms and tables. Free.

Established at the University of California at Los Angeles in 1953, the Child Amputee Prosthetics Project was until July 1, 1956, a mutual undertaking of the Departments of Engineering and of Pediatrics. Since the latter date, responsibility for administration of CAPP has resided solely in the Department of Pediatrics, under the direction of Dr. Milo B. Brooks, although a number of other Departments in the Medical School, as well as the Department of Engineering, continue to serve in a consulting capacity as needed.

This report, intended to summarize the activities of CAPP during 1956, covers administration (including the method of case management, the participation of the limb industry, the study in lower extremities, and the local system of case follow-up and information feedback), medical research (including a series of research protocols and methods of collecting data in studies in occupational therapy, social work, psychology, and pediatrics), and the system of education and information now in use (teaching, staff education, seminars, and so on). Finally, there is appended a section descriptive of the method of patient care, together with a tabulation of

data on 129 upper-extremity child amputees seen between November 1, 1955, and February 15, 1957.

Of the total number of patients seen during 1956, 83 percent were congenital amputees, only 17 percent being traumatic or elective. Statistics on the cases seen during the reporting period are said to reflect a growing interest on the part of project personnel in attempting to fit patients at an earlier and earlier age, especially children under one year. During the period reported upon, the infant patient case load increased 140 percent—from 10 patients to 24 patients, all of the infants being congenital amputees. The toddler and other younger patients (three to five years) increased from 12 patients to 23 patients (91 percent).

An interesting observation is concerned with the incidence of the below-elbow case among child amputees. In the sample presented in this report, more than half of the patients had below-elbow amputations. A very large proportion of these were congenital in origin.

As technical reports go, this one is exceptionally well prepared and therefore makes for easy reading. It is encouraging to note that the Project Director has taken the trouble to acknowledge the services of all the people who in one way or another participated in its preparation.

Cineplasty: Results of Follow-Up Study,

Thomas J. Canty and Eugene E. Bleck, U. S. Armed Forces Med. J., July 1957, p. 972. 7 pp., illus. Reprints available from the authors at the U. S. Naval Hospital, Oakland, Calif.

In an attempt to evaluate the usefulness of the cineplastic method of harnessing artificial arms, 40 young (between 20 and 35 years of age) adult males on whom the cineplastic operation (28 biceps muscle tunnels, 12 pectoral tunnels) had been performed were interviewed by means of a questionnaire. Biceps cineplasties had been confined to long below-elbow cases, pectoral cineplasties to very short above - elbow and shoulder - disarticulation cases, and the operations had been performed only on the most cooperative and more intelligent patients, only after thorough explanation of the whole matter, and only with the patients' complete and freely given con-

sent. Thorough training in the use of the prosthesis had been given in every case, and before discharge each patient had had to pass an 86-item achievement test.

Of the 40 patients questioned, 33 (82.5 percent) were found to be using their prostheses. Of the 28 biceps cineplasties, 23 (82.1 percent) were wearing their arms; 10 (83.3 percent) of the 12 pectorals were wearing theirs. Although some surgical complications were reported, only three patients were unable to use their arms for that reason.

Patients who were using their cineplastic prostheses gave a variety of reasons for their preference for this type over the conventional type, which they had worn previously and which was still available to them. Of the 23 patients using their biceps cineplasties, 22 preferred this method over the conventional method of shoulder harness. Of the 10 who were using pectoral cineplasties, 9 preferred the method over the conventional. Only one patient did not consider the extra hospitalization and training time worth while.

The reasons for the exceptionally good results (considerably better than those reported by others and better even than anticipated by the authors themselves) are said to relate to the careful selection of patients, the use of a modern and comfortable prosthesis, and thorough training in use of the device. An occupational therapist is said to be essential in any fully coordinated cineplasty program.

A Functional Ankle (Cable) Joint for Artificial Legs, Charles C. Asbelle and Thomas J. Canty, Navy Prosthetic Research Laboratory, U. S. Naval Hospital, Oakland, Calif., Final Technical Report [on] Research Project NM 740170.27, 9 December 1957. iv plus 117 pp., illus. Free.

Unlike the normal human ankle, the so-called "conventional" prosthetic ankle joint provides rotation of the foot about the ankle in one plane only, the plane of progression, so that the foot functions to provide plantar- and dorsiflexion only. The joint axis is commonly installed at right angles to the plane of progression and parallel to the floor. Proper resistance to rotation of the foot about the ankle, and the restoring means necessary to return the foot to its neutral position upon

release of external forces, are usually furnished by two separate and unmatched sections of rubber set into suitable recesses, one in front of the ankle axis (the front bumper) and the other behind it (the back bumper). Because this arrangement fails to provide the other motions characteristic of the normal ankle, it is often found to be responsible for walking difficulties in leg amputees wearing prostheses built around it.

This report presents the background, development, and field evaluation (200 leg-amputee subjects, all types) of an improved prosthetic ankle (now known as the "U. S. Navy Functional Ankle"; see ARTIFICIAL LIMBS, May 1954, p. 17) which provides not only for plantar- and dorsiflexion but also for mediolateral and transverse rotation such as has been demonstrated to occur in the normal counterpart. A flexible steel cable, $\frac{3}{16}$ in. in diameter and attaching in the heel section, is used to anchor the foot to the shank, and resistance to flexion is afforded by a single, two-durometer rubber bumper (55 durometer in the front, 35 durometer in the back) set in appropriately opposing bumper wells, the initial degree of compression of the bumper being adjustable by means of a nut located

on the distal end of the cable. Sponge rubber is used as the fairing between foot and shank, and the foot features an integral sponge-rubber toe section instead of the hinged toe piece typical of the "conventional" foot.

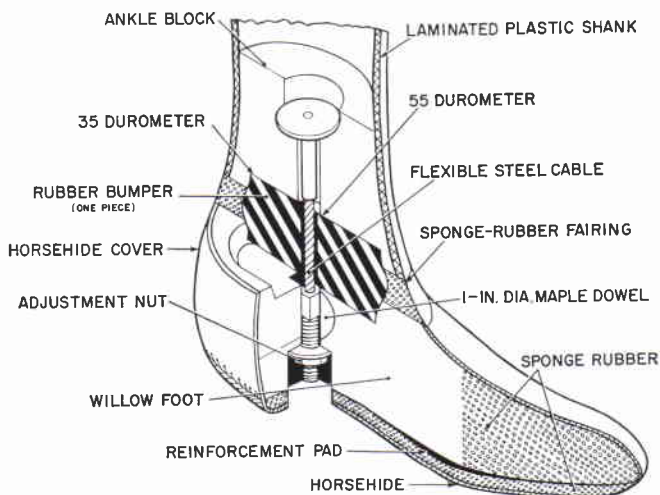
Test results, obtained both by personal interview and by questionnaire, proved to be exceptionally favorable.

Planning for Victory Over Disablement, Proceedings of the Seventh World Congress of the International Society for the Welfare of Cripples, Central Council for the Care of Cripples, London, 1957. Available from the International Society for the Welfare of Cripples, 701 First Ave., New York. 525 pp., illus. \$3.

This clothbound volume presents, as the title suggests, the scientific papers and other related addresses given before the Seventh World Congress and Exhibition of the International Society for the Welfare of Cripples in London last July 22 through 26 (ARTIFICIAL LIMBS, Autumn 1957, p. 93). Included are the contributions of a number of principals in the Artificial Limb Program who were among the American delegates.

In a foreword, His Grace the Duke of Devonshire, President of the Congress, points out that the Seventh, attended by more than 1000 persons from 54 countries, was by far the largest and most widely representative of the Congresses held thus far. That in addition to large delegations from the American continent and from all countries in Europe there were delegates also from the Soviet Union and both the Middle and the Far East is said to be remarkable and to prove that rehabilitation is no longer a Western concept but a worldwide principle.

In addition to the numerous papers and informal discussion, there is included at the back of this volume a list of formal resolutions adopted by the Seventh World Congress, a description of the exhibition held in connection with the Congress, the awards given for



THE NAVY FUNCTIONAL ANKLE—Features include a flexible steel cable requiring no lubrication, a one-piece, two-durometer rubber bumper, and a sponge-rubber toe section. The unit provides not only for plantar- and dorsiflexion but also for mediolateral and transverse rotation. From the NPRL report.

the international rehabilitation film competition, an alphabetical list of the delegates broken down by country of origin, and an index of the speakers.

Contained between the covers of this document is a wealth of information that will prove worth while for a number of different workers in rehabilitation fields. Among the subjects covered are hemiplegia and paraplegia; rheumatism and arthritis; poliomyelitis; multiple sclerosis; muscular dystrophy; epilepsy; cerebral palsy; prostheses, braces, and technical aids; placement and resettlement of the handicapped individual in society; the handicapped agricultural worker and his problems; employment in the professions and industries; and community education. In general, the material has been well prepared and edited considering that a rather large portion of it appears to have been in the nature of a verbatim transcript of extemporaneous discussion, a form of manuscript commonly very difficult to manage.

Artificial Limbs in the Rehabilitation of the Disabled, R. D. Langdale Kelham, with the collaboration of M. H. Cosbie, R. D. L. Davies, D. L. Harbinson, D. S. McKenzie, T. Ritchie, and E. S. Wheatley, all Medical Officers of the Limb Service, Roehampton. Her Majesty's Stationery Office, London, 1957. viii plus 188 pp., 120 illus. £1 net (\$2.80).

This volume, based chiefly on the experience gained during more than a quarter of a century of providing limbfitting services for beneficiaries of the British Government (some 45,000 pensioner amputees from World War I, another 11,000 from World War II, and about 50,000 civilian amputees for whom the facilities became available after the inception of the National Health Service in July 1948), purports to describe prevailing British practice in the art of limb prosthetics. It consists of eight sections devoted in turn to recommended stump lengths and character, pre-prosthetic care, prostheses for the upper extremity, prostheses for the lower extremity, special considerations in women and children, prosthetic use training, medical problems in amputation stumps, and occupational placement of amputees after fitting and training. Because of the inclusion of material on child prosthetics, some attention is given to the

management of congenital deformities. There is no index.

An inconvenience associated with the use of this book develops from the fact that all of the illustrations are grouped together at the back (presumably in an effort to avoid the cost of coated stock throughout the other 150-odd pages) and that they are simply arranged roughly in the order of presentation of the text subject matter but without actual text references. Strangely, most of the illustrations of devices, especially for the upper extremity, seem greatly outmoded as judged by present-day American standards. Although the text discusses harness-operated elbow locks, for example, and although a few harness patterns are presented in drawings, most of the arms shown appear to be built around manually operated elbow locks or else to provide no elbow lock at all. Because of the admitted deficiency (both functionally and cosmetically) of the only artificial hand shown, there seems to be a preoccupation with a wide variety of special terminal "gadgets," including special tools for completing the toilet, feeding oneself, driving an automobile, performing routine office duties, and doing other heavier labor. Only passing mention is made of any functional hook, and many of the devices indicated for the lower extremity appear to be more of World War I vintage than of any very recent period. The over-all impression left is that there has been in Great Britain virtually no progress in limb prosthetics since the days of Muirhead Little.

With these obvious shortcomings, this work of Langdale-Kelham and associates seems only to invite comparison with the rather remarkable achievements that have come about in the last decade in the development of limb prosthetics in the United States and to highlight the rather startling disparity now to be found between British and American practice in the rehabilitation of amputees.

Artificial Limbs, Leon Gillis (with foreword by Sir Harry Platt), Pitman, London, 1957. xiv plus 449 pp., 286 illus., 6 plates. £15 (\$42).

This new volume by Leon Gillis, said to be a sort of companion piece to his earlier work, *Amputations* (Heinemann, London, 1954), represents, according to the author's own statement, nothing particularly original in

the field of limb prosthetics but, rather, a compilation of material, from many and diverse authoritative sources, accumulated during a period of fifteen years of intensive study and research. Based in part on the author's clinical experience as a practicing orthopedic surgeon, it is somewhat more than the title implies. That is to say, it presents, in addition to the details of limb design, construction, and fitting, the principles of anatomy, physiology, psychology, physical therapy, and other disciplines now widely recognized as playing essential roles in the total rehabilitation of the amputee.

The text is divided into three principal parts comprising a total of 22 chapters. The first, called *Limb-Fitting*, deals with the surgical aspects of amputation and recommended stump lengths, anatomical and physiological principles involved in fitting prostheses, the physical treatment of the patient, the operation of the British Limb Service under the Ministry of Health, examination of the amputee and what amounts to prescription, measurements and cast-taking, and the role of the surgeon in the management of special medical problems and unusual cases in general. Part II, entitled *Artificial Limbs*, consists of 10 chapters concerned with the various aspects of the construction and application of limb prostheses, including methods of suspension, the mechanical principles involved in limbfitting, and the special considerations involved with children and the elderly. Part III is headed *Rehabilitation*. It consists of five chapters devoted, respectively, to normal and amputee locomotion, to use training in the upper extremity, to psychological problems, to social welfare and amputee placement, and to a discussion of the means of assessing disability. Included are three appendices, the first being excerpts from the British Government's official criteria for assessing disability in war pensioners and other beneficiaries, the second being a list of "accepted consequential injuries for amputees as a result of wearing artificial limbs," and the third being a tabulation of the number of amputees in Great Britain as of December 1953 (total, all types: 35,685).

