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Capabilities

Communicating the Science of Prosthetics and Orthotics

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Amy Davis has used muscle cineplasty for 40 years to control her upper limb prosthesis. Please see her story on page 3 of this issue.

A Century of the Sauerbruch-Lebsche-Vanghetti Muscle Cineplasty: The United States Experience

By Richard F. ff. Weir, PhD

Dr. Weir presented this paper at the 9th World Congress of the International Society for Prosthetics & Orthotics (ISPO) held June 28 to July 3, 1998 in Amsterdam, The Netherlands.

The procedure known as Sauerbruch-Lebsche-Vanghetti cineplasty is one hundred years old this year. Giuliano Vanghetti, in 1898[1] is generally credited with being the first person to conceive of the idea of using the residual limb muscles of an amputee to operate a prosthetic device. An Italian from Firenze, Vanghetti is said to have conceived of his ideas following his observations in the Italian-Abyssinian (Ethiopian) War (1896-8). Although Vanghetti suggested numerous possible methods, his surgical efforts were confined to chickens. He published a list of 52 different ways of cinematizing muscles and tendons. Of these, three predominant types of cineplasty arose: the loop motor, the club motor and the intramuscular canal. Vanghetti persuaded Ceci[2] to perform the first cineplastic amputation on people. Ceci made a skin-lined tendon 'loop' motor, using the biceps and triceps, over the end of the residual limb.

In the 'club' type (fig. 1, left) of the motor, two separate opposing muscle masses were isolated and covered with skin near the end of the limb, the distal two inches of bone usually having been resected. Metal rings were attached to the 'clubbed' areas of skin and muscle which were used to transmit motion to the prosthesis (fig.2). In the 'loop' type (fig. 1, right) the opposing tendons were sutured over the end of the stump and covered with skin. Movement of the loop of skin over the end of the limb could be made to transmit action to the prosthesis by means of a chain or lanyard. The Rizzoli Institute at Bologna, under Professor Putti[3] was the most renowned center for this type of work in its day. Putti's operative technique for the creation of 'loop' motors was the standard procedure. Vanghetti[4] published on some nineteen cases and went on a year later[5] to review the collected cases of several surgeons. With the appearance of these last publications, Vanghetti brought to a close the first period in the evolution of cineplastic surgery. At the close of World War I, a tour of cinematic amputations in Italian hospitals[6] by members of the American Expeditionary Force (A.E.F.) led to the conclusion that cineplasty, while experimental, held promise for the future.

Work in Germany paralleled that in Italy

In Germany, an independent study of cineplasty occurred in parallel to the Italian work. Ferdinand Sauerbruch started work in the field in 1915 at the suggestion of Dr. Stodola, a professor of mechanics at the Polytechnical Institute of Zurich. Stodola suggested constructing a superior prosthetic hand, provided the surgical

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Century of Sauerbruch-Lebsche-Vanghetti....

Continued

issues could be solved. Sauerbruch made preliminary studies on animals and later on humans and published his and Dr. Stodola's results in 1915[7]. Sauerbruch's first cases were very similar to Vanghetti's concepts. Singen Military Hospital was placed at Sauerbruch's disposal by the Prussian War Department, enabling him to conduct extensive studies into cineplasty. These studies resulted in his text "Die Willkurlich Bewegbare Kunstliche Hand" in 1916[8]. Sauerbruch placed a skin-lined muscle tunnel in muscle proximal to the bone end, as opposed to the Italian practice of constructing 'motors' distal to the bone end. Sauerbruch advocated the use of both protagonist and antagonist muscles to give physiologically correct control. Konrad Biesalski[9], founder of Oscar Helene Heim Hospital in Berlin, developed an exerciser and stretcher for use in the training period following the cineplasty operation.

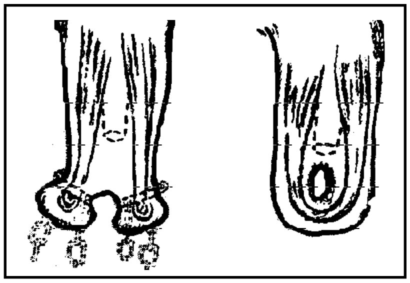

Figure 1: Early Italian 'Club' and 'Loop' Motors.

