



**The Journal of the International Society
for Prosthetics and Orthotics**

Prosthetics and Orthotics International

Special Issue

Appropriate Prosthetic Technology

April 1996, Vol. 20, No. 1

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BJÖRN M. PERSSON
C. MICHAEL SCHUCH

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The Journal of the International Society for Prosthetics and Orthotics

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ISPO

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J. Hughes (Education)	UK
S. Heim (Education in Developing Countries)	Germany
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G. Fitzlaff (Publications)	Germany
D. N. Condie (Standards)	UK
M. Ellis (ICTA, Consumer Affairs)	UK
B. Klasson (Quality Management)	Sweden
D. Jones (Information Exchange)	UK

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J. Fbbink (Interbor)	Netherlands
G. Hough III (WOC)	USA
T. Lagerwall (RI/ICTA)	Sweden
T. Verhoeff (ICRC)	Switzerland
H. R. Lehneis (WRF)	USA
T. J. Supan (ABC)	USA

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C. Marinck and E. van Laar	Central and Eastern Europe
J. Craig, R. Jované, J. Gomez, J. Martina, D. E. Suarez and C. Schiappacasse	Central and South America
O. E. Feldman	Russia
S. Sawamura and E. Tazawa	Pan Pacific
K. Abadi and M. A. A. El-Banna	Middle East
H. Shangali	Africa
A. Von der Borch	Pacific Rim

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J. Hughes (1986-1989)	UK
W. H. Eisma (1989-1992)	Netherlands
M. L. Stills (1992-1995)	USA

Secretary

Aase Larsson	Denmark
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Editorial

Once again the year gone past has been turbulent in the international money market, and in the Danish market in particular. The year 1994 was by far the most depressive for the ISPO finances with losses of close to DKK 1,000,000 on our assets because of decrease in value of our long term bond investments. For the year 1995 we have applied an investment policy, which aims at bringing us back to the previously successful investment basket with minimal risk or losses. The safe investment package consisted of bonds with short, medium and long term duration; at the same time maximising direct interest income, and making it possible to cash them in safely in order to run our activities. The constitution of ISPO does not allow for loans, not even to meet short term cash requirements. Closely following the financial market, combined with expert advice, we successfully managed to convert some of our long term bonds into cash and ultrashort bonds, and happily enough also the price value of our bonds started ascending again. As a result ISPO recovered most of the losses from 1994 and continued to monitor the money market development with the purpose of recovering the rest through safe money market trading.

The Australians further helped us to strengthen the finances by transferring an advance of DKK 300,000 as a preliminary payment of a comfortable profit. The final accounts of the Melbourne 8th World Congress are not yet available. ISPO can only be grateful for the financial success, but more important is the high level of satisfaction with the organisation and scientific content of this important event for ISPO.

A well publicised congress has a magnetic effect on enrolment of new members, the total now reaching a pinnacle of 2,631 active plus 97 emeritus members and a further 147 former members, who have yet not paid their 1995 dues. We are happy to announce that 21 members from Central America, Malawi, Bosnia and Micronesia gain from having their dues covered through twinning arrangements with the National Member societies of USA, UK, the Netherlands and Australia respectively. We hope that such arrangements will develop further to the benefit of education and patient care in areas of the world thinly covered with professionals.

The financial statement only slightly shows the heavy involvement ISPO has had in 1995 towards education activities. Many resources have been devoted to organising another consensus conference on appropriate prosthetic technology. This successful event took place in Phnom Penh in Cambodia, largely financed by USAID on a DKK 1,000,000 budget. Further ISPO has entered into the planning phase of yet another consensus conference on poliomyelitis.

ISPO has depended totally on voluntary work, in particular from the University of Strathclyde in Glasgow and from individuals from Kobe, Dallas, Durham, Wuhan, Dundee, Moshi and Copenhagen amongst others where the good will of the employers has been stretched to the edge in contributing manpower to a wide extent, to further the activities of the society.

Continuing financial support has been received from the War Amputations of Canada and the SAHVA Foundation in Copenhagen still provides office facilities and some clerical assistance free of charge. ISPO has over the years had only a single employee on salary, our well known secretary, Aase Larsson. In addition some professional service has been bought to keep the wheels running, e.g. book-keeping, journal production, financial and legal assistance. However, communication with the growing membership; increasing number of National Member Societies; subscribers and advertisers; conference course and congress organisers; affiliated associations; and project development results in a steeply increasing work-load.

The journal, *Prosthetics and Orthotics International*, has become a corner-stone in communicating the philosophies and work of ISPO to the membership at large and also to our collaborating bodies. The number of subscribers has been fairly constant, just below 400, in spite of librarian reluctance internationally to subscribe to minor, specialised journals. Through solid efforts from the Editors the advertising income has increased to a level allowing for a slightly profitable activity.

On the expense side for 1995 the costs of the Executive Board is a major line item. Throughout the past 10 years ISPO has applied the policy that Board members, and officers, are reimbursed for travel and living expenses in accordance with Danish Civil Servant rules and regulations, which are updated yearly by the Danish Ministry of Finance. These rules are seen to be reasonable and fair and are logical to apply because ISPO works under Danish law. In congress years the expenses are rather high, in particular in 1995, because of extra partial reimbursements for two Executive Board meetings during the congress added to two normal Executive Board meetings. Some costs are taken direct against the congress accounts but others are on the ISPO accounts. Executive Board meetings are cheapest in Europe, and in Copenhagen in particular. However, the international work and political influence of ISPO's activities demands holding Executive Board meetings at widely spread geographical locations, inevitably one of these being the venue of the World Congress.

In conclusion, ISPO finances are sound and have been strengthened in 1995. ISPO is a growing Society with a yearly turn-over of DKK 2-3,000,000 and securities of around DKK 6,000,000. ISPO is an important player in influencing education of the professionals and the provision of services, and is well positioned in the global picture to achieve its goals.

H. C. Thyregod
Chairman of the Finance Committee

J. Steen Jensen
Honorary Treasurer

New ISPO Publication

Consensus Conference on the Lower Limb Orthotic Management of Cerebral Palsy

Report of an ISPO Workshop, Durham, USA

Edited by D. N. Condie

Published 1995

Price: ISPO Members \$20 (US) Non-members \$30 (US)
(plus postage and handling \$5 (US))

Orders, which must be accompanied by the appropriate remittance (cheque or international bank draft made payable to ISPO) should be sent to:

Mrs Aase Larsson
ISPO
Borgervænget 5
2100 Copenhagen Ø
DENMARK

ISPO Statement of Accounts, 1995

Auditors Report

We have audited the enclosed Financial Statements for the year 1995.

The audit has been performed in accordance with approved auditing standards and has included such procedures as we have considered necessary.

The Financial Statements have been prepared in accordance with statutory requirements, and the constitution of the Society and generally accepted accounting policies. In our opinion, the Financial Statements give a true and fair view of the state of the affairs of the association as of December 31, 1995, and of the result for the year.

Copenhagen, March 8, 1996

Revisionsgruppen A/S

Søren Wonsild Glud

State Authorized Public Accountant

Accounting Policies

Securities

Bonds and shares have been stated at the lower of cost or market.

Office Equipment

Computer and office equipment have been stated at cost less accumulated depreciation computed straight line over 5 years.

Accrual Concept

The accrual concept of accounting has been used in these Financial Statements.