Each chapter of this volume is very extensively documented with a profusion of references, many to the American literature of limb prosthetics, including much material

from ARTIFICIAL LIMBS, from Klopsteg and Wilson's *Human Limbs and Their Substitutes*, and from the *Orthopedic and Prosthetic Appliance Journal*. But because the references are sorted out and applied to individual chapters as appropriate, there is, as would be expected, a good deal of repetition, so that the total number of individual citations is not quite as large as one might think at first glance. No harm is done, however, in having individual items appear in all chapters to which they seem pertinent. A glossary of some 100-odd terms and a rather inadequate index of five pages complete the work.

Although most of the techniques and devices discussed appear to be reasonably modern in terms of current American practice, there is nevertheless a rather noticeable difference, especially as regards devices and more particularly devices for the upper extremity, between what Gillis presents and the prosthetic armamentarium now available as a result of the Artificial Limb Program in the United States. Again, as in the case of the new volume by Langdale-Kelham and associates (see above), the seeming deficiencies in functional hands and hooks have resulted in a multiplicity of highly specialized terminal "gadgets" which in the United States would be viewed more or less with disfavor.

As books on limb prosthetics go, however, Gillis' contribution is quite well written and edited, well illustrated and documented, and possessed of a wealth of information perhaps deserving of comparison with our own state of knowledge. But the price, which seems rather exorbitant, is apt to keep Gillis off the shelves of many people who might otherwise use it to good advantage.

Correction

In the *Abstracts* section of ARTIFICIAL LIMBS for Autumn 1957 (page 75) there appeared a description of *A Manual for Occupational Therapists on the Rehabilitation of Upper Extremity Amputees* (Thelma L. Wellerson, College of Physicians and Surgeons, Columbia University, [and] Institute for the Crippled and Disabled, New York City, April 1957). Therein it was stated that this publication is free. Actually, Wellerson's *Manual* sells for \$2.50 per copy. ARTIFICIAL LIMBS regrets the error.

Digest of Major Activities of the Artificial Limb Program

This section of ARTIFICIAL LIMBS is intended to present a summary of principal news events of interest in the Artificial Limb Program during the several months preceding issue. Stories of activities in the various laboratories and associated agencies, reports of meetings, photographs, and items about individuals all are acceptable.

PRB Meetings

The Ramo-Wooldridge Corporation was host to the Prosthetics Research Board when the latter convened for its fifth meeting, in Los Angeles, October 29. The session followed a day in which the members of the Board visited the Engineering Artificial Limbs Project, the Child Amputee Prosthetics Project, and the Prosthetics Education Project, all at UCLA, where they witnessed demonstrations by a number of amputee subjects and met with regents, deans, department heads, and project leaders at the University.

After approval of the minutes of its fourth meeting (ARTIFICIAL LIMBS, Spring 1957, p. 109) and of the meetings of the Executive Committee held on May 25 and July 26, 1957, the Board considered the composition of its Committee on Prosthetics Research and Development and approved the reactivation of the Phase IV Subcommittee under the chairmanship of Lee J. Fawver, of the W. E. Isle Company, Kansas City, Mo. This new group, composed primarily of individuals associated with the limb industry, will be concerned with the introduction of new devices and techniques to the field, and thus it replaces the former Committee on New Devices, which is now disestablished.

The Board then took up the matter of implementing its Committee on Prosthetics Education and Information, which had been newly activated in mid-1956 (ARTIFICIAL LIMBS, Autumn 1956, p. 68). After discussion, it was voted unanimously to appoint Dr. Alfred R. Shands, Jr., as Chairman of CPEI

and to review at an early date the balance of the membership of this committee. Dr. Shands is Medical Director of the Alfred I. duPont Institute of The Nemours Foundation, Wilmington, Del., and Visiting Professor of Orthopaedic Surgery at the University of Pennsylvania School of Medicine in Philadelphia.

Thereafter the Board took under consideration a twofold proposal by Miss Mary E. Switzer, Director of the Office of Vocational Rehabilitation, U. S. Department of Health, Education, and Welfare, that the Prosthetics Research Board prepare a long-range plan setting forth needed research in the broad fields of prosthetics and orthotics, particularly in areas which might logically call for OVR support, and that the Board undertake to serve in a consulting capacity to OVR and its National Advisory Council in the review of applications for research grants. After discussion, it was voted unanimously "that the Board will be pleased and honored to work out with the Office of Vocational Rehabilitation a long-range plan for assistance in the rehabilitation of amputees and cripples and to advise in the consideration of research proposals and otherwise as requested by that Office, and further that the Chairman be authorized and requested to take early action toward accomplishing definitive plans for cooperative efforts with OVR toward common objectives, and to report to the Board at its next meeting."

The matter of proposed gradual expansion of activities into the field of braces was again explored, as was also the matter of proposed overseas activities having the purpose of bringing the results of the Artificial Limb Program to the peoples of other countries of the free world. The Board then adjourned, to meet again upon the call of the Chairman.

The sixth meeting of the Prosthetics Research Board was held in the Massachusetts Room of the Hotel Statler Hilton in Washington, D. C., January 14. Present as guest of



DR. SHANDS

honor was Miss Mary E. Switzer, Director of the Office of Vocational Rehabilitation of the U. S. Department of Health, Education, and Welfare. She was accompanied by Mr. Donald H. Dabelstein, Assistant Director of OVR for Program Planning and Evaluation. Present to represent the National Academy of Sciences—National Research Council was Mr. Louis Jordan, Executive Secretary of the Division of Engineering and Industrial Research.

After approval of the minutes of its fifth meeting, the Board considered the membership of its Committees on Prosthetics Research and Development and on Prosthetics Education and Information. To the membership of the former were added Mr. Dabelstein, of OVR, and Dr. Clinton L. Compere, who had theretofore served as Chairman of the old Subcommittee on Prosthetics Education, which is now abolished. After discussion of a slate of candidates for membership on the newly activated Committee on Prosthetics Education and Information under the chairmanship of Dr. Shands, the Board voted unanimously to approve the membership of ten persons as proposed by the Executive Director.

Upon introduction by Brig. Gen. F. S. Strong, Jr., Chairman of PRB, Miss Switzer addressed the Board and outlined the fiscal arrangements and methods of operation of her organization. Gen. Strong then described for Miss Switzer the plans of the Board for the development of the long-range master plan that she had requested and that would serve as a guide to her agency in the granting of research and training funds in the broad fields of prosthetics and orthotics. At a meeting of the Executive Committee of PRB in Detroit January 28 (see below), an *ad hoc* committee was appointed to carry out the Board's directive with respect to the development of this plan. Membership includes Gen. Strong as Chairman; Mr. Dabelstein, of OVR; Chester C. Haddan, a member of PRB; Dr. Paul B. Magnuson, until recently a member of the Board and now a consultant; and Dr.



MISS SWITZER

Robert E. Stewart, Director of the VA's Prosthetic and Sensory Aids Service. The next meeting of the Prosthetics Research Board is scheduled to be held at the Army-Navy Club, Washington, D. C., on April 28 to receive a report of the planning committee.

PRB Executive Committee

At the third meeting of the Executive Committee of the Prosthetics Research Board, in Detroit last January 28, it was voted unanimously to appoint as an additional member Dr. C. Leslie Mitchell, Surgeon - in - Charge, Division of Orthopaedic Surgery, at the Henry Ford Hospital. Appointment of Dr. Mitchell brings to four the membership of the Executive Committee, which was established by PRB over a year ago (*ARTIFICIAL LIMBS*, Spring 1957, p. 109) and which is currently authorized to consist of the Chairman and Vice-Chairman of the Board and such other members, not to exceed three, as the Chairman may recommend. The other appointee is Chester C. Haddan, of Gaines Orthopedic Appliances, Inc., Denver. One vacancy on the Executive Committee remains to be filled at the discretion of the Chairman.



DR. MITCHELL

Subcommittee Meetings, CPRD

The Committee on Prosthetics Research and Development of the Prosthetics Research Board receives the advice of a number of so-called "phase subcommittees" which together constitute a system for the orderly transition of ideas, devices, and techniques from conception, through development and testing, to manufacture and application. The Subcommittee on Criteria Determination and Technique Development (Phase I) has as its responsibility the planning of basic research from which to develop meaningful and realistic criteria for design of devices and evolution of suitable techniques. The design and development of working models satisfying the

criteria is the function of the Subcommittee on Prototype Development and Evaluation (Phase II), while the Subcommittee on Production-Model Development and Evaluation (Phase III) is, as its name suggests, concerned with the development and evaluation of production models of new devices. These groups meet periodically, usually twice a year, in the spring and in the autumn, and often at the various laboratories concerned, the thought being to give the committee members an opportunity to view firsthand the method of approach being used. Ample time is provided for complete and thorough discussion of all agenda items.

The autumn meetings for 1957 were held during November and extended from the 4th to the 26th of the month. Phase I met at the U. S. Naval Hospital in Oakland, Calif., on November 4, again at the Biomechanics Laboratory at the University of California Medical Center in San Francisco on November 5, and still again at the Engineering Artificial Limbs Project at the University of California at Los Angeles November 7 and 8. Phase II divided its time between UCLA, where it met November 11, the West Coast office of the Prosthetics Research Board, where it met November 12, and the Naval Hospital at Oakland, where it met November 13 and 14. Phase III met at the NYU Prosthetic Devices Study in New York City November 25 and 26.

Among the matters taken up by Phase I was the problem of the below-knee case. Analysis of a report on this subject by the Biomechanics Laboratory of the University of California, Berkeley, led to the adoption of a list of ten specific areas for further research. This constitutes a start of an organized program of investigation into the below-knee problem.

The classification of knee mechanisms for the above-knee case next came under consideration. With a view toward developing indications for prescription, the subcommittee adopted a Berkeley report in which such knee units are classified on the basis of functional characteristics, together with a listing of advantages, disadvantages, and suggested applications. At the meeting of Phase I at UCLA, attention was given to the problems of applying external power for the operation of upper-extremity prostheses.

During the meetings of Phase II, the subcommittee approved APRL Technical Report No. 5629 (ARTIFICIAL LIMBS, Autumn 1956, p. 67) and advanced to Phase III the APRL technique for building a one-piece laminated below-elbow arm. It also approved APRL Technical Report No. 5733 (ARTIFICIAL LIMBS, Autumn 1957, p. 71) and advanced to Phase III the APRL method of color-stabilizing plastic laminates using "U V Absorber 9" (American Cyanamid Co.). Phase II then laid plans for the evaluation of 15 production models of the Henschke-Mauch hydraulic knee unit which incorporates control in both swing and stance phases of walking, and it advanced to Phase III the Berkeley technique for making the Canadian-type Syme prosthesis (ARTIFICIAL LIMBS, Autumn 1957, p. 75). Finally, Phase II received a report of progress with the APRL technique for making porous laminates in the construction of plastic arm shells (page 97).

At the meetings of Phase III in New York City, the status of some 16 devices now in the production-model stage was reviewed. Recommended for use were the Hosmer E-600 outside-locking elbow, the Hosmer E-1500 outside-locking elbow for children, and the Sierra constant-friction wrist unit, also in the child's size; and the Henschke-Mauch hydraulic knee unit with swing-phase control was accepted for production-model evaluation.

The next series of meetings of the CPRD subcommittees is scheduled to be held during the Annual Prosthetics Conference in Washington, D. C., June 12 through 14 (page 115).

Conferences on Child Prosthetics Problems

On December 2 and 3, personnel of the Child Amputee Prosthetics Project at UCLA, members of the California Public Health Service, members of the Committee on Child Prosthetics Problems, and staff members of the Prosthetics Research Board held a planning conference at the UCLA Medical Center in Los Angeles. On the following day, the Committee on Child Prosthetics Problems, under the chairmanship of Dr. Charles H. Frantz, met in closed session for the purpose of making recommendations to PRB concerning the Child Amputee Program, which includes at present the activities of the Child Amputee Prosthetics Project at UCLA, the Michigan



DR. FRANTZ

Crippled Children Commission at Grand Rapids, and the children's project at New York University.

Among the ideas discussed, and subsequently proposed to PRB, was that the clinical base of the Child Amputee Prosthetics Program should be broadened by obtaining the assistance and cooperation of additional child-amputee clinics so as to make available for study of techniques and devices relating to child-amputee management a much larger patient volume from which to garner information. It was also recommended that all crippled children with anomalies of the extremities be included in the Child Amputee Program, inasmuch as it has been found that most of these children can be helped by the application of prosthetic devices. In order to qualify in the Child Amputee Program, clinics must meet certain basic criteria. These measures are now under development by a steering committee of CCPP.

In a third resolution, the Committee recommended that the Child Amputee Prosthetics Project at UCLA should concern itself with lower-extremity problems as well as with those of the upper and that it should assume responsibility for basic biomechanical research in the area of the juvenile amputee. Recognized also was a specific need for the teaching of prosthetics in medical and paramedical schools with particular reference to the child amputee, where a very large percentage of the patients present anatomical abnormalities offering highly specialized problems, and it was proposed that the techniques of prosthetics practice pertinent to the child amputee be included in existing schools operated under the Prosthetics Education Program (page 117).

Concluding its session, the Committee set forth the following areas as being promising ones for continued research in limb prosthetics for the child: fitting and harnessing, genetics as related to the incidence of congenital amputees in the United States, special surgical problems in the child, psychosocial

problems in adjustment of the child amputee, performance standards for various types of amputations and/or anomalies and for various age groups, and the development of training techniques for the child amputee.

The next meeting of the Committee on Child Prosthetics Problems is scheduled to be held in Washington, D. C., during the Annual Prosthetics Conference June 12 through 14 (page 115).