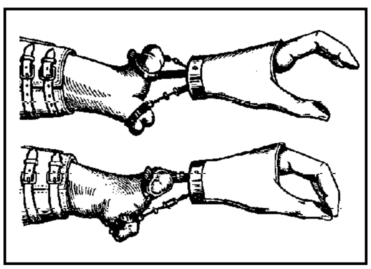

Figure 2: Rizzoli Institute Prosthesis

Sauerbruch stressed the necessity of surgeon, physiologist and technician all working as a team and was one of the first to take this team approach to rehabilitation. A team approach turns out to be crucial to the success of the cineplasty operation. Sauerbruch's prosthetist, Max Biedermann, devised a prosthesis (fig. 3) that utilized a Hufner hand and had a locking device to take the load from the muscle if prolonged pull against the tunnel was necessary. This prosthesis is still available today. While Sauerbruch's enthusiasm may have led him to overlook certain undesirable features of the procedure, surgical difficulties and a lack of access to adequate prostheses discouraged many surgeons from application of cineplasty. During the years between World War I and World War II, activity in cineplasty centered around Sauerbruch in Munich, then later, at Charite Krakenhaus in Berlin and Professor Max Lebsche in Munich. Lebsche, a former student of Sauerbruch, was surgeon in charge of the cineplasty work at several hospitals in Munich, including the Chirurgische Klinik of the University of Munich. Enthusiasm regarding cineplasty elsewhere waned. Kessler[10], who studied with Sauerbruch in Berlin was a lone voice in the USA in his espousal of this technique during the interim between the wars.

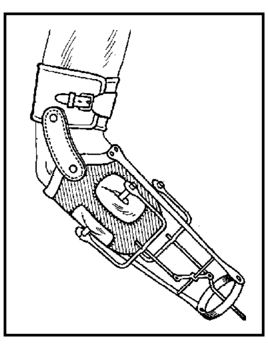

Figure 3

World War II increased the number of cineplasties

World War II saw several thousand cineplastic operations performed in Berlin and Munich. Immediately following WW II, the Surgeon General of the Army in the United States appointed a commission[11] to ascertain the status of new European developments in the treatment of amputees. It was Lebsche's modifications to Sauerbruch's original procedure that was to become the standard procedure for tunnel cineplasties in the USA. Lebsche had concluded that protagonist-antagonist control of the prosthesis was unnecessary and that better results could be obtained by placing the tunnel in a sound muscle in the first sound segment above the level of amputation (fig. 4). He also emphasized the need for a large tunnel diameter both for ease of cleaning and to accommodate a larger pin, thus providing lower unit pressure on the tunnel tissues. The successful results observed at Lebsche's clinics by Alldredge[12] prompted the start of an experimental program at the University of California, Berkeley, in the USA[13]. Cineplasty studies were instituted at the Navy amputation Center at Mare Island[14] and the Walter Reed Army Medical Center[15]. A large number of US veterans were fitted with

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Research in Prosthetics and Orthotics: The Role of Consumers

By Jan Little

The value of research in prosthetics and orthotics is reliant upon how research results affect the lives of people who use prostheses and orthoses. Northwestern disseminates the products of its research laboratories in many ways. Additionally, NUPRL&RERP relies on input from consumers, transferred to the research program in a number of ways.

Many consumers have a connection with Northwestern University. For example, Van Phillips, founder of Flex Foot, Inc., who was recognized for his contributions by the International Society of Prosthetics and Orthotics (ISPO), at their meeting in Amsterdam, The Netherlands in June this year, graduated from Northwestern University Prosthetic-Orthotic Center (NUPOC) and has frequent contact with member of the research staff.

In this issue, four people who are providing input to Northwestern University discuss their experiences and ideas. They are: Amy Davis, a wife, mother, artist and teacher who has used cineplasty for over 40 years and has shared her experiences with NUPR&RERP, Brian Frasure, a student at Northwestern University Prosthetic-Orthotic Center (NUPOC), Brian Ruhe, a student in Northwestern University McCormick School of Engineering and Applied Science, and Sandy Fletchall, member of Northwestern University Rehabilitation Engineering Research Program Professional advisory panel.

40 Years of Using Cineplasty...

...Amy Davis, a mother, artist and teacher, who may have been one of the first women to have cineplasty surgery, shares her views

I am a congenital arm amputee, born with a short below elbow residual limb. For the first 10 years of my life, I was totally ignorant of the fact that arm prosthetic devices existed. Then I learned of a research project being started at UCLA by the Veterans Association to help reduce the weight and size and improve the design and function of prostheses. A member of that research team happened to spot me and invited my mother to bring me into The Child Prosthetics Amputee Project. Although I had already figured out how to do everything without help, at age 10, I got my first prosthesis. I learned to use a Dorrance hook with the standard "Figure 8 harness". Later, I tried other hooks and several functional hands.

I found the harness too confining

I liked the ability to do things with my hook, but I hated the harness because it was confining and, as a female, I found it hard to dress around. My upper back seemed rather sensitive to its touch. I have since learned I am not the only female with both those complaints. Also, as I meet other women arm amputees I know I am not alone in having problems with the figure "8". Talking with other women suggests to me that women arm amputees have more to cope with than men.

I was probably 12 when I found a text at UCLA with a rather ugly set of photos of cineplasty surgery. I was astounded. A person could wear a prosthesis and not have to wear the harness, what a revelation!