Income Statement for the Year 1995

Summary	1995	1994
	DKK	DKK
Society membership fees (note 1)	1.055.700	1.050.147
Sponsorship (note 2)	24.330	27.715
Meetings with other organisations (note 3)	(38.944)	(81.395)
Conferences, courses etc (note 4)	300.284	(561.060)
Prosthetics and Orthotics International (note 5)	4.493	(3.648)
Publications (note 6)	(2.940)	(39.118)
Activity result	1.342.923	392.641
Administration expenses (note 7)	(1.312.450)	(1.049.634)
Primary result	30.473	(656.993)
Interest (note 9)	411.835	463.168
Dividend (note 9)	1.128	1.128
Change in value of securities (note 9)	693.147	(837.329)
Financial Income	1.106.110	(373.033)
Net Income (loss)	1.136.583	(1.030.026)

Balance Sheet as of December 31, 1995

	1995	1994
ASSETS	DKK	DKK
Cash	1.126.809	63.915
Accrued interest	92.952	113.385
Advertising receivable	142.847	160.016
Prepayment, World Congress 1998	89.305	83.040
Receivable World Congress	50.000	0
Miscellaneous receivables	42.211	173.032
Receivables	<u>417.315</u>	<u>529.473</u>
Securities (note 9)	<u>5.453.911</u>	<u>5.444.400</u>
Office equipment (note 8)	<u>55.133</u>	<u>0</u>
Total assets	<u><u>7.053.168</u></u>	<u><u>6.037.788</u></u>
 LIABILITIES AND EQUITY		
Accrued expenses	112.198	128.227
Accrued printing cost	0	162.000
Prepaid membership fees	103.515	105.247
Prepaid subscription income	58.558	0
Short-term liabilities	<u>274.271</u>	<u>395.474</u>
Equity January 1	5.642.314	6.672.340
Net result	1.136.583	(1.030.026)
Equity December 31	<u>6.778.897</u>	<u>5.642.314</u>
Liabilities and capital	<u><u>7.053.168</u></u>	<u><u>6.037.788</u></u>

Notes to the Financial Statements

1. Society membership fees

Membership fees consist of payments from members.

2. Sponsorship

Contribution from:

The War Amputations of Canada

24.330

27.715

24.330

27.715

3. Meetings with other organisations

	1995	1994
INTERBOR	(6.646)	0
Education Committee	(5.903)	(14.829)
Certification	(15.395)	(16.330)
Other	(1.333)	(50.236)
WHO Geneva	(4.548)	0
ICRC	(5.119)	0
	<u>(38.944)</u>	<u>(81.395)</u>

4. Conferences, courses etc

USAID	(38.034)	(56.560)
Panama	22.738	(94.399)
CP Consensus	(10.248)	(190.088)
Slovenia	(9.147)	(107.779)
Thailand	0	(71.771)
World Congress	346.399	(40.463)
Polio Consensus	(11.424)	0
	<u>300.284</u>	<u>(561.060)</u>

5. Prosthetics and Orthotics International

Advertising	406.621	309.627
Subscriptions	<u>193.757</u>	<u>266.901</u>
	600.378	576.528
Printing and mailing	(529.955)	(515.571)
Production editor	(33.750)	(31.802)
Meeting expenses	<u>(32.180)</u>	<u>(32.803)</u>
	(595.885)	(580.176)
Net result (loss)	<u>4.493</u>	<u>(3.648)</u>

6. Publications

Booksales	1.121	844
Amputation Video	(4.061)	(33.222)
Amputation surgery consensus	0	(6.740)
Total cost	<u>(2.940)</u>	<u>(39.118)</u>

7. Administrative expenses

Executive Board and Officers		
Travel and hotel costs	715.570	247.865
Meeting expenses	0	22.206
Copenhagen IC meeting	0	185.289
	<u>715.570</u>	<u>455.360</u>

Secretariat, Copenhagen	1995	1994
Staff salaries	302.709	298.327
Labour tax	16.339	16.716
Data service	1.379	4.023
EDP	17.727	0
Meeting expenses	7.349	28.862
Postage and Bank charges	56.951	58.310
Telephone	9.866	0
Stationery	28.453	4.640
Office supplies	7.625	0
Auditing	25.909	45.000
Bookkeeping	8.000	786
Consulting fees	34.318	18.750
Sundries	35.805	30.756
Depreciation	15.000	23.565
Bologna Court Case	0	19.284
Society promotion	4.383	45.255
Professional register	25.067	0
	<u>596.880</u>	<u>594.274</u>
Total	<u>1.312.450</u>	<u>1.049.634</u>

8. Office equipment

Computer equipment, at cost	187.543	123.196
Office equipment, at cost	32.006	26.220
Cost	<u>219.549</u>	<u>149.416</u>
Depreciation January 1	(149.416)	(125.852)
Depreciation during the year	(15.000)	(23.564)
Accumulated depreciation	<u>(164.416)</u>	<u>(149.416)</u>
Net book value	<u>55.133</u>	<u>0</u>

9. Securities

	Nominal value	Original cost	Year end value
Bonds			
8% Danish State 2001	1.387.000	1.486.454	1.486.455
6% Realkredit Danmark 2016	1.744.000	1.447.520	1.558.264
6% Danske Kredit 2026	2.872.000	2.653.728	2.386.632
Shares			
Den Danske Bank	94	30.891	22.560
Total		<u>5.618.593</u>	<u>5.453.911</u>

Executive Board Meeting

**10-11 February 1996
Copenhagen, Denmark**

The Executive Board welcomed Dr HR Lehneis (World Rehabilitation Fund) and Mr T Verhoeff (International Committee of the Red Cross) to their first Executive Board Meeting.

Finance Committee

The Honorary Treasurer, Steen Jensen, reported that the year had ended with a positive balance in excess of DKK 1,000,000. This was helped by the Australian Congress, investment income and the substantial recovery in value of the long term bonds held by the Society. A more detailed account of Financial matters is given in the Editorial in this issue of *Prosthetics and Orthotics International*.

Slate of Nominations for Executive Board 1998-2001

All National Member Societies have been invited to suggest members of the Society to be considered when the Slate of Nominations is drawn up. In keeping with the international nature of the Society, they have also been asked to put forward the names of individuals from National Member Societies other than their own, where possible. The deadline for submission of names is 15 May 1996. Thereafter, the Executive Board will compose the Slate of Nominations for presentation to the Interim Meeting of the International Committee in January 1997.

Education

The Education Committee, chaired by John Hughes, continues to be active on several fronts.

The next course in Amputation Surgery and Related Prosthetics is currently being planned to take place in Madras, India in late 1996. The possibility of holding a second course in the developing world is still under consideration with Vietnam as a possible venue. As regards the industrial world, courses are being planned for Sweden (April 1997) and Japan (January 1998).

The ISPO/INTERBOR Joint Education Committee, which deals with educational matters of mutual interest to the two Societies, met following the last Executive Board meeting. As one of its tasks, this Committee is organising a meeting of Schools and Associations aimed at the acceptance of the need for minimum standards of prosthetic/orthotic education. The meeting is being planned to take place in Glasgow, UK in late 1996. Most of those attending will be self funding. Thus costs will be relatively small and will be shared between ISPO and INTERBOR.

DSE (German Foundation for International Development) are planning, in collaboration with GTZ (German Agency for Technical Cooperation), a conference on orthopaedic technology in Wuhan, China in November 1996. They have asked John Hughes to be Moderator and Chairman of the Steering Committee, the Honorary Secretary to join the Steering Committee as secretary and the President-Elect to prepare a draft declaration for the meeting. Therefore, although this is not an ISPO event, the Society will be actively involved and will have the opportunity to contribute to the outcome.

Membership

The President-Elect informed the Executive Board that, over the past five years, membership of the Society had grown steadily reaching a total of 2,724 in 1995. The number of countries represented had increased to 91.

Publications Committee

The Chairman of the Publications Committee, Gerhard Fitzlaff reported that *Prosthetics and Orthotics International* had made a small profit in the last financial year, largely due to an increase in the number of advertisers. It was noted that 3,300 copies were currently produced and 3,100 were mailed.