Committee on Prosthetics Education and Information

The first meeting of the newly constituted Committee on Prosthetics Education and Information (page 112) was held on March 13 in the Reading Room of the National Academy of Sciences in Washington. Purpose of this first assembly was to provide for those new to the Artificial Limb Program a preliminary orientation in its background, organization, current activities, and future objectives. To this end, a number of guest speakers active in ALP participated in the morning session. These included Brig. Gen. F. S. Strong, Jr., Chairman of the Prosthetics Research Board; Mary E. Switzer, Director of the Office of Vocational Rehabilitation, U. S. Department of Health, Education, and Welfare; Dr. Robert E. Stewart, Director of the VA's Prosthetic and Sensory Aids Service; Glenn E. Jackson, Executive Director of the Orthopedic Appliance and Limb Manufacturers Association; Dr. Miles H. Anderson and Dr. Sidney Fishman, Directors of Prosthetics Education at UCLA and at NYU, respectively; and Dr. Eugene F. Murphy, Chief of the Research and Development Division of the VA's Prosthetic and Sensory Aids Service and a member of the Editorial Board of ARTIFICIAL LIMBS.

The afternoon session was devoted to a business meeting in which plans were developed for the group, especially those relatively new to the Program, to visit the various projects during the coming year. An initial meeting is planned for June 11 in New York City just prior to the Annual Prosthetics Conference in Washington (page 115).

The membership of the new Committee on Prosthetics Education and Information (see cut) represents the principal disciplines involved in the rehabilitation of amputees and



—Rideout & Stapp, Washington

NEW MEMBERS OF CPEI—Pictured during their first meeting, at the National Academy of Sciences in Washington March 13, are most of the members of the newly constituted Committee on Prosthetics Education and Information. Seated, left to right: Col. Harriet S. Lee, Chief of the Army Medical Specialists Corps, Office of the Surgeon General, Department of the Army, Washington; Dr. Alfred R. Shands, Jr., Medical Director of the Alfred I. duPont Institute of The Nemours Foundation, Wilmington, Del., and Chairman of the Committee; June Sokolov, Executive Director of the Hartford Rehabilitation Center, Hartford, Conn.; and William M. Bernstock, Assistant Chief of the Research and Development Division of the VA's Prosthetic and Sensory Aids Service, New York City. Standing, left to right: W. Frank Harmon, of the Atlanta Brace Shop, Atlanta; Renato Contini, Research Coordinator for the NYU College of Engineering, New York City; Dr. Herbert W. Park, Professor and Chairman of the Department of Physical Medicine and Rehabilitation at the Medical College of Virginia, Richmond; McCarthy Hanger, Jr., President of the J. E. Hanger Company of Missouri, St. Louis; and Dr. Samuel S. Herman, Chief of the Division of Medical Services and Facilities of the Office of Vocational Rehabilitation, Department of Health, Education, and Welfare, Washington. Absent when the picture was taken were the two remaining members of CPEI, Dr. George T. Aitken, orthopedic surgeon with the Mary Free Bed Guild Children's Hospital, Grand Rapids, Mich., and Dr. Henry H. Kessler, Medical Director of the Kessler Institute for Rehabilitation, West Orange, N. J.

on Prosthetics Research and Development since last year (ARTIFICIAL LIMBS, Autumn 1957, p. 79), the first meetings of the CPRD subcommittees since last November (page 112), and the second meeting of the newly appointed Committee on Prosthetics Education and Information (page 114).

PRB Exhibit

Since its first showing, a highly successful one in London before the Seventh World Congress of the International Society for the Welfare of Cripples last July 22 through 26 (ARTIFICIAL LIMBS, Autumn 1957, p. 94), the exhibit of the Prosthetics Research Board, entitled *The Artificial Limb Program in the United States*, has achieved wide popularity among diverse groups concerned in one way or another with the rehabilitation of amputees. Designed to present the organizational structure, method of operation, and some of the results of the nationwide program of research in limb prosthetics, the display was received enthusiastically by the participants in the First International Prosthetics Course given at the Orthopaedic Hospital in Copenhagen August 1 through 10, and it was one of the feature attractions at the 1957 National Assembly (the 40th Anniversary) of the Limb and Brace Profession

cripples, and the group is therefore ideally prepared to serve a vital role in the broad field of education, training, and information.

Annual Prosthetics Conference

All committees and subcommittees of the Prosthetics Research Board will meet at the National Academy of Sciences in Washington, D. C., June 12 through 14 for the Annual Spring Conference of the Artificial Limb Program. All aspects of research, development, and educational activities will be taken up. It will be the first meeting of the Committee

when it convened at the Statler Hotel in Washington, D. C., September 29 through October 2 (ARTIFICIAL LIMBS, Autumn 1957, p. 96).

Subsequent showings of the exhibit included one at the Clinical Meeting of the American Medical Association in Philadelphia December 3 through 6 and another at the Twenty-Fifth Annual Meeting of the American Academy of Orthopaedic Surgeons at the Waldorf-Astoria Hotel in New York City February 1 through 6. At both these sessions, the attending physicians revealed a growing interest

in the field of limb prosthetics, as evidenced by their numerous inquiries. At the meeting in Philadelphia, the presentation was under the supervision of Dr. Frederick E. Vultee, of the Medical College of Virginia, with the assistance of William A. Tosberg, of the Institute of Physical Medicine and Rehabilitation, NYU-Bellevue Medical Center, and Basil Peters, certified prosthetist of the B. Peters Company, Philadelphia. In New York, the showing was monitored by William M. Bernstock, Assistant Chief of the Research and Development Division of the VA's Prosthetic and Sensory Aids Service, and the effectiveness of the exhibit there was enhanced by the personal demonstrations of Brennan C. Wood, an arm amputee employed in the New York Regional Office of the Veterans Administration, and Herbert E. Kramer, a leg amputee on the staff of the Prosthetic Devices Study of New York University. On February 21 another showing was made before the Alumni Meeting of the Medical College of Virginia at Richmond.

The exhibit of the Prosthetics Research Board describes the efforts that are put forth in the Government-sponsored Artificial Limb Program to develop new and improved prosthetic devices, to evolve better techniques of fitting and training of the individual amputee in the use of a prosthesis, and to disseminate the new knowledge to the members of practicing clinic teams. Photographs and models depict the orderly and controlled procedures involved in the development of a hook and an artificial foot from the early phase of criteria determination to the advanced stage of production-model development.

Also displayed is an array of typical upper- and lower-extremity prostheses of modern design suitable for child and for adult amputees, and there is included a step-by-step description of the process of plastic lamination of sockets and arm shells for upper-extremity prostheses. Shown in addition are the harness patterns found most efficient for use with functional arm components. Of particular interest in the lower extremity is a hip-disarticulation prosthesis with a plastic shank, a single-axis knee unit with adjustable mechanical friction, a wood thigh section reinforced with plastic laminate, a one-piece laminated socket-waistband, and a stride-length control strap. Also featured is a new Syme prosthesis incorporat-



—“Scope Weekly,” courtesy The Ujjohn Co.

PRB EXHIBIT AT AAOS—Herbert E. Kramer, of the Prosthetic Devices Study at New York University, demonstrates a prosthetic knee to Dr. Kilian F. Fritsch, of East St. Louis, Ill., at the exhibit of the Prosthetics Research Board during the Annual Meeting of the American Academy of Orthopaedic Surgeons at the Waldorf-Astoria in New York City February 1 through 6. Standing in background is Brennan C. Wood, another test amputee with the Prosthetic Devices Study.

ing a SACH foot (*Solid Ankle, Cushion Heel*), a plastic-laminate shank with tibia pad, and a removable posterior section to accommodate the typically bulbous malleoli. Two types of experimental hydraulic units for above-knee amputees are described as being at the stage where field-testing can be undertaken.

In another panel, the activities of the prosthetics education centers at New York University and at the University of California at Los Angeles (page 117) are highlighted. Described in word and picture are the short-term prosthetics courses offered at these two institutions for members of the prosthetics clinic team—physicians, prosthetists, therapists, and other ancillary personnel as appropriate. The concept of teamwork in amputee rehabilitation is stressed, and some of the publications developed within the Artificial Limb Program are displayed.

Since the six presentations of the PRB exhibit already mentioned, there has been a growing demand for further showings during 1958. At present the schedule for the balance of the calendar year includes the meeting of the Minnesota State Medical Association in Minneapolis May 22 through 24; the Annual Assembly of the World Health Organization, also in Minneapolis, May 25 through June 14; the American Congress of Physical Medicine and Rehabilitation in Philadelphia August 24 through 29; the meeting of the Southern Medical Association in New Orleans November 3 through 7; and the 1958 Annual Convention of the National Society for Crippled Children and Adults in Dallas November 16 through 20.

New PRB Brochure

With the purpose of acquainting the professional public with the background, organization, and accomplishments of the Artificial Limb Program, and in order to provide a ready means of answering the many inquiries received concerning it, the Office of the Executive Director of the Prosthetics Research Board prepared early last winter an illustrated, 36-page brochure for free distribution to interested persons. Already more than 3500 copies have been given out.

The first major distribution of the new booklet was in conjunction with the showing of the PRB exhibit (see above) at the Clinical Meeting of the American Medical Association in Philadelphia December 3 through 6. Additional copies were consumed in the subsequent presentations of the exhibit at the Twenty-Fifth Annual Meeting of the American Academy of Orthopaedic Surgeons in New York City and at the Alumni Meeting of the Medical College of Virginia in Richmond.

It is planned to prepare new and revised editions of the brochure from time to time as appropriate. Those wishing to receive a copy of the present edition are invited to communicate with the Executive Director of the Prosthetics Research Board.

Prosthetics Education Program

During the fall and winter of 1957-58, the nationwide program in prosthetics education (ARTIFICIAL LIMBS, Spring 1957, p. 111;

Autumn 1957, p. 83) was continued at New York University and at the University of California at Los Angeles, at both institutions on the basis of a somewhat expanded subject matter. In addition to the usual courses in prosthetics for physicians, therapists, and prosthetists, there were offered this year several courses in orthotics for orthotists and in prosthetics and orthotics for rehabilitation personnel in general (vocational counselors, social-service workers, directors of rehabilitation centers, and the like). Some of the courses presented basic principles for those in their early years of training while others, intended for the more experienced workers, were of an advanced nature.

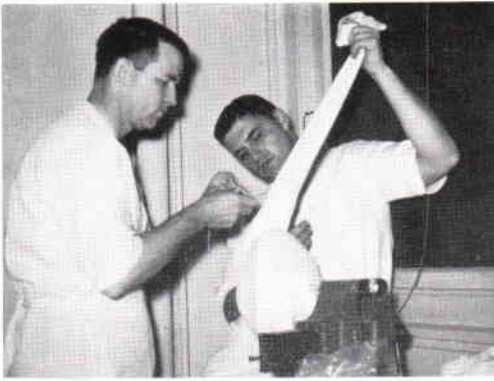
For the current academic year, New York University scheduled four series of courses in above-knee prosthetics, two series in upper-extremity prosthetics, three advanced courses in the diagnosis and correction of above-knee fitting problems, and three courses for rehabilitation personnel—a total of 24 individual courses aimed at accommodating as many of a large backlog of applications as possible. The advanced courses in above-knee prosthetic diagnosis, essentially three-day seminars, and the courses for rehabilitation personnel are being offered for the first time this year. By mid-April, one series of upper-extremity courses, three series of above-knee courses, two advanced seminars, and all three courses for rehabilitation personnel had been completed, with the following attendance:

	Physicians	Therapists	Prosthetists	Rehabilitation Personnel	Total
Upper-extremity courses	15	12	—	—	27
Above-knee courses	41	41	20	—	102
Advanced seminars	—	—	20	—	20
Rehabilitation courses	—	—	—	54	54
Total.....	56	53	40	54	203

Students of these classes were as follows:

COURSE 744A (Upper-Extremity Prosthetics)

Physicians, November 4 through 8—Dr. Henry J. Austin, Trenton, N. J.; Dr. Charles R. Borzilleri,



PROSTHETICS EDUCATION AT NYU—Students participate in a course in upper-extremity prosthetics offered by New York University during the academic year 1957–58. Left, top and bottom, prosthetists fabricate a shoulder cap for a shoulder-disarticulation prosthesis. Top right, physicians examine components of various types of arm prostheses. Lower right, a therapist gets practice in training an amputee.

Charlottesville, Va.; Dr. Gordon G. Carmichael, Roanoke, Va.; Dr. Wayne W. Kotcamp, Louisville; Dr. Albert B. Lipscomb, Charlottesville, Va.; Dr. Hugh J. McMenam, Peoria, Ill.; Dr. Herbert Nogin, Brooklyn, N. Y.; Dr. Peter E. Sabatelle, Santurce, Puerto Rico; Dr. Victor M. Santana-Carlos, Lisbon, Portugal; Dr. Frank A. Slowick, Pittsfield, Mass.; Dr. Janina Tomaszewska, New York City; Dr. John Trapuzzano, Hartford, Conn.; Dr. Joseph N. Vizzard, Philadelphia; Dr. Lacey S. Wornal, Roanoke, Va.; and Dr. Frederick Ziman, New York City.

COURSE 745A (Upper-Extremity Prosthetics)

Therapists, October 28 through November 8—Martha P. Anderson, New York City; Carol D. Billow, Durham, N. C.; James D. Chan, Windham, N. Y.; Phyllis B. Gaughran, Bronx, N. Y.; Wendell C. Hewson, Avoca, N. Y.; Jessie M. Kindel, Boston; Elsie H. McElroy, Stony Point, N. Y.; Edith B. Nichols, Saranac Lake, N. Y.; Marjorie Pardes, Chicago; Marian H. Pratt, Albany, N. Y.; Sylvia Rothstein, Jersey City, N. J.; and Nicholas Serino, Roanoke, Va.