During the next year I was introduced to men who had biceps cineplasty or pectoral cineplasty systems. I met the surgeon, Dr. Bechtal. I was evaluated by physical therapists, psychologists and just about anyone who wanted to take a poke at changing my mind or figuring out a reason why this wouldn't work on me. Apparently, I was the first person with a congenital amputation to be considered for this procedure — and probably the first female. My size was larger than most adult females at 5'8", 135 lbs. Everything looked like the procedure would work. I had the operation just before I turned 14. My brachiallis muscle actually provided my flexion strength, because my bicep was rather spindly. Additionally the skin graft machine malfunctioned, so the grafts were bad and the scarring extensive. The doctors and prosthetists considered my procedure a failure, and were very unhappy.

Unlike the doctors, I was happy

I was happy. I had enough strength to use the hook, and I could even use a hand for very limited operation. I'm still happy with the cineplasty. The muscle does tire quickly under heavy loads, or long term repetitive use.

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Amy Davis -- wife, mother, artist, teacher

Continued

I've learned to budget the opening of my terminal devices. The design of cables on my prosthetic unit includes a disconnect snap. I learned to pop this connection to relieve pressure on my very narrow muscle. I was always envious of men who had broader muscles, to distribute the weight of the pull better. However, I liked my freedom from the harness so much that I have never returned to wearing one.

Harry Campbell, head prosthetist of the children's project, initially fitted me with a standard cineplasty arm: standard below-elbow socket, step-up hinges, epicondyle clips at the base of triceps cuff for suspension with a stabilizing strap at the top of the cuff. I liked this set up better than the harness unit, but it was unstable for over-the-head operations. The cuff-strap started to make an indention in my upper arm, and I still had the "clothing eating" restrictive metal hinge system at the elbow.

A semi-suction socket solved the problem

Self-suspended sockets for arms did not exist at that time, but development of suction sockets for leg amputees had just begun. Dr Campbell crafted a semi-suction socket that had a high back with support over the olecranon and epicondyles. It also was cut low in the front, allowing my excess tissue plenty of freedom during its constriction in flexion.

I loved this combination of the cineplasty and this self-suspended socket. I could do work over my head, behind my back and out to either side. I had very good perception of the opening of the terminal device and also of how much pressure I was putting on an object held in that device. I even could get a slight amount of rotation from this unit, as my radius and ulna will rotate. Because1950-60 evening fashions featured long white gloves with strapless gowns, I could dress like other young women. I could hold very heavy weights because the suspension from the epicondyles and olecranon is so good, I have been measured in bench tests with zero displacement at 50 lbs.

The negative to this system is that I have to protect a very narrow piece of flesh that carries all the contact inside the tunnel. I may be more vulnerable to skin damage, fatigue, and infections than most men cineplasty users. To protect against breakdown, I've learned good skin care.

1. I wash the inside of the tunnel daily. I make sure it is dry and clean, whether I am using the prosthesis or not. I always keep cotton inside the tunnel to keep it dry. If I am wearing the prosthesis, I use a cotton finger tubing, around the plastic tube.

2. I ration my openings of the terminal device, and I use the disconnect snap when I do not need to be opening the terminal device.

3. I have a medicinal powder which I use on the cotton inside the tunnel, whenever I notice too much dampness, or a slight hint of breakdown. My last breakdown was well over 20 years ago.

I've spent my life teaching, raising my children, being an artist and living a normal life and had very little contact with prosthetics, except for trips to prosthetists to get terminal units or cables cleaned, repaired, and gloves replaced until July 1995, when I suffered a lower back injury and my old functional hand was too heavy for my back to tolerate. I started looking for options, for a replacement arm and was surprised to find how limited the options were.

I found my options were limited

An adult myoelectric hand would also be far too heavy for me. The alternative solution suggested was a child's myoelectric hook in the largest size available, with an adult glove. It would give me an operating device with less weight. I think I may be one of the few amputees in history who has used three different systems of operation, and who can also function well without prosthetic devices.

I find myself running comparisons between the three operating systems. The Myo eliminates the muscle fatigue and infection factors but is totally useless without a well suspended, closely fit socket. It lacks absolute control of the terminal device, especially in extended positions. To be sure the unit won't misfire, I have to stabilize the socket to a degree against my own body or a stationary object. To be sure I won't drop an object while carrying it, I turn the battery off. These are not things I do with the cineplasty. The myo works well for doing hand to hand work, like sewing a button on a shirt. Other jobs which are done at full extension invite misfirings, like tying shoes. The myo is painless and non-tiring compared to the cineplasty, which can be quite exhausting after a hard day of work.

I use my old cineplasty for the jobs I do best with a hook. I can tolerate that unit (about 12 oz) with the Dorrance hook. I shall use the myo with the child's hook/adult glove for other occasions. If a lighter weight (and preferably easier to operate) functional hand were available I would have stayed with the cineplasty as my only operating system.

At age 55 I'm proof that "even an old dog can learn new tricks". ❖

Two Brians....Amputations Led Them to Study for Professional Careers in Prosthetics

By Jan Little

Brian Frasure runs 100 meters in 11.02 seconds — a time that any Olympic athlete would train for years to attain. Brian wears a below-knee prosthesis and competes in national and international competition as part of Team Flex Foot. Later this year, Brian will graduate from NUPOC and, after serving a residency in an approved facility, will sit for the certification examinations in prosthetics.