The question of publicity material for use throughout the Society is being considered. It has been suggested that a package comprising a flag, banner and a drape for a speaker's lectern might be provided to National Member Societies for National events and this is being investigated. The Publications Committee will continue to consider the provision of a package which would give help to National Member Societies in publicising the Society.

The final report on the Consensus Conference on Orthotic Management of Cerebral Palsy has been printed and the draft report of the Consensus Conference on Appropriate Prosthetic Technology is complete and soon to be printed. These can be ordered from the Copenhagen office.

There was concern that the ISPO logo is not being correctly used. Some National Member Societies, and groups within the Society, are currently using their own logo. It was noted that the Publications Committee is currently examining this and will report at a later date.

Standards

David Condie reported on the work of the three committees: ISO TC168, ISO TC173 and CEN TC293. ISO TC168 working groups are close to publishing standards on Categorisation and Description of Prosthetic Components and Physical Testing of Lower Limb Prostheses. One ISO TC173 working group has devised a classification of all technical aids for people with disability. CEN TC293 has been working towards a level 1 standard for all technical aids and level 2 standard for specific categories of equipment. The documentation has been produced in draft form.

Research and Evaluation

David Condie informed the Executive Board that the final report of the Consensus Conference on Orthotic Management of Cerebral Palsy recommended further initiatives by ISPO as follows:

- (i) ISPO should act to obtain improved evidence of the effect of orthotic intervention by:
 - coordinating the developing of a standardised protocol to record the requisite information regarding patient status, type of orthotic intervention and outcome of intervention
 - establishing a multi-centre orthotic treatment evaluation project based on the above mentioned protocol
- (ii) ISPO should examine the feasibility of conducting multidisciplinary instructional courses designed to disseminate the principles of treatment agreed by the Conference allied to practical instruction on all forms of intervention by recognised experts from all the concerned disciplines.

The Executive Board will next consider how best to implement these recommendations.

The President-Elect announced that, following the publication of the report on the Consensus Conference on Appropriate Prosthetic Technology for Developing Countries, selected material will be compiled in the April issue of *Prosthetics and Orthotics International* together with a review paper.

Planning continues for the Consensus Conference on Poliomyelitis. The Steering Committee, chaired by Michael Schuch, is aiming towards holding the conference in September 1997. The World Health Organisation and World Orthopaedic Concern have expressed their support for this consensus conference.

International Consultants

Central and South America

Rosie Jované (Sácz) reported on several interesting activities in Panama during the period April to December 1995. She provided information about courses on prosthetics, orthotics and rehabilitation and a seminar on the use of thermoplastic materials. She commented that ISPO was of great value to rehabilitation professionals in Panama.

Miguel Gomez referred to the Congress on Trauma due to be held on 22-26 July 1996 in Bogota, Colombia. With speakers from throughout the Americas and beyond, this promises to be a very interesting event.

Central and Eastern Europe

Črt Marinček described his efforts to identify individuals willing to serve ISPO in their countries. He had achieved success in Croatia, Ukraine, the Czech Republic, Bosnia and Macedonia.

Ed van Laar reported on his visit to Romania where he had stimulated a great deal of interest in ISPO leading to ten immediate applications for membership. He anticipated holding a meeting in February or March 1996 at which a new National Member Society might be formed.

Pacific Rim

The President reported that he had communicated with a number of key persons in South East Asia and had received replies from 70% of them. He proposed sending them newsletters and inviting them to form National Member Societies. He also hoped to organise a regional conference in Tokyo in 1998 to involve these contacts.

South Pacific

Adrian von der Borch described ISPO related activities in the South Pacific. The Australian National Member Society had established twinning links with orthotists/prosthetists in several Pacific islands and was striving to improve prosthetic/orthotic provision and education in the region.

Africa

Harold Shangali reported that in Zaire the Christian Blind Mission had set up a satellite workshop. In Rwanda, following the war, Handicap International had installed a small workshop, near the Tanzanian border, which was serving the war amputees. He also reported that the workshop in Mulago Hospital in Uganda, which was initially funded by the British Red Cross, had now been taken over by Handicap International.

International Organisations

INTERBOR

Jan Ebbink, President of INTERBOR, reported that the INTERBOR General Assembly had agreed to the initiation of a project named PEDECO (Private Enterprise in Developing Countries). The aim was to achieve continued prosthetic/orthotic provision in developing countries when the NGOs (Non-Governmental Organisations), which provide short term help, leave. The plan was for INTERBOR members from the industrial world, together with participants in a developing country, to establish a substantial local private enterprise. Two pilot projects would commence this year.

He also reported that INTERBOR had become a member of an EU (European Union) institute known as UEAPME (European Association of Craft, Small and Medium-Sized Enterprises). He commented that this might benefit activities of the Joint Education Committee as it might prove easier to attract EU funding.

World Health Organisation (WHO)

The Honorary Secretary reported that he had written to WHO seeking renewal of official relations. His letter had described activities of the Society during the last triennium (1992-1995) and those being planned for this triennium (1995-1998) in which WHO collaboration might be sought.

The President-Elect reported that a joint ISPO-WHO meeting on "Standards on Rehabilitation of Persons with Traumatic Amputations" had been held in Amsterdam following the last Executive Board meeting. The draft report of the meeting had been circulated for comments.

Rehabilitation International (RI)

A communication had been received from the organisers of the RI World Congress in New Zealand. They welcomed ISPO involvement and the President will present an invited paper on behalf of the Society at the congress.

International Commission on Technology and Access (ICTA)

Maggie Ellis reported that ICTA had been asked to hold a seminar in conjunction with ISPO at the RI World Congress. There were overlaps between ISPO and ICTA regarding ideas about appropriate technology and this might form a basis for the joint seminar.

International Verband der Orthopädie Schutchniker (IVO)

Jan Bredie reported that the IVO Congress held in June 1995 in Berlin had been very successful with 1,500 delegates attending and an excellent exhibition. He advised the Executive Board that the newly-elected President of IVO was Mr R. Massaro of Paris, France. At the meeting of the IVO Board, chaired by Mr Massaro in November 1995, it had been agreed that greater cooperation with ISPO and INTERBOR would be desirable. Jan Bredie advised the Executive Board that the next IVO Congress would be held in Brussels on 5-7 September 1997 and that representatives of ISPO would be welcomed. It was noted that the next IVO Board Meeting will be held on 13-14 April 1996 in Brussels.

International Committee of the Red Cross (ICRC)

Theo Verhoeff reported on ICRC projects in Afghanistan, Azerbaijan, Georgia, Kenya, Pakistan, Angola, Cambodia, Iraq and Sudan. Activities include orthopaedic workshops (mainly producing prostheses), hospitals (mainly physiotherapy) and spinal cord injury centres. He described the ICRC philosophy. Usually ICRC enters countries during conflicts, and works in cooperation with local care providers with a view to handing over responsibilities for the service to them. In anticipation of this, training courses are provided for local personnel. The emphasis was on providing affordable technology (including use of polypropylene) and on local manufacture of components such as feet, knee assemblies and alignment systems.

World Rehabilitation Fund (WRF)

Dick Lehneis reported on the various WRF projects in Armenia, Lebanon and El Salvador where the emphasis was on providing prosthetic/orthotic relief following war or natural disasters. He also described a project in the Bronx, New York which was providing a training programme for prosthetic/orthotic and rehabilitation oriented technicians.

US Agency for International Development (USAID)

Mel Stills reported USAID had expressed satisfaction with the consensus conference on Appropriate Prosthetic Technology for Developing Countries which they had largely funded although it had been organised by ISPO.

Congresses*Amsterdam, The Netherlands 1998*

The Chairman of the International Congress Committee, the President-Elect, reported on the meeting of that committee. Preparations for the Congress are proceeding well. A new feature will be the form of the Congress Dinner. Instead of the traditional formal "sit-down" meal, it will take the form of an informal party, held in the Maritime Museum. It seems likely that the call for papers will give the deadline for receipt of abstracts as 1 November 1997.