COURSE 741A (Above-Knee Prosthetics)

Physicians, December 16 through 20—Dr. Eleanor M. Bendler, Philadelphia; Dr. Richard M. Cronin, River

Forest, Ill.; Dr. Frederick E. Dugdale, Branford, Conn.; Dr. Wyllys A. Dunham, Schenectady, N. Y.; Dr. Mario Gagliardi, Jersey City, N. J.; Dr. Warren S. Hayes, Bronx, N. Y.; Dr. Daniel Hunter, Ann Arbor, Mich.; Dr. Cairbre B. McCann, Atlantic City; Dr. Hugh J. McMenam, Peoria, Ill.; Dr. Ilhan S. Nuraltay, Bronx, N. Y.; Dr. Erma A. Smith, Cleveland; Dr. Janina Tomaszewska, New York City; Dr. Isidore M. Turner, Flushing, N. Y.; and Dr. Abraham Vinograd, Wilmington, Del.

COURSE 742A (Above-Knee Prosthetics)

Therapists, December 9 through 20—Joanne L. Bagwell, New York City; Metta Baxter, Whitmore Lake, Mich.; Seymour W. Behrman, Brooklyn, N. Y.; Michael Beirponch, Marlin, Texas; Isabelle M. Bohman, Chicago; Hubert R. Galford, Marlinton, W. Va.; Gordon A. Kober, Kalamazoo, Mich.; Margaret L. McComas, Swarthmore, Pa.; Robert W. Marsh, Gloversville, N. Y.; Arthur H. Ricklin, Bronxville, N. Y.; Jennie M. Romandi, Jamestown, N. Y.; Edwin F. Simmons, Wallinford, Conn.; and Robert L. West, Richmond, Va.

COURSE 743A (Above-Knee Prosthetics)

Prosthetists, December 2 through 20—Jack B. Faatz, Kingsport, Tenn.; Joseph A. Heldreth, Wyatt, W. Va.;

Richard Max Kraft, Buffalo; Alois G. Molitor, Buffalo; Andrew Joseph Nitti, Bronx, N. Y.; and George M. Parsley, Charleston, W. Va.

COURSE 741B (Above-Knee Prosthetics)

Physicians, January 27 through 31—Dr. Thomas A. Amburgey, Savannah, Ga.; Dr. Nathan Bander, Bronx, N. Y.; Dr. Joseph E. Cox, Shreveport, La.; Dr. Edward A. Jones, Regina, Sask.; Dr. Edwin L. Lytle, Bronx, N. Y.; Dr. Patrick J. McFadden, Erie, Pa.; Dr. Osvaldo E. Miglietta, Astoria, N. Y.; Dr. Henry F. Parry, Philadelphia; Dr. Richard W. Pomeroy, East Lansing, Mich.; Dr. William A. Schmidt, Brooklyn, N. Y.; Dr. James L. Schuster, Erie, Pa.; Dr. Russell N. Shroyer, Dayton; and Dr. James B. Wray, Winston-Salem, N. C.

COURSE 742B (Above-Knee Prosthetics)

Therapists, January 20 through 31—Florence E. Anderson, Mineola, N. Y.; Leon Anderson, Atlanta; Mario Andriolo, Brooklyn, N. Y.; Julia A. Carothers, Kansas City; Wayne E. Cummings, Savannah, Ga.; Enola S. Flowers, Chapel Hill, N. C.; Harold Glicklin, Hartford, Conn.; Derkje M. Leeseaman, Orange, N. J.; Mary K. McGuinn, Middletown, N. Y.; Josephine C. Poor, Augusta, Maine; Worth Randall, Dayton; Lillian Shoter, Albany, N. Y.; Edith M. Vail, Winston-Salem, N. C.; Virginia Whitfield, Pittsburgh; and Coralie Witherspoon, Hickory, N. C.

COURSE 743B (Above-Knee Prosthetics)

Prosthetists, January 13 through 31—Anthony R. Cocco, Philadelphia; George Fedorov, Philadelphia; William J. Hancock, Clemmons, N. C.; J. B. Haygood, Columbia, S. C.; Curt C. Hecht, New York City; Howard L. Mathieu, Onalaska, Wis.; Jefferson D. Rosser, Savannah, Ga.; and Morris I. Schneider, Brooklyn, N. Y.

COURSE 741C (Above-Knee Prosthetics)

Physicians, March 3 through 7—Dr. John S. Crawford, Toronto; Dr. Derek H. Cross, Greensburg, Pa.; Dr. Ismail H. Eroglu, New York City; Dr. Benjamin F. Griffith, Kingston, Pa.; Dr. John M. Herring, Warm Springs, Ga.; Dr. Robert T. King, Jr., Elmhurst, N. Y.; Dr. Constant S. Papageorges, Montreal; Dr. Arthur J. Pasach, Warm Springs, Ga.; Dr. Boris J. Paul, Latham, N. Y.; Dr. Alvin W. Paulson, Oklahoma City; Dr. Justis C. Pickett, Morgantown, W. Va.; Dr. Victor A. Ribera, Bronx, N. Y.; Dr. Luis Salomon, Jackson Heights, N. Y.; and Dr. Joseph R. Sgarlat, Kingston, Pa.

COURSE 742C (Above-Knee Prosthetics)

Therapists, February 24 through March 7—Wendell P. Browne, Englewood, N. J.; Daniel C. Ciavarella, West Pittston, Pa.; Kevin A. Cody, New City, N. Y.; Robert J. Hickok, Florissant, Mo.; Mildred E. Judge, Syracuse, N. Y.; Simone M. Kiven, West Orange, N. J.; Theodore M. Keys, Washington, D. C.; Joseph C. Lazarony, New York City; Jean A. Martens, Buffalo; Rosaline R. Messina, New York City; Margaret C.

Parizeau, Syracuse, N. Y.; Frances L. Riley, New York City; and Florence K. Winter, New York City.

COURSE 743C (Above-Knee Prosthetics)

Prosthetists, February 17 through March 7—Stanley J. Dew, Toronto; Warren F. Imwold, Baltimore; Gregory S. Marinello, Valley Stream, N. Y.; Nunzio Pulizzi, Williamsport, Pa.; George A. Schneider, Massapequa, N. Y.; and Ludwig Greilinger, Glendale, N. Y.

COURSE 749A (Above-Knee Prosthetic Diagnosis)

Prosthetists, September 26 through 28—Ivan A. Dillee, Woodside, N. Y.; Henry F. Gardner, New York City; Louis F. Iuliucci, Brooklyn, N. Y.; Richard McF. Locke, Birmingham; Thomas L. Maples, Metairie, La.; Charles S. Schaeffer, Dearborn, Mich.; Moody L. Smitherman, Birmingham; and William A. Tosberg, New York City.

COURSE 749B (Above-Knee Prosthetic Diagnosis)

Prosthetists, February 13 through 15—Raymond Beales, Fairfax, Va.; Charles Dankmeyer, Baltimore; John C. Gallo, Brooklyn, N. Y.; Marion Kessler, Hyde Park, Mass.; Stanley J. Kordasz, Brooklyn, N. Y.; Herbert E. Kramer, Little Neck, N. Y.; Ivan E. Letner, Washington, D. C.; Joseph H. Martino, Boston; Howard V. Mooney, Lowell, Mass.; Paul R. Rockett, Bronx, N. Y.; Allen G. Talley, Jr., Raleigh, N. C.; and Charles W. Wright, Springfield, Pa.

COURSE 7410A (Prosthetics and Orthotics for Rehabilitation Personnel)

November 12 through 22—Julius E. Hammett, Columbia, S. C.; Wilfred G. Holsberg, Waban, Mass.; Harry Katz, Bayside, N. Y.; Floyd L. Kefford, Harrisburg, Pa.; Joseph E. Lobuts, St. Albans, W. Va.; Leonard J. McCarthy, Levittown, Pa.; Earl L. Oldham, Nashville, Tenn.; Dodd Pace, Tallahassee, Fla.; James J. Segars, Decatur, Ga.; James G. Thomas, Jackson, Miss.; Martha M. Thompson, Binghamton, N. Y.; Leslie J. Waller, Birmingham; and Albert S. Zuidema, Worthington, Ohio.

COURSE 7410B (Prosthetics and Orthotics for Rehabilitation Personnel)

March 17 through 28—Henry W. Aston, Birmingham; Ralph J. Anslow, Nashville, Tenn.; C. B. Crippen, Memphis, Tenn.; George E. Currie, Savannah, Ga.; James G. Dashiell, Baltimore; William C. Dendy, Decatur, Ga.; Harvey J. Evans, Boston; Robert F. Flege, Lexington, Ky.; Guillermo Jordan, Hato Rey, Puerto Rico; Terence Kolpackoff, Jr., Brooklyn, N. Y.; Robert Lassiter, Pensacola, Fla.; Clarence McDaniel, Charlotte, N. C.; William Miller, Tampa, Fla.; Elliott Netzer, Brooklyn, N. Y.; Ruth O'Neil, Washington, D. C.; Rochester Watt, Jr., Albany, Ga.; Israel Weissfeld, New York City; Isaac Whitaker, DuBois, Pa.; Earl Wolfe, Charleston, W. Va.; and Brennan Wood, Staten Island, N. Y.

COURSE 7410C (Prosthetics and Orthotics for Rehabilitation Personnel)

March 31 through April 11—Ernest Allnutt, Baltimore; Marvin R. Barker, Charleston, W. Va.; David J.

Becker, Braintree, Mass.; W. P. Bobo, Greenwood, Miss.; Thomas E. Bowes, Worcester, Mass.; Flavius G. Byrd, Jr., Tallahassee, Fla.; Lawrence Curry, Greenville, S. C.; Odell B. Dyer, Augusta, Ga.; Ralph E. Gales, Charleston, S. C.; Veronique Gassette, Burlington, Vt.; James M. Hamilton, Sanatorium, Miss.; Agnes L. Hovey, Atlanta; Clarke Ketzle, Miami; Charles E. Miller, Montoursville, Pa.; Joseph R. Mirabella, Medford, Mass.; Dr. Daniel S. Sanford, Seaford, N. Y.; Frank D. Sheppard, Goddlettsville, Tenn.; Fred Siegel, Brooklyn, N. Y.; Robert M. Speed, West Point, Miss.; Horace E. Springer, Raleigh, N. C.; and Mary Stewart, Falls Church, Va.

At UCLA, courses offered by the Prosthetics Education Project during 1957-58 included three series of courses in *Clinical Prosthetics: Above-Knee Amputations*, three advanced courses in above-knee prosthetics for prosthetists, two courses in orthopedic and prosthetic rehabilitation for rehabilitation personnel, and four night courses (each meeting twice a week for a semester), two in the basic principles of upper-extremity prosthetics and one each in upper- and lower-extremity orthotics. Attendance through early spring is shown in the accompanying table.

There follows a list of the students attending these courses during the fall and winter of 1957-58:

SECTION I (Clinical Prosthetics: Above-Knee Amputations)

Prosthetists, October 21 through November 1—Thomas R. Bidwell, Madison, Wis.; Milton E. Bostwick, Baton Rouge, La.; James C. Chidester, Memphis, Tenn.; Robert O. Gooch, Durham, N. C.; William B. Gray, Memphis, Tenn.; Tokio Shiomichi, Milwaukee; William A. Sobbe, Chicago; Walter J. Stokosa, Farmington, Mich.; Arthur F. Thompson, Wellington, New Zealand; and Joseph E. Traub, San Bernardino, Calif.

Therapists, October 28 through November 1—John J. Arena, Houston; Phyllis B. Basford, Minneapolis; Eugenia J. Cox, San Antonio; Floyd Forrand, Reseda, Calif.; Kenneth E. Gaalaas, Los Angeles; Marilouise Knott, Los Angeles; Joe O. Luckman, Great Falls, Mont.; Robert J. Oswald, New Orleans; Jeanette M. Neckar, Seattle; Beverly J. Paquet, Los Angeles; Mary J. Rohan, San Francisco; Carol L. Spensley, Sioux Falls, S. D.; DeLois J. Wilkinson, Nashville, Tenn.; and Valerie M. Wilson, Palo Alto, Calif.