Brian Ruhe spent part of the summer roaming Europe to relax before entering a more challenging phase of his education — working toward a Master's Degree in Biomedical Engineering at Northwestern University. Brian, who was featured in *Capabilities*, October 1997, uses two lower limb prostheses. Brian walks with his prostheses so well, people meeting him for the first time often ask how he sprained his ankle, having assumed the cane he uses is to protect an injured limb.

Both men learned about prosthetics first hand

Brian Frasure recalls, "My first experience with a prosthesis was delayed after surgery due to a very bad infection in the residual limb....it took the limb nine months to heal. However, I was lucky to have an amputee as a prosthetist....I saw how active he was. I could also ask him all sorts of questions with the assurance that he could answer because he'd been there before. (When I got my first prosthesis) I slipped it on ...went into the parking lot and sprinted....it wasn't very pretty, but I was running again and it felt great....."

Frasure continued, "That experience did influence my decision to go into the field. Though it was many years later before I made that decision, I looked back to see how much it helped me. An amputee prosthetist can establish a bond and a trust with a patient that an able-bodied prosthetist cannot. There are many mental barriers that must be overcome after an amputation and having someone there who has overcome it is a valuable tool."

"You can't learn to be ambulatory..."

Brian Ruhe, on the other hand, was told by his orthopaedic surgeon that, with his levels of amputations— at knee level on one side and above the knee on the other — he had no chance of being ambulatory. Brian relied on a physical therapist — who had never worked with an amputee but who believed in Brian — and a commercial prosthetics shop to provide his major support after the physiatrist who cared for Brian at Miami Valley Hospital in Dayton, OH, felt Brian's determination might make him a candidate for ambulation. Ruhe was allowed by the prosthetists who were designing his system to become a very active participant in the development. He then realized that strong engineering practices were essential to advancing prostheses and enrolled in biomedical engineering at Wright State University in Dayton.

He is studying biomedical engineering at Northwestern because, as he expresses it, "Lower limb prosthetics is a rapidly changing field. Twenty-five years or so ago, it was still a predominately hands-on, apprenticeship art form. Now it is a science-based engineering field. (But) new products enter the market every year and most lack research on how they are trying to replace a component of normal limb function." Ruhe's research toward his Master's will be in areas of defining and analyzing "normal limb movement".

Ruhe adds that there are, in his opinion, steps in the right direction being introduced. He mentioned that the C-Leg from Otto Bock, which incorporates a microprocessor that controls the stance and swing phases of the knee, will be a move toward the goal of producing more functional prostheses that require less conscious effort from the user. "We are still a ways off from the perfect limb....if we can even get there." Ruhe isn't quite sure what his role will be in the future of advanced prostheses but adds, "I believe that when I have sufficient knowledge, I will be able to identify problems with prosthetics more readily because I am a user. One the other hand, maybe I will not be effective because I'm too close to the problem and how it hits home for me will affect my decisions. Who knows..."

"...what is possible, rather than what we can't do..."

Like Brian Ruhe, Brian Frasure feels it is important for him, as a person who uses a prosthesis, to work to help others in similar situations. Frasure says, "I have actually been working in the field over the past four years as an amputee athlete. Currently, I am ranked number one in the world for below-knee amputee sprinters in the 100 meter event with a recorded time of 11.02 seconds — an unofficial record because of wind. Through these years, I have been able to introduce amputee sports to thousands of people through track meets and motivational speaking across the US. My mission has been to educate people about people

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Sandy Fletchall....Using Professional Experience to Lead People with Recent Amputations to Success

By Sandy Fletchall, OTR/L, CHT, MPA

In my professional career as an Occupational Therapist — over 24 years — and as a Certified Hand Therapist — seven years — many changes have affected health care delivery. Perhaps my favorite change is the role of patient assigned to injured individual by the traditional medical model to a role of team member in his or her rehabilitation. The medical model viewed the patient as forever "ill or injured" and the medical system directed "what is needed". In a client centered model, the client is regarded as an individual to be offered skills and services to facilitate achievement of the goals he has identified. The individual becomes an active participate in his "recovery". In the progression of the individual through the client centered model, he emerges to as an informed consumer of medical services.

Client centered treatment is initiated when we receive communication from case managers, physicians and/or prosthetists, regarding an individual with an amputation. Assessments begin prior to the client's arrival at the clinic. Information is gathered regarding the date of injury, present and past medical history, family/work/school situation, and the client's goals. The verbal or written information gathered creates a partial foundation which is completed with direct contact with the individual with the amputation and significant others.