Invitations 2001

Only one bid had been received for the 2001 World Congress. This was submitted by the United Kingdom National Member Society and was accepted. Options are held on the weeks 24-29 June and 1-6 July 2001.

Information Exchange

Derek Jones, the Task Officer, had submitted a paper which suggested short term objectives of using the Internet and activities necessary to support these. In particular he invited the members of the Executive Board who have access to the Internet to send him their comments and suggestions. In due course he intends to write an explanatory article for Prosthetics International.

Quality Management

Bo Klasson had submitted a paper which presented the rationale of a proposed workshop on quality issues and a draft programme. The Executive Board supported the proposed workshop and agreed that Bo Klasson be appointed Task Officer for Quality Management.

Correspondence

Ugandan Association of Orthopaedic Technologists and Technicians

A request to be granted Affiliated Membership of ISPO had been received from the Ugandan Association of Orthopaedic Technologists and Technicians. This was approved by the Executive Board.

Nomination for Fellowship

A completed nomination form had been submitted by the Swedish National Member Society proposing Yvonne Meyer for Fellowship of the Society. This was approved by the Executive Board.

Twinning

Harold Shangali presented a proposal on twinning activities with African countries in which he gave a suggested procedure for establishing twinning and maintaining a twinning arrangement.

Mike Schuch reported that the US is engaged in twinning using a fund of contributions donated voluntarily by United States Members at the time of paying their annual subscription.

Brendan McHugh
Honorary Secretary

New ISPO Publication

**Consensus Conference on
Appropriate Prosthetic Technology for Developing Countries**

Report of an ISPO Workshop, Phnom Penh, Cambodia

Edited by H. J. B. Day, J. Hughes, N. A. Jacobs

Published 1996

Copies of this publication are now available. Enquiries to:

Mrs Aase Larsson
ISPO
Borgervænget 5
2100 Copenhagen Ø
DENMARK

**THE FOLLOWING PAPERS SUMMARISE THE CONSENSUS CONFERENCE ON
APPROPRIATE PROSTHETIC TECHNOLOGY FOR DEVELOPING COUNTRIES
HELD IN PHNOM PENH, KINGDOM OF CAMBODIA, 5-10 JUNE 1995.**

Foreword

J. HUGHES

National Centre for Training and Education in Prosthetics and Orthotics, University of Strathclyde, Glasgow, UK

The problem

Prosthetic replacement following amputation poses problems of function, cosmesis, self-esteem, economics and social integration of the individual concerned, to which must be added the wider implications for the community or national economy.

In the industrial world these issues have been addressed by the professions involved, and by appropriate governmental, international and non-governmental agencies. Although there are still areas of controversy, an enormous body of knowledge is available, systems of treatment are understood and documented, and methods of prosthetic construction exist in abundance. In general the level and standard of prosthetic supply is a matter of national economics, social conscience and demand driven by patients and the medical profession. The differences in service which exist between various countries depend on national issues and the system of provision is determined, and the outcome judged on that basis.

In the developing world the situation is completely different and much more complex. The total number of amputees is unknown, but is large and is made larger, in some countries, by conflict and its aftermath. Antipersonnel mines detonated accidentally long after the cessation of hostilities have caused many amputations in SE Asia — in Cambodia alone it was estimated that 20,000 people had lost limbs from these mines and some 35,000 patients awaited revision surgery. It was reported that in

Vietnam there were 200,000 amputees in need of prosthetic fitting, but the prosthetic services could deal with only 20,000 per year. These countries suffer to a greater degree the same problem as others who have escaped conflict. The industrialisation of developing countries brings new demands in the number of amputations from work related and road traffic accidents. The size of the patient load results in a compromise being sought between quantity and quality.

This enormous demand confronts a chronic lack of resources and of trained personnel. In many cases, the intervention of a non-governmental organisation (NGO) provides the best possibility of initiating a prosthetic service, but the development of national programmes and governmental support of NGO activities is essential to the achievement of long term objectives.

Probably the single most important issue facing the developing countries and the various agencies which attempt to help them in the rehabilitation of the amputee, is that of "appropriate technology".

Unfortunately this phrase has sometimes been used to describe primitive or crude technology, when it should mean the application of the best that can be done with the resources of equipment, staff, materials and finance which are available. When applied to prosthetics the technology must satisfy accepted biomechanical and functional principles, and this implies that the practitioners must be trained to a satisfactory level.

There is evidence that many of the artificial limbs supplied in the developing world do not function in the manner intended. This may be due to poor design, the use of inappropriate

All correspondence to be addressed to John Hughes, National Centre for Training and Education, University of Strathclyde, 131 St. James Road, Glasgow G4 0LS, UK.

materials, or to poor fit and alignment. Many will remain serviceable for only two or three years and many prosthetic feet will not last for more than six months.

Sockets, however they are made, must be properly designed and correctly fitted and aligned. In prosthetic construction, the choices include — the provision of temporary or permanent prostheses, the use of available “local” materials such as wood, bamboo, leather, various types of plastics, etc., the design concepts of endo- and exoskeletal (crustacean) structures, and the use of imported components or those of local manufacture. These choices have to be considered in the light of costs, climatic and environmental conditions, durability, capability of simple repair, together with the weight of the prosthesis and the psycho-social demands of both the patient and the community at large.

However, the technology of the prosthesis itself is not the sole problem, and appropriate national systems of prosthetic provision have to be considered. These must reflect the circumstances and needs of the particular country in such factors as the number of specialist referral units per capita, the number of associated peripheral units and their relationship to community care, their staffing requirements at all levels and the education of staff.

Many agencies are already involved, some providing prostheses made by local craftsmen using indigenous materials, others using components which are imported or individually made in the workshop. At least one organisation employs local manufacture of components using recycled plastic. Sockets may be made of plastic moulded over modified plaster casts, or from other materials using measurements and hand tools. One group is using computer aided design/computer aided manufacture (CAD CAM) methods to produce sockets to be associated with imported components. In other cases prefabricated sockets made in a range of sizes are used.

There is some intermingling of systems when one type of component is used in several countries matched with different fabrication methods.

Training schemes which have been inaugurated vary from the simple training of local craftsmen to structured 3 year courses based within an academic and clinical

environment producing orthopaedic technologists (mid-level professionals).

All the agencies are well intentioned ranging from the highly professional to those sincere charitable bodies which work earnestly but do not always spend their money to the greatest benefit of the patient. The contributions which they make are extremely variable and there is an almost complete failure to evaluate the outcome of their efforts.

No matter what technology is used all countries and agencies involved have to answer the same questions: how to best utilise the resources which can be made available and how to measure the outcome and effectiveness of their programmes?

The objective and the methodology

The International Society for Prosthetics and Orthotics (ISPO) has been particularly successful in publishing a series of authoritative reports on subjects as diverse as “Training and Education in Prosthetics and Orthotics for Developing Countries” and “Computer Aided Design and Manufacture”. These reports have all been based on carefully structured workshops bringing together those directly involved in the problem, and identified experts to study, debate and reach conclusions. In recent years ISPO has developed the workshop concept into that of the consensus conference.

Agencies intending to set up prosthetic programmes in developing countries need guidance as to the most suitable technologies and method of delivery of services. They require advice on adequate procedures for evaluation of such factors as effectiveness, cost, quality of fitting and durability. In short, the agencies need help in deciding what type of approach is best in different situations.

ISPO in collaboration with the United States Agency for International Development (USAID) and the World Health Organisation (WHO), attempted to meet this need by organising a consensus conference of invited experts at which the prosthetic technologies in use in developing countries were described and discussed. This provided a framework for further discussion which led to the formulation of guidance on appropriate technologies and on related areas of assessment, organisation and coordination.