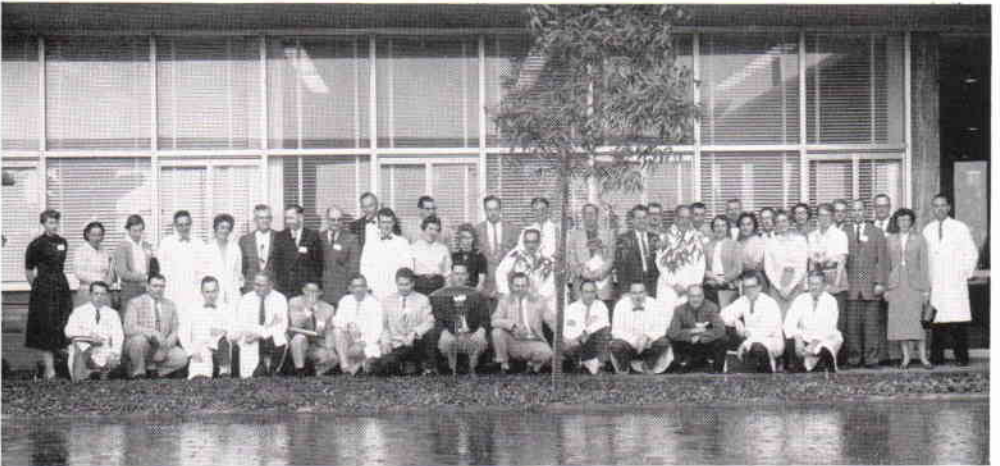
	Prosthetists	Therapists	Physicians	Rehabilitation Personnel	Prosthetists-Orthotists (unspecified)	Total
Above-knee prosthetics	30	46	45	—	—	121
Advanced above-knee prosthetics	26	—	—	—	—	26
Rehabilitation courses	—	—	—	26	—	26
Basic upper-extremity prosthetics (night classes)	—	—	—	—	23	23
Basic lower-extremity orthotics (night classes)	—	—	—	—	12	12
Basic upper-extremity orthotics (night classes)	—	—	—	—	10	10
Total	56	46	45	26	45	218

Physicians, October 28 through November 1—Dr. Leonard E. Burton, Alhambra, Calif.; Dr. Warren D. Eddy, Jr., Tucson, Ariz.; Dr. Margaret S. Folante, North Hollywood, Calif.; Dr. Robert R. Giebink, Sioux Falls, S. D.; Dr. James R. Glessner, Jr., Portland, Conn.; Dr. Laurence W. Green, Denver; Dr. Joseph C. Johnson, Los Angeles; Dr. James J. Klobucar, Los Angeles; Dr. Jack L. Lewis, Long Beach, Calif.; Dr. James A. MacDonell, Grand Rapids, Mich.; Dr. Jack W. Newport, New Orleans; Dr. Albert W. Shiflet, Harland, Ky.; Dr. David J. Simon, Los Angeles; Dr. Donald Y. Stewart, Akron; Dr. Alfred B. Swanson, Grand Rapids, Mich.; and Dr. Robert G. Treat, Los Angeles.

SECTION II (Clinical Prosthetics: Above-Knee Amputations)

Prosthetists, January 13 through 24—Jasper Bohannon, North Hollywood, Calif.; Cecil O. Brand, San Bernardino, Calif.; William J. Brunner, Houston; Albert E. Corfman, Jr., Long Branch, Calif.; Walter M. Joslin, Glendale, Calif.; Harold L. Lloyd, Reno, Nev.; Orlyn C. Oestereich, Washington, D. C.; and Rex W. Sobers, Vallejo, Calif.

PROSTHETICS EDUCATION AT UCLA—Continuation of a series. Pictured are the students and instructors in the courses in *Clinical Prosthetics: Above-Knee Amputations* presented by the Prosthetics Education Project at the University of California Medical Center, Los Angeles, during the fall and winter, 1957-58. Top, class of October 21 through November 1; middle, class of January 13 through 24; bottom, class of March 10 through 21. Additional classes are to be conducted during the 1958-59 academic year.



Therapists, January 20 through 24—Shirley L. Adams, Los Angeles; Doris B. Aldridge, Reno, Nev.; Virginia M. Barr, Los Angeles; Bernard J. Brault, Boise, Idaho; Priscilla T. Chandler, Los Angeles; Cecile J. Cottave, Glendale, Calif.; Junie M. Coursey, Inglewood, Calif.; Barbara R. DeYoung, Ann Arbor, Mich.; Charles A. Dorando, Farmington, Mich.; Elizabeth J. Fellows, Los Angeles; Dorothy Frederickson, Nashville, Tenn.; Felicia M. Gacek, Miami; Betty Kester, Seattle; Kathleen McNally, Culver City, Calif.; Martin O. Mundale, Minneapolis; Elizabeth S. Parrish, Berkeley, Calif.; and Margaret M. Wintz, Los Angeles.

Physicians, January 20 through 24—Dr. Lawrence Adler, Los Angeles; Dr. Harlan C. Amstutz, Los Angeles; Dr. Asdrubal Arzola, San Francisco; Dr. Martin E. Blazina, Los Angeles; Dr. Robert L. Cole, Los Angeles; Dr. Alice L. Garrett, Los Angeles; Dr. John W. Hillman, Nashville, Tenn.; Dr. Robert L. Horner, Glendale, Calif.; Dr. Frederic B. House, Ann Arbor, Mich.; Dr. Miland E. Knapp, Minneapolis; Dr. Paul J. Kowallek, Reno, Nev.; Dr. Gordon M. Martin, Rochester, Minn.; Dr. Wilbur A. Selle, Hollywood, Calif.; Dr. Bryan M. Shieman, Los Angeles; Dr. Ralph A. Thomas, Cheyenne, Wyo.; and Dr. Rachel F. Weems, Fishersville, Va.

SECTION III (Clinical Prosthetics: Above-Knee Amputations)

Prosthetists, March 10 through 21—Michael T. Grubisa, Tacoma, Wash.; Frederick L. Hampton, Glenview, Ill.; Erich Hanicke, Kansas City; John M. Janosek, Davenport, Iowa; Dale E. Jenkins, Phoenix, Ariz.; Harvey D. Jones, Boise, Idaho; Ferdinand J. Karg, Los Angeles; Roy M. Keimig, Wichita, Kan.; William M. Nannay, Fresno, Calif.; Vernon T. Pate, Memphis, Tenn.; Ervin A. Phillips, Fresno, Calif.; and John L. Weldon, Madison, Wis.

Therapists, March 17 through 21—Marilyn J. Anderson, San Francisco; Margaret B. Barker, Kansas City; Mary L. Cacherio, Los Angeles; Mack Crutcher, Jr., Van Nuys, Calif.; Gustav V. Hallbom, Salt Lake City; Mary A. Hanzo, New Orleans; Raymond E. Hogue, Bethany, Okla.; Ann E. Hueter, Mt. View, Calif.; Donald K. McKenzie, Detroit; M. Janice Nelson, Missoula, Mont.; Ann E. Parten, Tucson, Ariz.; Mary E. Rexroad, Oklahoma City; James L. Schilling, Minneapolis; Trude Seligman, San Diego, Calif.; and Eleanor J. Westcott, Denver.

Physicians, March 17 through 21—Dr. Russell S. Blanchard, Detroit; Dr. Francis J. Carr, Whipple, Ariz.; Dr. Ronald G. Goldberg, Los Angeles; Dr. Donald W. Grimes, Bakersfield, Calif.; Dr. William B. Harris, Hondo, Calif.; Dr. David Hoehn, Denver; Dr. Talmadge Hunt, Saskatoon, Sask.; Dr. Marilyn K. Hutchison, Kansas City; Dr. Arthur B. Quiggle, Minneapolis; Dr. Robert H. Ramsey, Dearborn, Mich.; Dr. Daniel C. Riordan, New Orleans; Dr. George W. Settle, Baltimore; and Dr. Robert Watanabe, Los Angeles.

SCHOOL I (Advanced Above-Knee Prosthetics)

December 12 through 14—Earl Beall, Fresno, Calif.; Don Colwell, Glendale, Calif.; Richard Fadely, Los

Angeles; Vance Meadows, Grand Rapids, Mich.; and Carl Sumida, Los Angeles.

SCHOOL II (Advanced Above-Knee Prosthetics)

January 30 through February 1—Arthur L. Boland, Los Angeles; Robert W. Brown, Edmonton, Alta.; William E. Brownfield, Boise, Idaho; Lenart C. Ceder, Tacoma, Wash.; Clarence T. Cole, Portland, Ore.; Eugene Coleman, Seattle; William E. Cummings, Sacramento, Calif.; Charles R. Newton, Portland, Ore.; John J. Galdik, San Francisco; August W. Prushsmeier, Portland, Ore.; and Victor Tourluk, San Bernardino, Calif.

SCHOOL III (Advanced Above-Knee Prosthetics)

February 20 through 22—Alexander Finlay, Milwaukee; Richard L. Kleiber, Denver; Flavell L. Lake, Oklahoma City; Ivan A. Long, Denver; Pat MacKendrick, Salt Lake City; David C. McGraw, Shreveport, La.; John A. Pentland, Vancouver, B. C.; Walter L. Sandberg, Salt Lake City; Bruce A. Scott, Denver; and George E. Snell, Little Rock, Ark.

REHABILITATION COURSE I

February 17 through 21—Dorothy Army, Lansing, Mich.; James R. Burress, Washington, D. C.; John R. Daniels, Chicago; Thelma L. Fletcher, Columbus, Ohio; Dr. David Frost, San Francisco; Helmer Gunnarson, St. Paul, Minn.; August Heineman, Jefferson City, Mo.; Merrill E. Hunt, Des Moines, Iowa; Minoru Ikehara, Lihue, Hawaii; Harry MacBird, San Francisco; Nathan Nelson, Sacramento, Calif.; Vlad F. Ratay, Denver; Mary P. Seaman, Olympia, Wash.; Alfred W. Simpson, Denver; and Adrian Towne, Madison, Wis.

REHABILITATION COURSE II

March 24 through 28—Earl R. Graybeal, Wenatchee, Wash.; Harry Houghton, Los Angeles; Raymond L. Hauver, St. Louis; Dennis Johnson, Mankato, Minn.; Arthur E. Larsen, Seattle; Thomas C. Lindsay, Lansing, Mich.; Curtis O. Little, Little Rock, Ark.; Austin Miller, Chillicothe, Mo.; Andrew J. Osborne, Los Angeles; Herbert S. Schnare, Portland, Ore.; and Donald C. Van Rooy, Yakima, Wash.

BASIC UPPER-EXTREMITY PROSTHETICS

Fall Semester 1957—Emery Blumenberg, Van Nuys, Calif.; Roy J. Cavender, Pasadena, Calif.; Roddy Chipurdia, Los Angeles; Donald F. Colwell, Glendale, Calif.; Rudy Curinga, Reseda, Calif.; Phyllis B. Ingman, South Pasadena, Calif.; Louis F. Jansen, Los Angeles; Richard R. LaTorre, Van Nuys, Calif.; Paul M. Lawson, Los Angeles; Charles J. LeMoyné, Van Nuys, Calif.; Robert W. Lundquist, Maywood, Calif.; Jesus G. Nunes, Los Angeles; Richard D. Roe, Los Angeles; and Fred J. Sanders, Los Angeles.

Spring Semester 1958—Roy J. Cavender, Monrovia, Calif.; Roddy Chipurdia, Los Angeles; Phyllis B. Ingman, South Pasadena, Calif.; Paul M. Lawson, Los Angeles; Charles J. LeMoyné, Van Nuys, Calif.; Robert W. Lundquist, Maywood, Calif.; Jesus G.

Nunes, Los Angeles; Fred J. Sanders, Los Angeles; and Jack Vollmer, Los Angeles.

BASIC LOWER-EXTREMITY ORTHOTICS

Fall Semester 1957—Stanley S. Carlton, Canoga Park, Calif.; John L. Ericson, Garden Grove, Calif.; John C. Greene, Long Beach, Calif.; David M. Heizer, Downey, Calif.; Robert W. Hinchberger, Lomita, Calif.; Max Lerman, Los Angeles; Pete F. Manghera, San Pedro, Calif.; Kurt Schoewstein, Los Angeles; Charles A. Sigars, Lynwood, Calif.; William F. Simpson, Los Angeles; Frank Szerdahelyi, South Pasadena, Calif.; and Al Wing, Whittier, Calif.

BASIC UPPER-EXTREMITY ORTHOTICS

Spring Semester 1958—Ralph P. Eames, Garden Grove, Calif.; John C. Greene, Long Beach, Calif.; Robert W. Hinchberger, Lomita, Calif.; Albert S. Johnson, Artesia, Calif.; Max Lerman, Beverly Hills, Calif.; Pete F. Manghera, San Pedro, Calif.; Curtis R. Sherman, Los Angeles; William F. Simpson, Los Angeles; Frank Szerdahelyi, South Pasadena, Calif.; and Stanley Wells, Long Beach, Calif.

All of these courses are presently supported by special grants from the Office of Vocational Rehabilitation of the U. S. Department of Health, Education, and Welfare. Additional courses of a similar nature will be offered by NYU and UCLA during the academic year 1958-59, and it is planned to establish early in 1959 a new school of prosthetics under the

supervision of Northwestern University with quarters in the Rehabilitation Institute of Chicago.

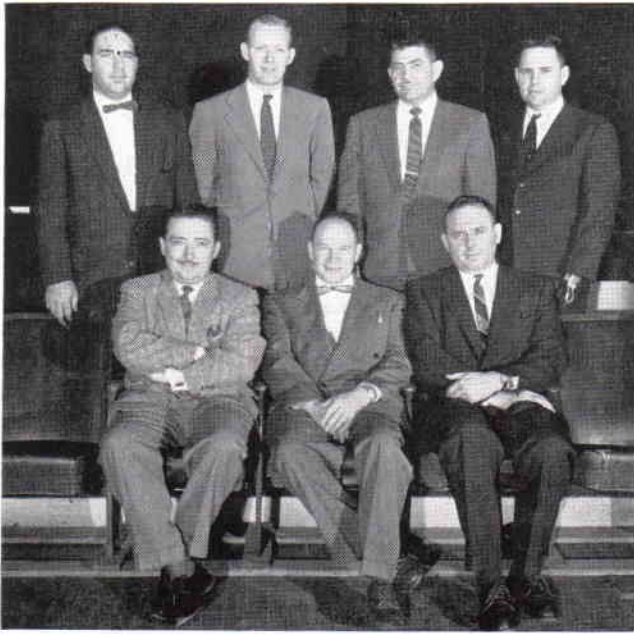
PSAS Training Course and Conference

Twenty-nine supervisors of VA Orthopedic Brace Shops throughout the United States and Puerto Rico participated in a training course December 2 through 6, 1957, at the New York offices of the Prosthetic and Sensory Aids Service. The latest techniques in bracing and fitting were discussed and demonstrated, with active participation by the supervisors. Members of the Veterans Administration Prosthetics Center served as instructors, together with staff officials from the Washington offices of the Prosthetic and Sensory Aids Service. William M. Bernstock, Assistant Chief of the Research and Development Division, PSAS, coordinated the training course.