Client and family direct the team

Once the client arrives at our facility, further assessments and evaluations are initiated. Family members and friends are invited to participate in the sessions with the client. Assessments begins with questions to identify whether the client perceives himself differently than before the amputation, how he deals with stress now as compared to before the amputation, and the process and the type of decision making skills he utilizes. In addition, questions are asked of the significant others to enhance or identify the consistency of information. During the assessment, further information is gathered regarding the client's perception of why they are in the clinic, what services they wish to have, what they want to accomplish or perform. Activities that the client previously and presently participates in are noted. Activities the client desires to initiate are also noted.

Objective evaluations are then begun which include, but are not limited to: range of motion of both upper extremities, lower extremities, back and neck; gross strength of the total body; length, shape, skin integrity of the residual limb. If the dominant extremity was amputated, coordination evaluation of the remaining extremity is conducted. Subjective data is gathered regarding learning styles, and the individual's perceived difficulties — which may indicate a learning disability or visual motor difficulties.

All information and data is compiled, then immediately shared with the client. We discuss the client's goals and activities he wants to accomplish. Given the client's level of present functioning and his anticipated future performance, I discuss whether or not an intense 5-6 hour daily therapeutic program would benefit him accomplishing his goals. I develop time frames for achieving physical improvement or advancement of activities of daily living skills. If a program is desired by the individual, I present rationale to the reimbursement source for funding. If the client desires a prosthesis, a conference with the prosthetist is scheduled.

Discussions lead to choosing a prosthesis

I share information with the prosthetist regarding the client's present and anticipated physical abilities and activities within home, work and leisure. The final decision regarding the type and style of the prosthesis is determined by the individual, prosthetist and therapist. The decision is influenced by the goals of the client. Time frame from casting to prosthetic fit is identified and the need for future follow-up for prosthetic maintenance and/or component change is discussed. It should be noted, in consideration of goals, the prosthetist and therapist will frequently recommend two styles of prosthesis with two interchangeable terminal devices. When the weight of one prosthetic style is less, the recommendation may include fabrication of the second style once strength is regained to a level adequate to handle a heavier prosthesis.

If learning disabilities are suspected and can influence the client's return to vocational retraining or school opportunities, a request is made for formal testing. The individual is informed about reasonable accommodations under ADA in relationship to the amputation and other problems, such as identified learning disability.

Initial discussions by the clients include phrases of "I want only the best, or most expensive arm or leg". After the individual has been included in his recovery, the phrase heard is "I want something I can use". It would appear the change of statements is a reflection of individualizing the program and assisting the client to become an active participant in his program.

The best way to illustrate the advantages of including the person with the amputation on the team is to review several of the clients who have recently used our clinic.

Client I, male, age 32 — Diagnosis: 35% thermal burns, right above elbow, left below elbow amputation

Date of injury occurred 3 years prior to our intervention. The client presented with body powered prosthesis without wrist flexion units, forearm length extremely short for stature and height. He was dependent in self care and had not returned to work since his injury. Driving was accomplished through pressure sensitive modifications.

Initial assessment: Client identified a goal of returning to his former vocation of driving a tractor-trailer rig over the road. Therapist identified significant weakness throughout the lower extremities, abdominals and upper extremities and dependence in activities of daily living skills. Prosthetist recommended alternative body powered components based upon my recommendation that the client desired to improve strength and could achieve his stated goals. Client and his father participated in the discussion regarding the rationale for component change.

Because the client lived 800 miles away from Memphis, he returned to begin the therapeutic program with the fitting for the new body powered prostheses. He participated in a daily intense outpatient program for three weeks. The first week, he required assistance at night because of his dependence. By the second week he was independent in self care and meal preparation and no longer required assistance. His program concentrated on the skills, both coordination and physical, to drive a tractor-trailer rig. Close communication was maintained with his out of state Vocational Rehabilitation Counselor to coordinate follow up after therapy. The counselor made arrangements for the client to continue to refine his skills through a local instructor with a tractor trailer driving school.

The client successfully completed the examination within his state and drives tractor-trailer rigs over the road. Because of the intensity of the program, the only adaptations required for driving was a removable amputee driving ring. Training to achieve independence in activities of daily living, simulation of releasing the trailer from the tractor, strengthen to climb into the cab, and coordination for writing in his log book facilitated achievement of his goals.

Client II: 17 year old male, amputation of dominant right extremity resulting in a short below elbow.

Residual limb required skin grafting for wound closure. The client's goal was to resume acting, singing and, possibly, work as a model. He requested a prosthesis that could "work, yet look like a hand". Following assessments and evaluations, a conference was held with the client and family regarding how to assist goal achievement. Because of his weakness, it was recommended he participate in an intense daily exercise program. Within a short period of time he was fitted with a body powered prosthesis with an elbow flexion assist. With improvement in strength he was fitted and trained with a myoelectric prosthesis with a hand and cosmetic glove. He did resume acting, singing and modeling wearing his prosthesis. Five years later he remains a daily user of his myoelectric prosthesis.

Client III: 42 year old male, one year post an electrical injury resulting in right shoulder disarticulation and permanent injury to the brachial plexus of the left extremity.