The full report details the work of the conference and contains the background papers

and reports the discussion on them; it includes literature reviews on key areas of interest; it contains extensive reporting of syndicate discussions on formulated questions leading to plenary discussion; it focuses on areas of agreement and consensus conclusions. This work was the outcome of display, discussion, argument and agreement by all the major agencies in this field. The report is a valuable document in its own right. It is the Society's hope that it will form the foundation for continued dialogue among the agencies involved.

This special edition of Prosthetics and Orthotics International presents an overview of the conference providing the membership with a brief summary of the presented papers, the literature review papers and reports of

discussions and conclusions. The full report is available as indicated elsewhere in this journal. It is hoped however that this volume will adequately inform most of the members on this important aspect of the Society's work and provide an invaluable reference for all those interested in the problems of the developing world.

Organising Committee

Binks Day	England	(Task Officer)
Lloyd Feinberg	USA	
Sepp Heim	Germany	
John Hughes	Scotland	(Chairman)
Norman A. Jacobs	Scotland	
Brendan McHugh	Scotland	
Seishi Sawamura	Japan	
Melvin L. Stills	USA	

VIDEOTAPE ON TRANS-TIBIAL (Below-Knee) AMPUTATION

As an outcome of the Consensus Conference on Amputation Surgery, a videotape on Trans-Tibial amputation has been produced for ISPO by Amar Jain, consultant orthopaedic surgeon, and Worcester Videos. The videotape lasts for 18½ minutes and covers Indications, Assessment and Standard Surgical Techniques.

The videotape is available in PAL, NTSC and SECAM formats. Please state the format when ordering.

Copies of this videotape are now available at a price of USD 35 plus postage from:

ISPO
Borgervænget 5
2100 Copenhagen Ø
DENMARK

A review of the consensus conference on appropriate prosthetic technology in developing countries

H. J. B. DAY

Knutsford, Cheshire, UK

The conference

Sixty-three individuals, representing 37 agencies and units, together with 16 resource persons, accepted invitations to attend and these were joined by 15 professionals working in prosthetic units in Cambodia — making a total of 94 participants from 27 countries. Those agencies and units providing prosthetic service had been asked to present a paper describing their service provision in terms of:

- the numbers of amputees and levels of amputation fitted;
- staffing levels, including grades and training;
- fitting and prosthetic technology used;
- unit costs, durability and repairability;
- evaluation of service;
- and arrangements for transfer to local providers of service.

Others were invited to speak on component availability, assessment and evaluation of programmes and education and training.

Most participants arrived in Phnom Penh on Sunday 4th June 1995 in time to attend a welcome reception in the Cambodia Sharaton hotel attended by the US Ambassador. The conference was held in the conference centre of the National Paediatric Hospital, and was formally opened on Monday 5th June by His Excellency Dr. Hong Theme, Under Secretary of State for Social Affairs, Labour and Veterans Affairs of the Kingdom of Cambodia. Other speakers in the opening session were Mr Robert Porter, US Embassy Deputy Chief of Mission; Mr Loyd Feinberg, Manager, War Victim's Fund of USAID; Mr Joel Vanderburg,

Cambodian Office of the World Health Organisation (WHO); and Dr Seishi Sawamura, President of ISPO.

The first day continued with presentations by USAID, WHO and six of the main agencies together with a literature review of rehabilitation of the amputee. All these were discussed in plenary session.

Tuesday started and ended with syndicates considering such topics as — the factors to be considered in defining appropriate technology, or in setting up a prosthetic project, and what different features might apply in an emergency situation. In the first session the syndicates were also asked to identify topics on which they hoped the meeting would reach a consensus. In the main part of the day a further 15 presentations by agencies were heard and discussed.

Wednesday started with reports from the rapporteurs of Tuesday's syndicates followed by discussion in plenary sessions. Mid-morning the meeting divided into four groups to be taken to various facilities in the Phnom Penh area. These included the Camodia Trust facility and The National School for Prosthetics and Orthotics (NSPO), the International Committee of the Red Cross (ICRC) factory and the Foundation for the Support of the United Nations (FSUN) project, the Kien Khleang Rehabilitation Centre and the Handicap International (HI) foot factory. Everybody was able to visit each of these centres.

Thursday morning's session concentrated on components, with presentations from four manufacturers/agencies in the developing world together with an overview of components and systems manufactured in the developed world specifically for the developing world. Other

All correspondence to be addressed to Dr. Binks Day, Tithe House, Over Peover, Knutsford, Cheshire WA16 8UG, UK.

papers dealt with the possibilities of technology transfer, quality control and the use of nails as roller bearings in joints. The afternoon was devoted to syndicate work dealing with:

- the sustainability of projects;
- methods of displaying the cost of prosthetic supply;
- the definition of acceptable socket fit and any permissible compromises;
- the suitability of CAD CAM systems in the developing world;
- and the specification of acceptable durability.

Friday morning was largely devoted to evaluation, with commissioned papers on needs assessment — evaluation of projects — and medical/rehabilitation evaluation. In addition there were a number of submitted papers giving results of assessment and evaluations of various projects in Cambodia. At the end of the morning, and in the early afternoon, plenary sessions listened to, and discussed, the reports of Thursday's syndicates. Further syndicates then discussed:

- the factors to be considered in performing needs assessment;
- criteria when evaluating on-going projects;
- performance indicators/and outcome measures;
- the role of Community Based Rehabilitation.

After this a short session on education contained commissioned papers on ISPO education policy, the NSPO in Cambodia, and medical education in developing countries. It was felt by the Organising Committee that this vital subject had already been aired thoroughly in previous meetings and publications. Saturday started with the reports and discussion of two small syndicates which had examined the results of earlier syndicates in order to identify points on which a consensus could be reached.

Small groups were then chosen to consider other syndicates results in order to identify points of consensus. Meanwhile the main meeting continued with a wide ranging discussion of matters which had arisen during the conference. Finally a plenary session considered the work of the small groups.

In all some 44 papers were presented at the conference, and the remainder of this paper attempts to review these with the exception of the two literature reviews of Staats and Cummings which are re-printed in this issue of the journal.

Scale of the problem

Various estimates were given of the number of amputees in developing countries, 30,000 in Cambodia (Hong Theme), 10,000 in El Salvador (Snelson) 60,000 in Afghanistan (Berhane), and estimates for Vietnam of 200,000 (Kieffer). These figures, however, have been derived, they are estimates rather than based on factual assessments.

The American Red Cross has carried out three "needs assessment" surveys in Cambodia. These covered 17% of the population but can be extrapolated to the whole country, although the author warns that as the provinces surveyed were not in high conflict areas, the true national amputation figure is likely to be higher. The report suggests that there are some 21,200 amputees and 100,000 other handicapped people in a total population of 8.8 million (Blatti).

Cause and level of amputation

War injury has been the most common cause of amputation in those countries which have been the scene of conflict (Table 1). However the passage of time from the cessation of conflict means that the number of war injured presenting for treatment now may not be as high, except in those countries where there are large numbers of land-mines and other ordnance whose explosion continues to cause amputations. There is evidence of increasing road traffic accidents (RTA); in Hanoi compound fractures of the lower limb increased 400% from 1990 – 1991 due to the increased use of motor cycles. The number of amputees in Vietnam is increasing at the rate of 3-4% per annum since the end of the conflict (Boone). All papers showed a preponderance of amputations at the trans-tibial level, though the providers of service are quoting the levels which present to them. This may not be the same as the proportion of various levels in the amputee population.

Socket fitting and fabrication technique

The choice of fitting and fabrication technique used in a particular service or provision centre depends not only on the availability of materials but also on other factors, including the training level of the staff employed and the objectives of the organisation.