A three-day conference was held in New York City December 2 through 4, 1957, for the seven Area Chiefs of the Prosthetic and Sensory Aids Service. Important administrative matters were discussed with these key prosthetics personnel. Joint sessions on technical problems were held with the supervisors of the Orthopedic Brace Shops. The



TRAINING COURSE FOR VA SUPERVISORS—Twenty-nine supervisors of VA Orthopedic Brace Shops participate in a training course in latest techniques. Sitting, left to right, Carl G. Albright, Brack Cordial, Carl Dahmen, Eric Balke, Arnold L. Hogan, Frank Zeman, Andrew J. Cates, and Joseph W. Oldham. Middle row, left to right, Emil Houk, Clive Weaver, Joseph A. Guillory, Lyman J. Miller, Robert A. Blake, James P. Matthews, John C. Greene, Carl H. Messerknecht, Walter J. Jans, Lester Fulton, and Homer J. Neely. Top row, left to right, Gus T. Lydahl, Glenn O. Bliss, Werner Greenbaum, Marvin T. Taylor, Andrew DeMarco, Theodore L. Kruzel, Roddy Chipurdia, Herbert L. Bath, Willie C. Hazelip, and Daniel J. Cronin.



CONFERENCE OF PSAS AREA CHIEFS—The seven Area Chiefs of the VA's Prosthetic and Sensory Aids Service met in New York City December 2 through 4, 1957, to discuss administrative matters. Sitting, left to right, Donald W. L. Smith, St. Louis; Voigt W. Baker, St. Paul; and Leonard J. McCarthy, Trenton. Standing, left to right, Wilfred G. Holsberg, Boston; Albert S. Zuidema, Columbus; Harry D. MacBird, San Francisco; and William M. Sumner, Atlanta.

conference was under the chairmanship of William H. Talley, Chief of the Plans and Policies Division, Prosthetic and Sensory Aids Service, Washington.

Research Institute on Bracing

During the period December 8-11, 1957, an institute devoted to brace research was held at Richmond, Va., under the joint sponsorship of the Medical College of Virginia and the Easter Seal Foundation. The principal participants in the discussions made up an interdisciplinary group representing the fields of orthopedic surgery, physical medicine, engineering, and orthotics. Present as observers were representatives of the U. S. Office of Vocational Rehabilitation, the Veterans Administration, the Orthopedic Appliance and Limb Manufacturers Association, the National Foundation for Infantile Paralysis, the Pope Foundation, the Armour Research Foundation, and the Prosthetics Research Board.

The group recognized that the subject of bracing is extremely complex owing to the wide variety of medical conditions that underlie the various types of crippling disabilities involving the trunk and extremities. That considerable confusion exists in this field is evidenced by the absence of a generally accepted classification of braces and prescription patterns for their use. There was general agreement that a need exists for a broad research program of an interdisciplinary character. Just as progress in prosthetics followed basic medical and biomechanical studies, so also in a brace research program there is a vital need for a body of information that can be developed only from fundamental investigations of this character.

As an initial step, it was recommended that a thorough survey and analysis of the literature be carried out to provide a basis for establishing priorities of research efforts. It was felt that, pending the results of research, progress of an interim character could be achieved by a systematic evaluation of the appliances now in use and by studies conducted in the interest of improving the physical characteristics of braces by the use of new materials.

Although the participants did not outline specific research projects, the recorded discussions, to be summarized in a final report, will be highly valuable to all organizations having an interest in the field of orthotics. Responsibility for preparation of the report has been assumed by Dr. Herbert W. Park, Professor and Chairman of the Department of Physical Medicine and Rehabilitation at the Medical College of Virginia and a member of PRB's newly appointed Committee on Prosthetics Education and Information (page 114).

Return of Dr. Murphy

Dr. Eugene F. Murphy, Chief of the Research and Development Division of the Pros-

thetic and Sensory Aids Service, Veterans Administration, New York, returned to the United States last February after completing his service as a Fulbright lecturer in prosthetics (ARTIFICIAL LIMBS, Spring 1957, p. 119). With Copenhagen's world-renowned Home and Society for Cripples as his headquarters during a six-month assignment, Dr. Murphy lectured and served in a consultative capacity at a wide variety of hospitals, clinics, limb and brace shops, and other institutions in a number of European countries. His was the first direct award in prosthetics under the International Educational Exchange Program (Fulbright Act), and all evidence indicates that his mission was eminently successful.

A limited supply of reports covering Dr. Murphy's activity and experience abroad is still available. While they last, copies may be obtained from the Office of the Chief, Research and Development Division, Prosthetic and Sensory Aids Service, U. S. Veterans Administration, 252 Seventh Ave., New York 1, N. Y.

Seminar on European Activities

On March 28, in the auditorium of the New York Regional Office of the Veterans Ad-

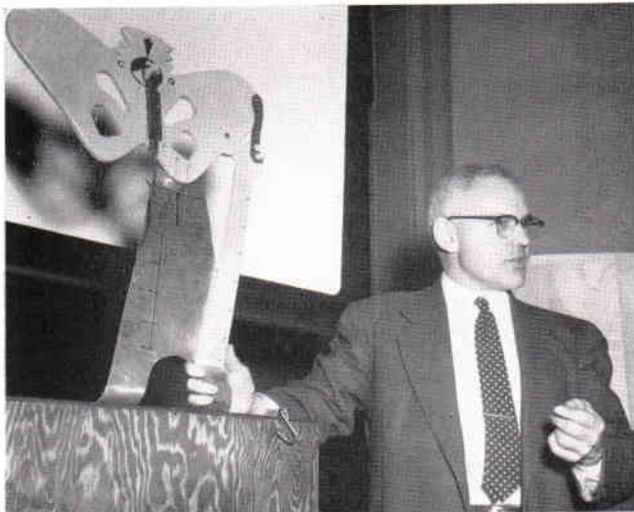
ministration, New York City, some 75 persons attended a three-hour seminar given by Dr. Eugene F. Murphy, Chief of the Research and Development Division of the VA's Prosthetic and Sensory Aids Service, covering his experiences as a Fulbright lecturer in prosthetics on assignment in Europe last summer and winter (ARTIFICIAL LIMBS, Spring 1957, p. 119). Among other duties, Dr. Murphy had served on the faculty of the First International Prosthetics Course given at the Orthopaedic Hospital in Copenhagen last August (ARTIFICIAL LIMBS, Autumn 1957, p. 94).

In the seminar on March 28, Dr. Murphy described specific examples of European techniques which might be considered in the United States and emphasized the need for continued interchange of information with our foreign colleagues. Included was a showing of slides taken of places of interest in Scandinavian and other European countries.

Conference on Disability

On February 10 and 11, a conference entitled *Contributions of the Physical, Biological, and Psychological Sciences in Human Disability* was held at the Barbizon-Plaza Hotel in New York City under the sponsorship of the New York Academy of Sciences. Called to discuss the interdisciplinary approach to research in rehabilitation, the meeting was under the cochairmanship of Renato Contini, Research Coordinator of Special Projects of the Research Division, College of Engineering, New York University, and Dr. Sidney Fishman, Project Director of the Prosthetic Devices Study, New York University. It consisted of four sessions, three devoted to specific areas of physical disability and one to the philosophic and administrative aspects of interdisciplinary research.

The opening session, with Dr. Fishman as chairman, dealt with amputation. Technical papers concerning biological, engineering, and psychological research were delivered by Dr. Charles O. Bechtol, of the University of California at



SEMINAR ON EUROPEAN ACTIVITIES—Dr. Eugene F. Murphy, Chief of the Research and Development Division of the VA's Prosthetic and Sensory Aids Service, New York City, and just recently returned from Europe, explains one of several teaching aids used abroad in demonstrating biomechanical principles while he was serving as a Fulbright lecturer in prosthetics.

Los Angeles; Hans Mauch, of the Mauch Research and Development Laboratory, Dayton, Ohio; and Dr. William B. Haber, of New York City. The papers were then discussed by a panel consisting of Dr. Fishman, the speakers, and three staff members of the Prosthetic Devices Study—Dr. Samuel A. Weiss, representing the psychological sciences; Bertram D. Litt, representing the biological sciences; and Renato Contini, representing the physical sciences.

The second session consisted of a panel on interdisciplinary research presided over by Brig. Gen. F. S. Strong, Jr., Chairman of the Prosthetics Research Board. This group discussed the problems involved in the integration of the physical, biological, and psychological sciences in rehabilitation, with particular emphasis on the purposes and values of interdisciplinary research, methods and sources of stimulating interdisciplinary research, problems in coordination and supervision, difficulties in interdisciplinary communications, and future prospects. Papers were presented by Dr. Kenneth S. Landauer, of the National Foundation for Infantile Paralysis; Dr. I. Jay Brightman, of the New York State Interdepartmental Health Resources Board, Albany; Donald Dabelstein, of the Office of Vocational Rehabilitation, Washington, D. C.; Dr. Dale Lindsey, of the National Institutes of Health, Bethesda, Md.; and Dr. Harold K. Work, of the College of Engineering of New York University.

The third session, with Dr. Herbert Elftman, Professor of Anatomy at the College of Physicians and Surgeons of Columbia University, presiding, was devoted to neuromuscular dysfunction. Technical papers concerning biological, psychological, and engineering research in this field were delivered by Dr. Morton Marks, of the Institute of Physical Medicine and Rehabilitation, NYU-Bellevue Medical Center; Dr. Morton Seidenfeld, of the National Foundation for Infantile Paralysis; and Dr. Rudolf Drillis, of New York University. Participating in the panel discussion that followed were Dr. Elftman; the speakers; Dr. Harold Chenven, of the Institute for Crippled and Disabled (psychological sciences); Dr. William Spencer, of the Southwest Polio Rehabilitation Center, Baylor University (biological sciences); and Anthony

Staros, of the Veterans Administration Prosthetics Center, New York City (physical sciences).

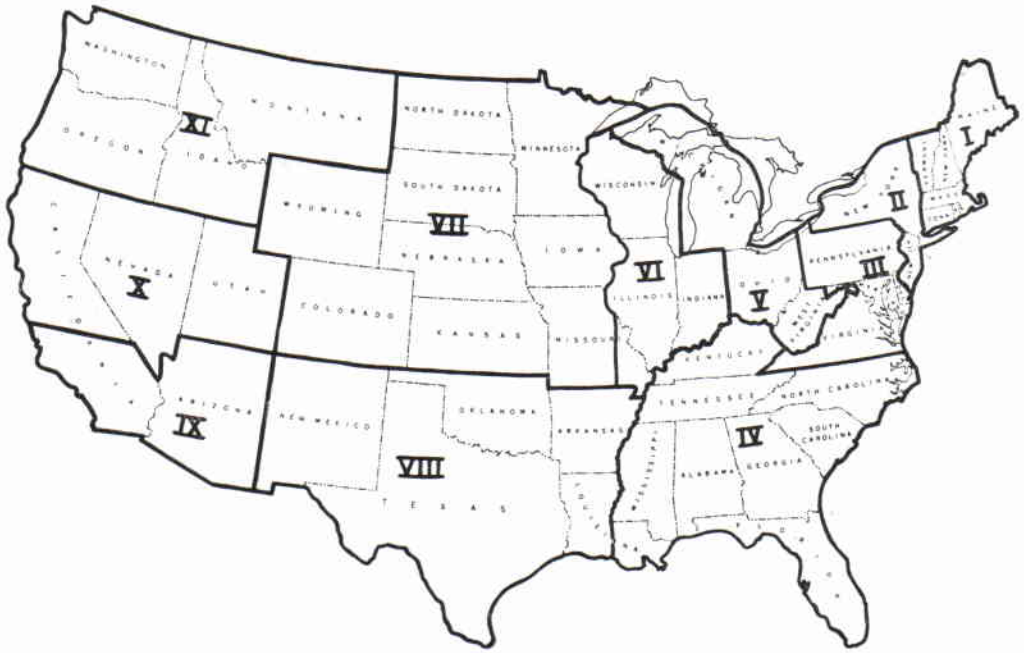
The fourth and final session, led by Dr. Franklin S. Cooper, Director of the Haskins Laboratories, New York City, dealt with sensory dysfunction with particular reference to blindness and deafness. Technical papers were delivered by Wallace E. Frank, of The Franklin Institute (physical sciences); Dr. Lee Meyerson, of the University of Houston (psychological sciences); and Dr. Henry Imus, of the National Institute of Neurological Diseases and Blindness (biological sciences). A concluding panel discussion was under the chairmanship of Dr. Cooper. Participating were Dr. Nathaniel Raskin, of the Children's Memorial Hospital, Chicago; Howard Freiburger, of the Veterans Administration, New York City; Dr. Joseph E. Hawkins, of the New York University Post-Graduate Medical School; and the three speakers.

Attended by almost 150 professional workers, and well received, the conference is considered to be the first effort to summarize and integrate the variety of scientific activities that have been progressing in this field. It became quite clear from the discussions that, although there are important areas of research which call for cooperative activities between the several scientific disciplines, there are also broad areas where each of the contributing disciplines needs to work independently with the body of skills and knowledge which it alone possesses.

The papers and discussion will be published shortly by the New York Academy of Sciences in the *Annals* of the Academy under the title *Contributions of the Physical, Biological, and Psychological Sciences in Human Disability*.