Motor function of the left extremity consisted of deltoid functioning. He was dependent in self care. The client's goal was to use a prosthesis to take care of himself, drive and possibility return to work. Following assessments and discussions with the client and reimbursement source he was fitted with an electronic system with a Griefer terminal device. Following training, this client was independent in dressing, toileting, bathing, basic meal preparation and communication skills. He was independent in driving using the left upper extremity and a custom fabricated orthotic device and special driving adaptations. He did return to his former employer in a different job. Follow up: after a year, this client has chosen to use only his left custom orthotic device, but remains independent in many self care activities and in driving.

In each of these case studies, clients were encouraged to participate in their program. Initially, the clients were educated regarding their strengths and weaknesses. They were presented options which could lead to their goal achievement. They identified a desire for prosthetic devices and became educated and then knowledgeable regarding what they needed to accomplish their goals. Within our facility, the goal is not for every individual with an amputation to have a prosthesis, but for every individual to have an opportunity to achieve their goals.

Actively involving the individual during the assessments and evaluations and providing interpretation of the data as it relates to the client's goals are necessary for them to become informed consumers. The team, whose composition is influenced by the client's goals, must communicate frequently and openly, encouraging the individual to regain control over his life. ❖

Sandy Fletchall OTR/L, CHT, MPA is owner and therapist of an outpatient clinic. Her specialty is trauma, burns, crush injuries, replanations, and amputations. She and her husband, Hector Torres, who has an amputation, are active advisors to NUPRL&RERP. She can be contacted at: Functions By Fletchall, 4623 American Way Plaza, Memphis, TN. 38118. E-mail: Hecsand@aol.com

It is with great sorrow that we inform you of the death of Margaret C. Pfrommer. She died October 14, 1998, of heart failure at the age of 61. In 1956, when she was an 18-year-old college student, she contracted polio that left her with quadriplegia. For the past 25 years she was a research associate with our program and strong advocate for the rights of persons with disabilities. We will dedicate a future issue of *Capabilities* to Margaret to tell you more about her life, her work, her impact on our research program and her impact on the world. ❖

Students from University of Strathclyde visit Northwestern

Seventeen students in the prosthetic and orthotic curricula at the University of Strathclyde, Glasgow, Scotland, planned their summer break to spend time at Northwestern University. The students spent several days in July sharing differences in techniques and philosophies as the visited colleagues at NUPOC, the Rehabilitation Institute of Chicago P & O Clinical Services, and Northwestern University research programs and laboratories. The students, who will enter their senior year, also visited Scheck & Siress, Inc., Oak Park, IL and NovaCare Orthotics & Prosthetics, Oak Brook, IL.

NUPRL & RERP Hosted Many Visitors Over the Summer

Visitors to the laboratories of NUPRL & RERP during the summer brought a wide range of knowledge and shared professional experiences with the Northwestern staff.

James Goh, PhD, who coordinates research in prosthetics at the Institute of Materials and Research Engineering (IMRE) in Singapore visited the NUPRL&RERP in July. Dr. Goh, a graduate of Strathclyde University in Bioengineering, has conducted research in the biomechanics of human joints and the properties of various materials used in prostheses and orthopaedic implants.

Ms. Aruna Tole, Department Head of Occupational Therapy at the Tata Memorial Hospital in Bombay, India, shared information about her work to develop low cost, practical prosthetic and orthotic devices in her clinic.

Karen Roberts, an occupational therapist with the Amputee Unit at the Caufield General Medical Centre in Caufield, Australia, was another visitor in June. During her visit, she worked with staff from NUPRL&RERP, NUPOC and the Rehabilitation Institute of Chicago Prosthetic-Orthotic Clinical Services.

Liang-Wey Chang, PhD, PE, a Research Associate Professor at the Center for Biomedical Engineering, College of Medicine, National Taiwan University, Taipai, Taiwan, is spending seven months conducting research at NUPRL&RERP and taking the certification program for orthotics at NUPOC. Dr. Chang began his work July 1, 1998.

NUPRL&RERP Staff Presentations

Joshua Rolock discussed the philosophies and technical approaches of implementing CAD/CAM in prosthetics in a presentation to the general assembly at the Canadian Association of Prosthetists and Orthotists 1998 CAPO Convention. The conference was held in Saskatoon, Saskatchewan, June 23-28, 1998.

Richard F. *ff* Weir presented “A Century of Cineplasty: Implications for the Future of Upper-Limb Prosthetic Control” at the Grand Rounds Series for the Rehabilitation Institute of Chicago (RIC) and Northwestern University Medical School. The presentation was May 27 at RIC.

Dudley S. Childress presented an overview of Biomedical Engineering at Northwestern University at the Alumni Weekend, April 24-25. The weekend is an annual event arranged by the Northwestern University Medical School to provide alumni with current accomplishments of the school.