Table 1. Numbers and levels of amputation

	War	Other trauma	Disease	Trans-tibial level	Author
India		80%	20%	78%	Sethi
Cambodia	94.6%	4.5%	1.15%	66%	Alton
				77%	Nother
				75-80%	Ludowyk
Vietnam	Was 75%	RTA increased 400% 1990/91			Hansen
	Now 48%				Pomatto
Armenia	52%				Boone
Uganda		40% RTA			Feinberg
Zimbabwe	65%	25%	10%	50%	Hunter
El Salvador				77%	Madonko
Afghanistan				60%	Snelson
Yugoslavia (former)				50%	Berhane
Mexico				77%	Nummelin
					Snelson

Trans-tibial amputation

In the vast majority of service units a plaster wrap cast is taken and a modified plaster model used to fabricate a plastic patellar-tendon-bearing (PTB) socket. This requires the skill of a trained prosthetist, usually an expatriate, or a trained orthopaedic technologist (Berhane; Hansen; Hunter; Ludowyk; Madonko; Nother and others). CAD CAM in which the negative cast is digitised and a modified model produced by a computer controlled carver is in use by one provider in Vietnam (Boone), who claims that the use of a software programme to control the modification of the cast increases the productivity of the trained prosthetist, or indeed allows the use of appropriately trained technicians.

Polypropylene is the most commonly used material for socket fabrication, though laminated polyester is used in parts of Vietnam (Lamine; Pomatto) and in Zimbabwe (Madonko). Leather is preferred in some areas of China where there is high humidity (Heim).

Three methods of producing PTB sockets without casting were described, all of which were designed to satisfy particular situations.

- a) A socket may be made (as part of the shank) of aluminium sheet beaten by a trained metal worker, who repeatedly tries it on the patient (Sethi; Nagels). This method is claimed to be appropriate particularly in those countries which have a large patient load and a considerable number of skilled metal workers,
- b) Selection of the best fit by trained expatriate

prosthetists, from a range of preformed polypropylene sockets enables the first fitting of large numbers of amputees attending camps (Snelson). The whole process takes about 45 minutes and 200-250 patients are fitted during a three day camp. The intention is that appliances will be replaced by conventionally made prostheses later and that this latter programme will be sustainable.

- c) Direct forming of a thermoplastic material on the stump (Nummelin) was chosen by the Finnish Red Cross as a suitable method to fit large numbers of war victims in the former republic of Yugoslavia.

Many authors asserted that end contact in sockets is contra-indicated because the terminal soft tissue cover of many stumps was inadequate in amount or quality (Berhane; Boone; Ludowyk; Nother; Sethi). In such cases plastic sockets are deliberately lengthened to avoid such contact, and many are fitted as hard sockets without a liner (Boone; Ludowyk, Pomatto) particularly when some time has elapsed between amputation and fitting. Others preferred the use of a soft liner (Berhane; Hunter; Nother). The commonest type of suspension was by means of a thigh cuff, though most authors used polypropylene sockets in a supracondylar or patellar-tendon supracondylar (PTS) configuration for short stumps (Berhane; Nagels; Sethi).

Trans-femoral amputation

The quadrilateral socket shape is used in

almost every case, most commonly being obtained by hand casting, but sometimes by the use of brims (Hunter). The most popular socket material seems to be polypropylene often fabricated by "wrap" draping with a welded seam. The "bubble" drape method is considered to produce a stronger socket (Nother).

CAD CAM, allowing centralised socket production from measurements transmitted by fax from distant units is undergoing trial in China (Heim). Preformed quadrilateral sockets are used as part of a complete prosthetic system (Nummelin) and the metal quadrilateral socket previously used in Jaipur is being superseded by the ISNY (Icelandic-Swedish-New York) flexible type with a rigid frame (Sethi). Again most authors avoid terminal contact because of the inadequate soft tissue cover of many stumps. Suspension is usually by Silesian belt or pelvic band; self suspension, or "suction" sockets, are not common particularly when the polypropylene socket has been seam welded.

Other levels of amputation

A small number of lower limb amputees at other levels are fitted, often using imported modular components (Nother). Upper limb amputees are seldom fitted as most can manage their lives better without a prosthesis, though the value of the Krukenburg procedure was mentioned (Sethi).

Staffing

Hughes indicated that ISPO recognises four categories of worker:

- Category I is the Prosthetist/Orthotist who has had three years formal training leading to a University degree (or equivalent);
- Category II, the Orthopaedic Technologist (or equivalent term) who has had three years formal training to a lower level than that of Category I.
- Category III, Prosthetic/Orthotic Technician who has been trained on the job and is involved in construction;
- Category IV Technician who has no formal training.

The majority of those agencies which have prosthetic programmes in developing countries provide their service using expatriate Category I prosthetists together with local staff of varying levels. This works out in several ways. Cambodia Trust employs 6 Category I

expatriate prosthetists who do all the patient care backed up by 11 local category IV technicians who have had "on the job" training (Nother). Sandy Gall's Afghanistan Appeal (SGAA) takes a different course in employing 1 Category I expatriate prosthetist plus 2 local Category II orthopaedic technologists, 20 Category III and 10 Category IV technicians (Berhane).

On a much larger scale ICRC, worldwide, employs 26 expatriates (20 prosthetists, 5 physiotherapists, and 1 doctor) together with 336 local prosthetists, physiotherapists, doctors, nurses and trainees plus over 500 local technical personnel (Garachon and Gehrels).

As an example of sustainability, the service in Harare which once used expatriate prosthetists, now runs with 11 Category II orthopaedic technologists, 7 of whom were trained at the school in Tanzania (Madonko). On the other hand the CAD CAM project of the Prosthetics Outreach Foundation (POF) operates with 1 orthopaedic technologist and 3 trainees.

Prosthetic components and construction

Prosthetic feet

The prosthetic foot/ankle unit is particularly important in developing countries. It is the durability of this component which really determines the durability of the whole prosthesis.

Almost all the feet used are variations of the SACH (solid ankle cushioned heel) type, and may be locally made conventional design types (Hunter; Madonko), or imported (Boone; Nummelin; Snelson). In many cases the foot has to withstand climatic extremes, often being immersed in water, and provide a large range of dorsiflexion to allow squatting. This led to the design of the Jaipur type, which has no keel and incorporates variable density blocks and an external capsule (Sethi) and to the Handicap International foot (Simon) and the Veterans International Cambodian (VIC) foot which has short plastic keel (Nagels).

Other components

- Other components and systems include:
- the ICRC polypropylene system (Gehrels) which is used by many of the service providers (Berhanu; Hansen; Heim; Ludowyk; Nother). This system is produced by ICRC workshops in a number of countries;
 - locally made components (Berhane);

- traditional PTB shanks using wood or Pedilen (Hunter; Madonko);
- a formed metal shin as an extension of the socket (Sethi; Nagels);
- traditional metal, leather and wood methods (Lamine; Pomatto);
- locally cast aluminium alignment device (Nother);
- glass reinforced plastic pylon tubes (Snelson);
- prefabricated prosthesis kits (Nummelin);
- imported endoskeletal components designed for the project (Boone).

Three papers dealt with component manufacture in developing countries.

1. The ICRC system (Gehrels), using recycled polypropylene comprises:
 - a) the polypropylene Colombia alignment system (PPCAS) which is used to connect the socket to the foot in the trans-tibial prosthesis, and is used in the shank and above the knee in the trans-femoral prosthesis;
 - b) the Debra Zeit knee unit, for the trans-femoral prosthesis, which can be used as a "free" or as a locked knee;
 - c) the polypropylene single axis joint (PP SADA joint) which can be used for knee and hip disarticulation;
 - d) a crustacean polypropylene cosmetic cover.
2. ALIMCO in India produces a range of components for sale originally in the prosthetic centres in its own country, but it is now exporting to a number of countries in Asia, Africa and the Middle East (Kherwa). Many of these are prefabricated "set-ups" intended for incorporation in a laminated cover, though the use of laminated plastics is increasing.
3. The Shaanxi Centre in China, is not only a major supplier in China, but is now exporting components and endoskeletal systems to some countries, particularly in SE Asia (Shang).