OALMA Regional Meetings

The Orthopedic Appliance and Limb Manufacturers Association divides the United States into 11 Regions, each representing a different geographical area and each electing one of the 11 members of the Board of Directors of the national organization. Every year the Association sponsors a series of Regional Meetings throughout the United States. Each Region holds at least one meeting a year and is encouraged to hold more if interest warrants. A



THE REGIONS OF OALMA—The United States is divided into 11 geographical areas. National headquarters are in Washington, D. C.

part of the Association's educational program in which activities sponsored by the Prosthetics Research Board hold a prominent place, these sessions are open to both member and nonmember firms and are often attended by research personnel and others active in the Artificial Limb Program.

There follows a summary of meetings already held in 1958, plus a listing of those planned for later in the year:

Region I (New England States). Meetings are held on the second Monday of every month, usually at the Liberty Mutual Rehabilitation Center in Boston. For information, contact John F. Buckley (Orthopedic Services of Rhode Island, 824 Eddy St., Providence) or Regional Director Karl W. Buschenfeldt (Karl W. Buschenfeldt & Son, 1522 Turnpike St., Stoughton, Mass.).

Region II (New York and New Jersey). The Metropolitan Orthopedic Appliance and Limb Manufacturers Association (MOALMA) usually meets on the first Monday of each month. In addition, MOALMA sponsors annually a two-day technical seminar, the dates for 1958 being May 2 and 3. All meetings are held in the Biltmore Hotel, New York City. John A. McCann (John J. McCann Co., 454 Lawrence St., Burlington, N. J.), President of OALMA for 1957-58, is Regional Director.

Region III (Middle Atlantic States). C. D. Denison (C. D. Denison Orthopaedic Appliance Corp., 220 West 28th St., Baltimore), Regional Director, is arranging a

meeting to be held at the Lord Baltimore Hotel, Baltimore, May 25. Dr. Harold W. Glatty, Executive Director of the Prosthetics Research Board, is scheduled to speak at the morning session. He will discuss progress in the Artificial Limb Program.

Region IV (Southeastern States and Eastern Louisiana). At a meeting held February 14 through 16 at the Fort Sumter Hotel, Charleston, S. C., Col. Maurice J. Fletcher, Director of the Army Prosthetics Research Laboratory, was a guest. He addressed the group with a review of recent developments in the field of prosthetics research. The 1959 session will be held in Chattanooga, the program Chairman being Carlton E. Fillauer (Fillauer Surgical Supplies, 930 East 3rd St., Chattanooga). D. A. McKeever (J. E. Hanger, Inc., 134 Baker St., N. E., Atlanta) is Regional Director.

Region V (Ohio, Michigan, and West Virginia). Charles W. Rosenquist (Columbus Orthopaedic Appliance Co., 50 No. Sandusky St., Columbus), Regional Director, reports that the Regional Meeting for 1958 will be held at the Secor Hotel in Toledo April 19 and 20. Program and hotel arrangements are being made by A. E. Kloene (Kloene-Marshall Orthopaedic Appliances, 736 Galena St., Toledo).

Region VI (Illinois, Eastern Missouri, Indiana, and Wisconsin). Ralph Storrs (Pope Brace Division, Kankakee, Ill.), Regional Director, has announced tentative plans for a Regional Meeting to be held in Chicago under his chairmanship on Saturday evening and Sunday afternoon, June 14 and 15. Chairman Storrs extends to all research personnel who may be returning by way of Chicago from the Annual Spring Conference of the Artificial Limb Program in Washington (page 115) a cordial invitation to stop over and take part in these sessions.



—S. A. Wall, Charleston, S. C.

OALMA REGION IV MEETING—Col. Maurice J. Fletcher (left), Director of the Army Prosthetics Research Laboratory, Glenn E. Jackson (right), Executive Director of the Orthopedic Appliance and Limb Manufacturers Association, and Howard R. Thranhardt, of the J. E. Hanger Co., Atlanta, review the program of the Regional Meeting of OALMA Region IV held February 14 through 16 at the Fort Sumter Hotel, Charleston, S. C. Mr. Thranhardt is currently Chairman of the Phase II Subcommittee (prototype development) of PRB's Committee on Prosthetics Research and Development.

Region VII (Middle Western States). A Regional Meeting was held April 12 at the Fort Des Moines Hotel in Des Moines, Iowa. Everett F. Haines (The Winkley Co., 908 Sixth Ave., Des Moines) was in charge of arrangements. Joseph Gitlin (Minneapolis Artificial Limb Co., 410 Portland Ave., Minneapolis) is Regional Director.

Region VIII (Western Louisiana, Arkansas, Texas, Oklahoma, and New Mexico). The Regional Meeting for 1958 was held on March 8 at the Gonzales Warm Springs Foundation, Gonzales, Texas. The 1959 meeting of this Region is scheduled to be held in the Hilton Hotel in San Antonio March 15 and 16 under the co-chairmanship of Charles Kymes and Harold Prescott (Lux Artificial Limb Co., 523 San Pedro Ave., San Antonio).

Region IX (Southern California and Arizona). According to Fred Quisenberry (Alpha Orthopedic Appliance Co., 401 West Pico Blvd., Los Angeles), Regional Director, a Regional Meeting was held in Los Angeles on March 15 and 16. The local Society of Prosthetists and Orthotists, headed by Leroy Noble (Universal Orthopedic Appliances Co., 212 West Penn St., Whittier, Calif.), holds monthly meetings at the Mayfair Hotel in Los Angeles.

Region X (Northern California, Nevada, and Utah). Herbert J. Hart (C. H. Hittenberger, Inc., 421 Nineteenth St., Oakland), Regional Director, reports that

the 1958 meeting of Region X was held March 22 in San Francisco.

Region XI (Washington, Oregon, Idaho, and Montana). Lenart C. Ceder (Tacoma Brace & Limb Co., 723 So. Kay St., Tacoma) is Regional Director. Dates for the 1958 meeting of this Region have not yet been fixed.

OALMA Augusta Conference

Prominent leaders of the limb and brace profession and several officials of the Artificial Limb Program met in the Bon-Air Hotel in Augusta, Ga., January 9 through 12 in an attempt to appraise the current program of the Orthopedic Appliance and Limb Manufacturers Association, to analyze the past and present condition of the limb and brace industry in the United States, and to evaluate trends and future prospects. Present to represent the Association were all of the eight Past-Presidents who have held office during the decade since OALMA was organized (Chester C. Haddan, A. P. Gruman, Lucius G. Trautman, Lee J. Fawver, McCarthy Hanger, Jr., D. A. McKeever, W.

Frank Harmon, and Charles A. Hennessy), the present Executive Committee (John A. McCann, President; Karl W. Buschenfeldt, 1st Vice-President; Paul E. Leimkuehler, 2nd Vice-President; and M. P. Cestaro, Secretary-Treasurer), Executive Director Glenn E. Jackson, and Assistant Executive Director Lester A. Smith. Representing the Artificial Limb Program were Brig. Gen. F. S. Strong, Jr., Dr. Harold W. Glattly, and Tonnés Dennison, Chairman, Executive Director, and Assistant Executive Director, respectively, of the Prosthetics Research Board. Also participating was James W. Tower, of Industrial Relations Counselors, Inc., New York City, an independent, nonprofit organization famous for its research work in the field of personnel. Theme of the meeting was *Planning Our Future*.

The technique adopted for the conference was that which is now most favored by conference experts and which is referred to as "unstructured" (*i.e.*, there is no agenda to follow). Since it was not the intent to formulate policy, but rather to appraise the past



—Morgan Filiz, Augusta

OALMA AUGUSTA CONFERENCE—Pictured are the leaders of the limb and brace profession and the executives of the Artificial Limb Program who met in Augusta, Ga., January 9 through 12 to explore the present and to chart the future of the prosthetics-orthotics industry. Seated, left to right, are Chester C. Haddan, of Denver; Brig. Gen. F. S. Strong, Jr., Chairman of the Prosthetics Research Board; John A. McCann, President of the Orthopedic Appliance and Limb Manufacturers Association for 1957-58; Glenn E. Jackson, Executive Director of OALMA; Charles A. Hennessy, of Los Angeles; and W. Frank Harmon, of Atlanta. Standing, left to right, are Tonnés Dennison, Assistant Executive Director of PRB; Karl W. Buschenfeldt, of Stoughton, Mass.; D. A. McKeever, of Atlanta; Lucius G. Trautman, of Minneapolis; Lee J. Fawver, of Kansas City; A. P. Gruman, of Minneapolis; James W. Tower, of Industrial Relations Counselors, Inc., New York City; McCarthy Hanger, Jr., of St. Louis; Paul E. Leimkuehler, of Cleveland; Dr. Harold W. Glattly, Executive Director of PRB; M. P. Cesaro, of Washington, D. C.; and Lester A. Smith, Assistant Executive Director of OALMA.

and present of the limb and brace industry and to attempt to identify the conditions under which the members of the prosthetics-orthotics profession are likely to operate in the future, no definitive action was taken. Five major areas came in for discussion. They were:

I. *General Conditions, Past and Present.* The first day of the conference was devoted to an attempt to identify all of the factors that affect the present and that might affect the future.

II. *Research.* What impact will research have on the future of the prosthetics-orthotics industry and profession? How can the industry best participate for the maximum benefit to all concerned?

III. *Professionalism.* What is involved if the art-science of prosthetics and orthotics is to become a profession?

IV. *Personnel and Training.* What kind of personnel with what kind of education and training will be required in the future of the limb and brace industry?

V. *Economic Factors.* What is necessary to ensure economic stability in an industry where there can be no talk of "finding new markets" and where the



—Morgan Filiz, Augusta

OALMA AUGUSTA CONFERENCE—An example of intergroup cooperation. Shown with Brig. Gen. F. S. Strong, Jr., Chairman of the Prosthetics Research Board and long the prime mover in the Artificial Limb Program in the United States, are some of the industry members who serve in ALP. Seated with Gen. Strong and Chester C. Haddan, a member of PRB, is Lucius G. Trautman, a member of the Committee on Prosthetics Research and Development. Standing, left to right, are Lee J. Fawver, Chairman of the Phase IV Subcommittee; Charles A. Hennessy, of the teaching staff of the Prosthetics Education Project at UCLA; Paul E. Leimkuehler, another member of CPRD; and McCarthy Hanger, Jr., and W. Frank Harmon, both newly appointed members of the Committee on Prosthetics Education and Information (page 114).

total clientele is determined by conditions over which the industry has no control?

On the whole, the meeting was viewed by the participants as highly successful and probably a landmark in the history of the limb and brace profession. According to Executive Director Jackson, it was the first and only time that so many of the eminent leaders in this art-science had been brought together. Never before had all the nine presidents of the last eleven years sat, thought, and talked together on the "state of the Union" and where it is going. It was the first and only time that any group of leaders in this field had devoted so much time to fundamental thinking rather than to immediate administrative problems, Jackson said.

Eighth World Congress, ISWC

The world's foremost rehabilitation forum, the Eighth World Congress of the International Society for the Welfare of Cripples, will convene at the Waldorf-Astoria Hotel in New York City August 29, 1960. President of the Congress will be Dr. Howard A. Rusk, a Past-President of the Society, a physician internationally known for his work with the handicapped, and a member of the Prosthetics Research Board. The Eighth Congress will be the first such meeting to be held in the Western Hemisphere.

A number of principals in the Artificial Limb Program are active in ISWC. Among the members of the Society's Committee on Protheses, Braces, and Technical Aids are Capt. Thomas J. Canty, Director of the Navy Prosthetics Research Laboratory at the U. S. Naval Hospital, Oakland, Calif.; Glenn E. Jackson, Executive Director of the Orthopedic Appliance and Limb Manufacturers Association, Washington, D. C.; Dr. Eugene F. Murphy, Chief of the Research and Development Division of the VA's Prosthetic and Sensory Aids Service, New York City;



—New York Times
DR. RUSK

William A. Tosberg, Technical Director of Prosthetic Service at the Institute of Physical Medicine and Rehabilitation, NYU-Bellevue Medical Center, and a member of the teaching staff of the Prosthetics Education Program at New York University; and Muriel Zimmerman, Supervisor of Special Services at the Institute of Physical Medicine and Rehabilitation. Most of these and a number of others participated in the Seventh World Congress held in London last July (*ARTIFICIAL LIMBS*, Autumn 1957, p. 93) and in the First International Prosthetics Course given in Copenhagen last August 1 through 10 (*ARTIFICIAL LIMBS*, Autumn 1957, p. 94).

Host for the Eighth World Congress will be the ISWC national affiliate in the United States, the National Society for Crippled Children and Adults, otherwise known as the Easter Seal Society. It is scheduled to hold its own annual meeting in conjunction with the Congress. An exhibition, intended for the general public, will provide an opportunity to become acquainted with the latest work of worldwide organizations providing research, equipment, and services for the handicapped.

Dr. Taylor

Dr. Craig L. Taylor, one of the prime contributors to upper-extremity prosthetics for more than a decade and known familiarly to intimates in the Artificial Limb Program as The Great White Father and Chief of the Muckleshoots, died suddenly on April 24 at the University of California at Los Angeles. He would have been 49 on May 3.