NUPOC hosts 40th Anniversary & Tour of NUPOC, NUPRL&RERP

Over 300 people attended the Northwestern University Prosthetic-Orthotic Center 40th Anniversary and Alumni Reunion held Saturday, September 19. Many early NUPOC faculty members were honored during the evening including Charles Fryer, MA, James Russ, CO and Gunter Gehl, CP.

A highlight of the evening was the announcement that the $40,000 “Thranhardt Challenge”, donated by Ted Thranhardt, CPO and NUPOC alumni, has been matched by other alumni. Dudley Childress presented Mr.

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The VA Presents

News from the
Department of Veterans Affairs

By: Robert M. Baum, Chief, PTC, VA Chicago Health Care System

VA and State-of-the-Art-Technology

Automated Fabrication of Mobility Aids (AFMA)

By Wanda Hattaway, Chief, PTC, Hines VAMC

In April of 1990, the Edward Hines, Jr., VA Hospital, Prosthetic Treatment Center, was selected as the first in the Department of Veterans Affairs for the development and implementation of the AFMA system. AFMA is a system which utilizes computers in the design, measurement, and fabrication of below/above knee prosthetic sockets for artificial limbs.

The process utilizes computer equipment to measure approximately 1,000 reference points in a passive cast of the patient's residual limb. This information is digitized for use by the computer in determining the contours, shape and size of the residual limb to be fit. A template pattern for the specific type of socket to be designed is chosen from the permanent computer memory of templates. The digitized socket design is transmitted to a computer-controlled milling machine and a positive model of a modified socket is cut from a plaster blank.

Confirming the fit of the socket

Check sockets, made of copolymer, are vacuum-formed over this mold and tried on the patient. Once it is determined that the test socket provides a satisfactory fit, a duplicate socket model is fabricated. A soft insert liner is formed over the model using 1/4" Pelite and a polypropylene socket is formed over the liner. This socket may be incorporated into either endoskeletal or exoskeletal prostheses.

The VA prosthetist will use the conventional method of physical examination of the amputation. The prosthetist will note the physical characteristics of the residual limb and of the subject's physical condition, in general, paying special attention to anything which may affect the socket design.

AFMA lowers some treatment costs

The cost effectiveness of AFMA is not just related to fabrication or material. The system is also cost effective in terms of:

- Patient care can be managed more cost effectively by health care professionals by utilizing time saved by AFMA's faster delivery time.
- Hospital stays can be shorter. This in itself can be an effective cost reduction.
- Patients are more likely to recover successfully with early prosthetic care.
- The cost of the prosthesis/orthosis has been reduced and can be reflected in the overall cost of amputee care.

Currently in the VA, there are 14 primary sites that have the complete AFMA Suite (computer/software, digitizer, carver and vacuum former) and 24 sites that are remote sites (digitizer, computer and phone modems). To

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Two Brians....

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with disabilities — what is possible, rather than what we can't do. After I finish my graduate studies in prosthetics and orthotics in December, I will become a certified prosthetist. I eventually plan to combine this degree with my engineering background and — hopefully — work in design of athletic prostheses."

Both Brians recognize that there are problems involved in assuring that each amputee receives a system that is optimum for him or her. As Ruhe points out, "there are so many devices on the market, who is to say this one is the one and only perfect device for a specific person. The decision made by a therapist, a prosthetist and, sometimes, a doctor is a "guesstimate" of the person's probable level of function. Sometimes that person goes beyond what was expected. Sometimes, he or she does not make it to the level that was anticipated. Then, the factor of money must be considered. It is sad, but people get cheap limbs that do not function up to the person's ability because funding is looking for economy."

But, both Brians are optimistic about the future and enthused about the roles they will play. Frasure says, "I would like to continue to change the perception that many people have of amputees. I would also like to see the products continue to advance and increase the quality of life for all amputees. I would like to see more young amputees encouraged to take part in sports and other activities — and not be told that they can't do something."

Ruhe agrees. "More available funding for prostheses would be a start. We need to keep alive the team approach — therapist, prosthetists, doctor and patient. We need better education for patients. If she or he has a better idea of what to expect, better outcomes should be seen. Some people I've met think they can do more now that they've lost a leg — others think they can't do anything. We need to educate new amputees about the middle ground and what they can do."

And a word to other people who use prostheses comes from Frasure, "Consumers can make a huge difference, establishing a voice as to what they would like to see in prosthetics. They need to make suggestions, share things they've learned that make function a little easier with both other amputees and prosthetists. Then prosthetists need to express these ideas to the designers (and manufacturers). Perhaps this will lead to being aware of areas that prosthetic users feel need improvement. Too often we see something developed without consumer input — and it is a prosthesis few people can use or have need for. Consumers need to keep up to date on the latest technology, get involved with organizations for the disabled and form a voice." ❖

NUPOC Anniversary

Continued

Thranhardt with a plaque and announced that the Thranhardt Information Resource Center within the NUPOC library will be dedicated in the near future.