To compare some component prices:

- the ICRC knee unit made in Ethiopia is priced at US\$ 12.3;
- ALIMCO market a knee/shin assembly with constant friction swing phase control for approximately US\$ 20;
- the Shaanxi centre quotes a price of US\$66 for a 4 bar modular knee.

A review of prosthetic components manufactured in the industrialised world for use in the developing world (Quigley) stated that some major manufacturers have now started to

develop components specifically for this market. As might be expected most of these tend to be "low tech" solutions, although one manufacturer's philosophy is to use high manufacturing and design technology to produce cheaply in quantity. Although all these components and systems are cheaper than those designed for their home market, it remains to be seen whether they can be produced at a low enough price to be suitable for the developing countries.

The whole question of technology transfer is complex. Sometimes the industrialised world sees the attraction of supplying simple prostheses using "traditional" methods and materials. Sometimes in developing countries a few centres offer "blurred Xerox copies" of the prostheses of the industrialised world to a few urban dwellers. The need is to ensure that the benefits of technology transfer reach the mute majority, and that the products should be appropriate to the culture and environment of the people, who can develop self reliance rather than suffer from over dependency (Sethi).

Durability

However and wherever components are manufactured, quality control and compliance with manufacturing standards is essential (Kherwa; Nakagawa) to ensure consistency. There is also a need for physical testing using standardised test methods and the relation between the new International Standards Organisation standard (ISO 10328: Prosthetics-structural testing of lower limb prostheses) and local standards (Nakagawa). Physical testing is necessary to avoid the unsatisfactory method of waiting to see how long a component or prosthesis lasts in amputee service. This latter can be particularly inappropriate in developing countries where the patient may live too far away from the service provider to return when a component breaks. Almost all speakers agreed that the foot was the component with the shortest life, with estimates varying from 3 - 9 months for a SACH foot (Berhane; Pomatto), 12 - 18 months for a Cambodian (HI) rubber foot (Ludowyk; Nother), to 2 - 5 years for a Jaipur foot (Berhane; Sethi)

Cost

This has to be divided into two parts, the cost of the prosthesis and the cost of transport to,

and accommodation at the fitting centre. Some presenters quoted the cost of prostheses for the trans-tibial and trans-femoral levels and these are displayed with comments in Table 2, but the absence of any standardisation in the method of calculating the costs makes it very difficult to obtain proper comparisons. This table also displays information concerning the number of prostheses fabricated per year.

The cost of transport and accommodation may be as great or greater than the prosthetic cost. The cost of travel and accommodation at Wuhan for an amputee living in Xiangfan equals 85% of the cost of a trans-femoral prosthesis (Heim). In Vietnam these costs may be more than twice that of the prosthesis (Boone). This element, usually payable by the patient, affects not only the first fitting process

but also subsequent refitting or repair.

Both authors claim that CAD CAM fitting methods reduce these costs by allowing fabrication at a distance or by providing the prosthesis more quickly. WHO has established a service in Eritrea using a main workshop with a number of satellites which are visited regularly by staff from the main shop. They cast patients and fit and deliver prostheses which are made centrally. This project is also linked with Community Based Rehabilitation (CBR) to provide a flow of information between the centre and its clients in both directions (Eklund).

Assessment and evaluation

Needs assessment

Needs assessment has to consider the medical, surgical and prosthetic/orthotic needs of an

Table 2. Prosthetic costs and production

Unit (Author) (Country)	Cost US\$ trans-tibial	Cost US\$ trans-femoral	Approx number of prostheses p.a.
AFSC (Hansen) (Cambodia)	24	32	650
ARC (Ludowyk) (Cambodia)	25	40	450
CT (Nother) (Cambodia)	37 ⁽¹⁾	34	1200
<p>In the above group the components and feet are supplied free of charge by ICRC and HI respectively. The costs are for materials and do not include labour and overheads. Nother suggests that if they were included a realistic cost would be 230 US\$.</p> <p>⁽¹⁾The CT trans-tibial prosthesis costs more because it uses a locally made alignment device and imported Plastazote for the cosmesis.</p>			
SGAA (Berhane) (Afghanistan)	35	50	2400
BRC (Hunter) (Uganda)	40	60	300
Jaipur (Sethi) (India)	30	100	3000 (1982)
WRF (van Rollegem) (Armenia)	55	—	200
Harare (Madonko)	82	185	340
<p>In this group SGAA uses mostly local materials: BRC uses some local, some imported but is changing to ICRC polypropylene technology: Jaipur claims costs are low because of the use of locally available materials and because the wage bill for the locally trained limb makers is much less than would be required by qualified prosthetists (Sethi).</p>			
Wings of Calvary (Snelson) (El Salvador)	400	600	750
FRC (Nummelin) (Yugoslavia)	520	1100	800+
<p>Wings of Calvary's fitting costs include the prosthesis and travel, lodging and food for the expatriate prosthetists, but no salary as they are volunteers (Snelson). Some of the prefabricated components of the FRC system can be reused in the permanent version</p>			
POF (Boone) (Vietnam)	—	—	1000
VVAF (Nagels) (Cambodia)	—	—	1200
WV (Pomatto) (Vietnam)	—	—	11,000 (1993)
HI (Simon) (Cambodia)	—	—	1500
ICRC (Garachon) (16 countries)	—	—	15,000 (1994)
<p>HI also is involved in a foot factory in Cambodia. ICRC manufactures polypropylene components in a number of countries. Their factory in Cambodia manufactured over 20,000 components in 1994.</p>			

area. The number needing services has to be identified by pathology, age and location (Stills). This might be fairly easy to carry out in an industrialised country but it is not easy in a developing country for such reasons as poor communications and security problems.

In one district of Cambodia whose population was estimated to be 36,000, interviewers found 3% to be impaired. This rather low figure was assumed to be due to lack of information from some 25% of the area because of security problems. Of the known cases amputation accounted for 12% of impairments (Coren-Willimzik). This means that the incidence of amputation in the population is 0.36%. Another paper describing a needs assessment carried out in another province of Cambodia suggested that the incidence of amputation could be 0.28% (Blatti). The population of Cambodia is 8.8 million (1993 UNTAC census) so the total numbers of amputees could be between 24,000 and 31,000.

The actual "needs" must be balanced against the available facilities, staffing and training (Stills). This is not always the case, as an example, only one state hospital in Panama City has prosthetic and orthotic facilities and treatment of the amputee there depends on the availability of components, so they can treat only 20% of the amputees. In another provincial hospital where 20 amputations were performed in 1994, none were fitted with prostheses (de Saez).

Programme planning

All speakers agreed (Feinberg; Heim; Stills; *et al.*) that, with the possible exception of the emergency or war situation, the intention is to initiate a sustainable operation, and therefore a partnership with the host government is necessary at the planning stage. Goals must be set, the type of technology and personnel to be employed decided and plans made for the training of local personnel. A budget must be prepared, and if necessary, a funding application must be made (Feinberg). The duration of the whole project and its sustainability has to be decided.

Interim and final evaluation

One or more interim evaluations are required, to monitor the operation and determine whether or not the programme is on course to achieve its goals, or whether changes are needed (Heim;

Stills). The final evaluation must establish whether or not the goal was met, and whether there should be a renewal or a different project. The German Agency for Technical Cooperation (GTZ) uses a goal oriented planning instrument from the start, which is designed to operate throughout the programme (Heim).

Funding agencies may not possess "in house" prosthetic expertise and therefore use independent evaluators, and it is desirable that these use a standardised evaluation protocol such as the USAID/ISPO form (Stills).