Recognized throughout the world as one of the great modern researchers in the field of human biomechanics, Dr. Taylor was Professor of Engineering and Physiology at UCLA. With this unusual combination of interest and talent at his command, he provided invaluable services in the field of prosthetics "above," as he was wont to say, "the umbilicus." He had long served as Chairman of the old Upper-Extremity Technical Committee of the former Advisory Committee on Artificial Limbs, was a member of the Committee on Prosthetics Research and Development of the Prosthetics Research Board, and had been Director of the Engineering Artificial Limbs Project at UCLA almost since its inception in mid-1946. He was the

author of two chapters (7 and 12) in Klopsteg and Wilson's *Human Limbs and Their Substitutes* (McGraw-Hill, New York, 1954), the author or coauthor of a number of principal articles in *ARTIFICIAL LIMBS* (January 1954, p. 4; May 1955, p. 22; September 1955, pp. 4 and 61; Spring 1957, p. 4), and the originator of numerous research reports and technical articles in professional publications. The image of his right hand has been preserved in *ARTIFICIAL LIMBS* (May 1955, Fig. 8, p. 87).



DR. TAYLOR

Besides his outstanding accomplishments in the field of prosthetics, Taylor was well known in many quarters for his part in the establishment of the science of biotechnology, and especially for his pioneering investigations of the influence of environmental conditions on the physiological processes of the human body. In work conducted for the U. S. Air Force, he once demonstrated, by himself serving as the subject, that normal man can exist in an environmental atmosphere some fifty Fahrenheit degrees above the boiling point of water (*Time*, December 22, 1947; *Life*, February 9, 1948), and he has since been referred to as one of the leaders in the field of space medicine. The results of many of his investigations are today being put to practical use by hundreds of former students now in industry and the Armed Forces.

In 1954, Dr. Taylor was awarded the Gilbreth Medal of the Society for Advancement of Management for his development of new techniques for recording hand, arm, and body movements and for the application of the results to the design and testing of artificial limbs. And in the same year he was the corecipient (with Mathematician Alfred C. Blaschke) of the Louis Edward Levy Medal of The Franklin Institute (*ARTIFICIAL LIMBS*, September 1954, p. 78) in recognition of an outstanding paper, *The Mechanical Design of Muscle-Operated Arm Prostheses*, which appeared in *The Journal of The Franklin Institute* for November 1953. Friends at the University have created the Craig Taylor

Memorial Fund to establish in the Engineering Library a biotechnology collection named in his honor. Dr. Taylor's personal library is to form the nucleus.

Taylor was born in Edmonds, Wash., and was educated at the University of Washington (B.S., 1933) and at Stanford University (M.A., 1937; Ph.D., 1940). Between 1943 and 1946 he saw military service as a captain in the Air Corps, where he served as Chief of the Thermal Research Unit, Biophysics Branch, of the Aero Medical Laboratory. He had been on the faculty of UCLA since 1946 and had been a full professor since 1953. Active in a number of technical areas, he was a member of Sigma Xi, the American Physiological Society, the American Society for Engineering Education, and the American Association for the Advancement of Science, and he was a member of the Technical Advisory Committee for Physiological Research of the American Society of Heating and Air-Conditioning Engineers.

Friend, humorist, scientist, and educator, Dr. Taylor is survived by his wife, Mrs. Bertha Taylor, of Los Angeles, and by a brother, Robert, of Seattle. His loss will be keenly felt by all who knew him and his works. On behalf of the Prosthetics Research Board, *ARTIFICIAL LIMBS* expresses deepest regret at the passing of one of the distinguished leaders in the Artificial Limb Program.

Appointment for Motis

All of the early participants in the Artificial Limb Program will be interested to learn that Gilbert M. Motis, of Northridge, Calif., has been engaged to serve as a consulting prosthetics engineer at Rancho Los Amigos, Downey, Calif., and at the Child Amputee Prosthetics Project at UCLA. He will divide his time between the two institutions. It will be recalled that Mr. Motis was Supervisor of the Prosthesis Department at Northrop Aircraft, Hawthorne, Calif., during the period 1946-50 and that in 1951 and 1952 he was active in the prosthetics research program in the Department of Engineering at UCLA.

Much of the current technology for the plastic lamination of arm shells and sockets was developed under Mr. Motis' supervision, and it was under his guidance that many of

the present-day harness and control systems for upper-extremity prostheses were evolved. He was, for example, responsible for the pioneer application of the Bowden cable to arm controls. In addition to designing numerous experimental devices, Motis developed the Northrop-Sierra voluntary-opening two-load hook (*ARTIFICIAL LIMBS*, January 1954, p. 17; May 1955, p. 72), and he is the co-inventor of the F-M (Fletcher-Motis) quick-disconnect wrist unit (*ARTIFICIAL LIMBS*, January 1954, p. 18).

Honors for Fletcher

On December 5, 1957, the Legion of Merit, the U. S. Army's fifth-highest decoration, was awarded to Col. Maurice J. Fletcher for exceptionally meritorious conduct and the performance of outstanding services as Director of the Army Prosthetics Research Laboratory, Walter Reed Army Medical Center, Washington, D. C. Col. Fletcher was cited for his leadership of the laboratory during the decade beginning in November of 1946.

As the chief of this Army activity, Col. Fletcher organized and staffed APRL as a laboratory of the industrial type prepared to conduct investigations relevant to the design, development, and testing of artificial-limb

components. Under his guidance, and in close cooperation with the Artificial Limb Program as a whole, APRL has been instrumental in the introduction of many new and improved devices and techniques now accepted as commonplace in the armamentarium of upper-extremity prosthetics. Among these, perhaps the better known are the APRL voluntary-closing hand with lifelike cosmetic glove (*ARTIFICIAL LIMBS*, May 1955, p. 68), the APRL voluntary-closing hook (*ARTIFICIAL LIMBS*, January 1954, p. 17), the Fletcher-Motis quick wrist disconnect (*ARTIFICIAL LIMBS*, January 1954, p. 18), the unit-construction method of direct lamination of a wrist-disarticulation socket (*ARTIFICIAL LIMBS*, September 1954, p. 13), the outside-locking elbow hinge for the elbow disarticulation and the very short below-elbow case (*ARTIFICIAL LIMBS*, January 1954, p. 22; September 1954, pp. 19 and 20), and a wholly new system of harnessing efficiently the power of a cineplastic muscle tunnel (*ARTIFICIAL LIMBS*, September 1955, p. 37). In addition, Col. Fletcher was instrumental in basic research leading to the establishment of the five hand sizes required to satisfy the population from age four to maturity (*ARTIFICIAL LIMBS*, May 1955, p. 84).

A native of Mapleton, Iowa, Col. Fletcher began his military career in 1930 at the old Indian forts at Ft. Meade, S. Dak., and Ft. Des Moines, Iowa. He is the son of Mr. John Fletcher, of Mapleton, attended Iowa State College at Ames, and was a patent attorney before entering the service.

Cumner Award

The Biomechanics Laboratory of the University of California, center of several groups long active in the Artificial Limb Program (*ARTIFICIAL LIMBS*, Autumn 1957, p. 89), achieved national professional recognition at the convention of the American Academy of Dermatology and Syphilology in Chicago December 7 through 12. Drs. S. William Levy and Gilbert H. Barnes, Clinical Instructors in Dermatology at the University of



—U. S. Army photograph

HONORS FOR COLONEL FLETCHER—Col. Maurice J. Fletcher, Director of the Army Prosthetics Research Laboratory, receives from Maj. Gen. Leonard D. Heaton, commanding officer of Walter Reed Army Medical Center, the Legion of Merit for his outstanding contributions to the field of limb prosthetics. Mrs. Fletcher looks on.

California School of Medicine in San Francisco and members of the staff of the Biomechanics Laboratory, were presented with the Clyde L. Cummer Gold Medal, the convention's first-place award for professional exhibits of high teaching value (Category II). The prize-winning display panels outlined in graphic form some of the important skin disorders common in amputees and demonstrated the consequences of amputation and the inevitable problems arising from contact with a prosthesis. Included was a representative display of prosthetic devices for the lower extremity.



DR. LEVY

With the aid of a grant from the National Institutes of Health, Drs. Levy and Barnes have since 1955 been studying and classifying the skin disorders of amputees, particularly the disorders associated with the wearing of a lower-extremity prosthesis. They have documented these studies with 35-mm. color transparencies taken of patients' stumps during clinical examinations, and it will be recalled that their contributions made up the bulk of the issue of *ARTIFICIAL LIMBS* for Spring 1956. For the exhibit, color transparencies especially illustrative of the various types of skin disorders of amputation stumps were used to make color-film enlargements, which were then illuminated in two large panels. A third panel illustrated some of the other medical problems of leg amputees.



DR. BARNES

In the preparation of the panels, Drs. Levy and Barnes were assisted by Seymour S. Winston, electronics technician with the Biomechanics Laboratory, who devised the electrical system for illumination of the color

films, and by Alfred Teoli, artist at the Laboratory, who helped with the general arrangement of the panels and who did the necessary lettering. Tom Raubenheimer, artist formerly with the Laboratory, did the drawings that occupied the third panel.

The exhibit is currently on display in the lobby of the Medical Sciences Building of the University of California Medical Center. It is to be exhibited again at the Annual Meeting of the American Medical Association in San Francisco June 23 through 27.

Retirement of Major Bell

On December 12 last, Major C. A. Bell, long an active participant in the Artificial Limb Program, retired as Director of Prosthetic Services of the Canadian Department of Veterans Affairs. Perhaps best known to the readers of *ARTIFICIAL LIMBS* as the author of the editorial, *Canadian Candidate*, in the issue for Autumn 1957 (Canadian-type hip-disarticulation prosthesis), Major Bell had been in the service of the Department for almost 38 years. During this long tenure, the group under his direction was responsible for many forward-looking advances that have contributed immeasurably to the welfare of Canada's amputee veterans, among others the establishment of the present orderly system for fitting amputee beneficiaries on a Dominionwide basis.

Charles Austin Bell was born in Toronto in 1891 and graduated in engineering from the University of Toronto. He enlisted in August 1914 in the First Division of the Canadian Engineers and rose through the ranks to become an officer. Thrice wounded in action, which eventually resulted in bilateral below-knee amputation and loss of the right eye, he returned to civilian life in April 1920 to become connected with DVA. Since 1938, he had been Director of Prosthetic Services.



MAJOR BELL

For his performance during World War I,

Major Bell received the Military Cross and Bar, and in 1946 he was awarded the Order of the British Empire. Last year he was the recipient of the Gold Medal of the Professional Institute of the Public Service of Canada.

ARTIFICIAL LIMBS expresses the hope that during retirement Major Bell's pastures will turn out to be green.

Post for Klopsteg

Dr. Paul E. Klopsteg, Associate Director for Research of the National Science Foundation, a member of the Prosthetics Research Board, and for many years Chairman of its predecessor, the Advisory Committee on Artificial Limbs, has been named President-Elect of the American Association for the Advancement of Science, it was announced at year's end. Already active in the affairs of the Association for almost a decade, Dr. Klopsteg will take over as President on January 15, 1959, succeeding Dr. Wallace R. Brode.

New Patents

On October 22, 1957, Clare L. Milton, Jr., of Baltimore, formerly with the Army Prosthetics Research Laboratory, and Carl A. Nielson, of APRL, assignors to the United States Government as represented by the Secretary of the Army, were jointly awarded U. S. Patent 2,810,161 (6 claims) covering the process they developed for the manufacture of seamless cosmetic gloves, such for example as those now widely used by arm

amputees who wear the APRL voluntary-closing artificial hand (ARTIFICIAL LIMBS, May 1955, p. 68). The entire procedure has otherwise already been described in detail in Chapter 9 of Klopsteg and Wilson's *Human Limbs and Their Substitutes* (McGraw-Hill, New York, 1954).

Reinforced Alkylacrylate Latices and Elastomeric Resins Obtained Therefrom is the title of U. S. Patent 2,820,718 (25 claims) granted January 21, 1958, to Paul Fram, Carl A. Nielson, and Fred Leonard, all of the Army Prosthetics Research Laboratory. Although it is apparent from the disclosure that the general purpose of this invention is to produce polymeric materials with special properties making them suitable for the manufacture of a variety of articles, and although the specification does not mention cosmetic gloves as such, it is understood that a principal goal of the process described is to produce, for the manufacture of cosmetic gloves, elastomeric materials better suited than the plasticized polyvinyl chloride now in use.

On November 12, 1957, U. S. Patent 2,812,961 (7 claims) was granted to Noel J. Brown and Ralph K. Daugherty (assignors to A. J. Hosmer Corp., San Jose, Calif.) for a new design of an outside-locking elbow hinge intended principally for use in the elbow-disarticulation case. Similar to the older Hosmer E-500 outside-locking elbow hinge, the present invention discloses a new and supposedly improved alternator mechanism in the pull-and-release-to-lock, pull-and-release-to-unlock system.

NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL

The National Academy of Sciences—National Research Council is a private, nonprofit organization of scientists, dedicated to the furtherance of science and to its use for the general welfare.

The Academy was established in 1863 under a Congressional charter signed by President Lincoln. Empowered to provide for all activities appropriate to academies of science, it was also required by its charter to act as an adviser to the Federal Government in scientific matters. This provision accounts for the close ties that have always existed between the Academy and the Government, although the Academy is not a governmental agency.

The National Research Council was established by the Academy in 1916, at the request of President Wilson, to enable scientists generally to associate their efforts with those of the limited membership of the Academy in service to the nation, to society, and to science at home and abroad. Members of the National Research Council receive their appointments from the President of the Academy. They include representatives nominated by the major scientific and technical societies, representatives of the Federal Government, and a number of members-at-large. In addition, several thousand scientists and engineers take part in the activities of the Research Council through membership on its various boards and committees.

Receiving funds from both public and private sources, by contribution, grant, or contract, the Academy and its Research Council thus work to stimulate research and its applications, to survey the broad possibilities of science, to promote effective utilization of the scientific and technical resources of the country, to serve the Government, and to further the general interests of science.