Over 100 prosthetists, orthotists, and others attending the Annual Meeting of the American Prosthetic & Orthotic Association (AOPA), held September 17-19, toured the laboratories and class areas of NUPRL&RERP and NUPOC.

VA Uses Automated Fabrication

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date, at the Hines VA, over 600 prostheses have been fit to veterans utilizing this state-of-the-art system.

At this time, Veterans Integrated Service Network (VISN) 12, which includes VA Chicago Health Care System (formerly Lakeside and West Side facilities), Hines, North Chicago, and Milwaukee, Madison, Iron Mountain and Tomah, Wisconsin, is looking at even more current state-of-the-art technology in the fabrication of prostheses. The system under review replaces the procedure of casting patients with a "wand-type" device used to trace the critical reference points on a residual limb. This system is also portable enough to allow VA prosthetists to travel with it to remote facilities in order to provide better access to veterans and their prosthetic needs. The Hines VA, which recently acquired this new system, will be used as a test site prior to further review and/or implementation at the other VISN 12 sites. ❖

***Attention VA Facilities**: If interested in submitting an article for future publications, please contact Robert M. Baum at (312) 640-2141. FAX and e-mail drafts can be sent to Baum's attention at (312) 640-2247 or Robert.Baum@Med.VA.Gov*

Century of Sauerbruch-Lebsche-Vanghetti....

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cineplastic limbs after WWII and after the wars in Korea and Vietnam.

The first definitive end-use study on cineplasty was published by Brav, et al.,[16,17] for the Walter Reed Army Hospital. The conclusions of the study were that in spite of the higher success rate associated with conventional prosthetic fittings, the advantages of the biceps tunnel cineplasty procedure to the below-elbow amputee were sufficiently great that the operation was still warranted. The report also stated that while the surgery was well defined, impeccable execution, gentle handling of the cineplastized muscle and careful patient selection were vital to the success of the procedure. By the mid-60s, the incidence of tunnel cineplasty at Walter Reed was on the decline. The enthusiasm of the Chief of Surgery at many facilities determined the number of cineplasties performed and, with the retirement of many of the surgeons who were present at the end of World War II, tunnel cineplasty in the USA gradually faded out of use. The Philadelphia Naval Hospital was the last institute in the USA to perform the tunnel cineplasty operation on a regular basis[18,19]. This facility's closure in the early 70s brought to a close the era of the cineplasty procedure in the USA.

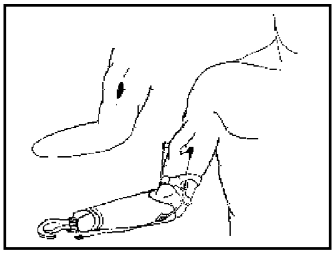

Figure 4: Lebsche Cineplasty

During the eighties, there was a brief revival of the procedure in Germany. Biedermann[20], the son of Sauerbruch's original prosthetist, reported on the value of the Sauerbruch cineplastic arm prosthesis and presented a redesign of this prosthesis using modern day materials and techniques. Bruckner and Thomas[21] reevaluated the Vanghetti-Sauerbruch-Lebsche procedure and suggested that the procedure may be indicated for below-elbow and unilateral long above-elbow patients. They gave the long term results for cineplasties performed by Bruckner's group since 1988. Baumgartner and Ploger[22], based on an extensive review of cineplasty by Ploger[23], presented a follow-up of thirty patients, each of whom had worn their prostheses for an average of forty years. Marquardt[24] reported the use of a pectoral cineplasty in the control of an externally powered arm. Unfortunately, this revival has been short lived. Bruckner is no longer at a facility where he can perform the procedure. Baumgartner and Marquardt are retired and Biedermann is deceased.

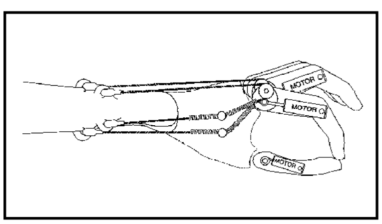

Figure 5: Multiple Miniature Cineplasties

Interest in cineplasty is still being nurtured in the USA through the idea of the use of miniature cineplasties as control inputs to externally-powered prostheses[25,26,27]. If the controller embodies the concept of extended physiological proprioception (e.p.p.) then, with the appropriate linkage, the cineplastized muscle's own proprioceptive receptors can be used to provide feedback information about the prosthesis' state. Externally powered components implies small cineplasties. Small cineplasties present the possibility of creating multiple tunnels on the residual limb to control multiple prosthetic degrees-of-freedom. The possibility exists for a below-elbow amputee to achieve independent meaningful multi-digit control through the use of multiple miniature forearm cineplasties providing control inputs to multiple e.p.p. controllers, one cineplasty per controller per digit to be controlled (fig. 5). Alternatively, it might be possible to create multiple miniature pectoral cineplasties, for high level above-elbow amputees, to control a multi-degree-of-freedom arm prosthesis in a more subconscious manner than is now possible. ❖

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