Sustainability

Any prosthetic programme can only survive the departure of the initiating agency and its funding, if its goals, technology and use of resources, both human and financial, were planned in collaboration with the host government (Feinberg). A problem can arise when more than one agency is operating using different technologies in the same country. It was interesting and encouraging to see that there is now collaboration between the various agencies providing services and training in Cambodia, extending to the use of similar technology e.g. the Handicap International (HI) foot and ICRC polypropylene components.

Outcome

Two papers were presented on "prosthetic outcome" in Cambodia. One carried out by the Coren-Willimzik for American Friends Service Committee (AFSC) interviewed 347 amputees, of whom 97% suffered amputation as a result of war, 92% from land-mine injury. Some 60% had amputations below, and 30% above the knee. At the time of interview about 80% had a prosthesis and of these 62% claimed to use their prosthesis "all the time", 18% regularly, 16% sometimes and 4% never. The paper provides considerable information about patients' occupations and their preferences for different types of prosthesis.

The basic figures are confirmed in the paper by Alton who reviewed the Cambodia Trust records of 1725 amputees. Some 94.6% were as a result of war, 90% from land-mine injury of these 66% had amputations below, and 28% above the knee. It also analysed the repair incidence (or at least those who attended for repair, a service for which there is an increasing demand).

Although these papers and that of the Prosthetics Outreach Foundation (POF) (Boone) suggested that most found their prosthesis highly desirable, Neff examined other evaluations which showed that in many cases the subjective worth of the prosthesis (as perceived by the patient) was greater than the objectively observed poor fit and condition of the device. But he also showed that as many as 30% were not worn. Hotchkiss made the point that many successful prosthetics wearers also require wheelchairs, and this is probably the best form of mobility for the bilateral transfemoral amputee in many environments

Education

NGOs and agencies employing expatriate prosthetists to provide services in developing countries can never satisfy the enormous demands (Shangali). Education and training of sufficient prosthetists and technicians in the developing countries is the only longer term solution. Such training must take into account the local needs, abilities, culture, availability, economy and the possibility of licensing or certification (Harsha). ISPO, recognising four categories of worker, appreciates that Category I training in developing countries does not exist, but considers that some supervisory personnel should be trained to this level, in order to direct the locally trained Category II technologists (Hughes). The need for local schools to train technologists who will provide the majority of clinical services was recognised many years ago. GTZ uses its fitting services to provide clinical training in the schools for orthopaedic technologists which have been set up with their collaboration in many countries (Heim). The National School of Prosthetics and Orthotics in Cambodia was set up in 1994 by the Cambodia Trust with the assistance and co-operation of other agencies working in the country and with the blessing of the Government. This is a formal three year course, with a supervised clinical placement in the final year, and there is an associated Category III training course (Harte).

Conclusion

This was an excellent conference in which many views and opinions were aired and discussed, and there is no doubt that it will prove helpful to those who provide or fund the provision of prosthetic services in developing

countries. The exchange of information must have been helpful and valuable to everyone who attended. Many agencies are so busy providing service that perhaps it is not easy for them to find time to stand back and look at what they are doing and report it.

It, is of course, inevitable and right that a conference entitled "appropriate prosthetic technology" should concentrate on prosthetic rehabilitation. However it should not be forgotten that the rehabilitation of an amputee does not begin or end with the supply of a prosthesis, and this reviewer, as a doctor specialising in amputee rehabilitation, would like to see further discussion about the rehabilitation process, and its evaluation, of the amputee as a person and member of society, including whether or not providing a prosthesis (even though correctly fitted and aligned) is necessarily the best rehabilitation. The use of techniques of "clinical audit" should not be confined to the industrialised world.

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USAID's War Victims' Fund

L. FEINBERG

USAID's War Victims Fund, Arlington, Virginia, USA

Introduction

USAID's (United States Agency for International Development) War Victims' Fund was established in 1989. Since that time AID has provided a modest amount of funds each year to respond to the needs of people injured by war and civil strife in developing countries around the world. Recently, this has amounted to approximately five million dollars per year. As the needs in any single country can far exceed the resources of the programme the Fund attempts to address the humanitarian needs of those injured, but also to complement and leverage other donor funding to establish sustainable systems which might be able to meet these needs on a long term basis.

The programme has emphasised the importance of "unassisted mobility" and especially the provision of artificial limbs to civilian victims of civil strife, because amputations, especially of the lower limb, are one of the most common and critically disabling aspect of civil conflict in the developing world.

In addition to prosthetic assistance, where feasible, a comprehensive programme of medical, surgical, orthotic, physical and vocational rehabilitation services is provided.

For the purposes of funding "war victims" have been defined to take local circumstances into account. For example, children who contract paralytic polio as a result of interrupted immunisation programmes during periods of strife, are considered to be victims as much as those who step on land-mines, during or after the period of conflict. The scope of the programme has been focused on the direct and swift response

All correspondence to be addressed to Lloyd Feinberg, USAID, Office of Health and Nutrition, 1601 North Kent Street, Room 1200, Arlington, VA22209, USA.

to the needs of physically disabled war victims.

The dilemma of the War Victims Fund (WVF) is how to strike an appropriate balance between support for direct and swift provision of prosthetic devices to as many victims as possible, and addressing the medium to long-term needs of prosthetic supply and rehabilitation. The supply of an initial prosthesis to an amputee, while critical, is not sufficient, as the victim has a life-long problem and thus a need for long-term services.

Rather than get involved with many small and geographically scattered projects, an effort has been made to focus assistance on a few countries where significant results can be expected. Wherever possible, support has been directed to the expansion, improvement and sustainability of existing programmes, since amputees and other disabled individuals require continuing, life-long access to rehabilitation services. The probability of ensuring continuation of services is increased by improving existing programmes that have a financial base, rather than by initiating new activities which are dependent on continued USAID support.

USAID has used the following guidelines in setting priorities for use of the Fund:

- Develop programmes that are country specific and provide direct services to civilians injured in civil strife. Projects of a worldwide nature are not a priority unless there are special circumstances.
- Design interventions with the purpose of providing the greatest number of war victims with the most appropriate assistance possible, with an emphasis on safety and efficacy.
- Provide priority funding to programmes that can be continued after USAID funds are no longer available and which promise a comprehensive rehabilitation system.

- Favour larger and more comprehensive programmes which would eventually develop into national rehabilitation systems having lasting results. Smaller, less ambitious projects will be considered, with the understanding that the objectives and funding levels will be lower so that management and evaluation will not be undue burdens.
 - When possible, fund programmes in countries with USAID Missions that are able to commit support and can assist with project development, management and evaluation.
 - Continue support, as needed, to projects that have already been started under the Fund, but ensure that project integrity is not compromised by undue dependency on future funding.
 - Implement projects, wherever possible and appropriate, through US PVOs and/or local NGOs.
 - Most important, provide support to projects that have the best potential to improve the quality of life of people injured in civil strife in countries where the need is greatest.
- What AID and the War Victims Fund hope to gain from this conference is a consensus on as many of the following issues as possible.
1. Guidance on assessment and programme planning for developing countries related to:
 - a) techniques and technologies;
 - b) materials;
 - c) componentry;
 - d) local manufacture versus importation;
 - e) human resource development, training, supervision and management.
 2. Requirements for emergency response, and long term development.
 3. Means of achieving collaboration, co-ordination and standardisation within countries, which will allow for responsible innovation but which also ensures maximal utilisation of scarce human, material and financial resources.
 4. Means of encouraging joint, and/or collaborative planning of various donors, and the development of complementary interventions by host government, NGOs and, where appropriate, private providers.
 5. Methods of supporting and facilitating the development of community based initiatives for the long term care of the disabled and to protect their rights. "Community" in this context, refers to both a geographically defined community and to the "disabled community" at local, district and national levels.

Table 1. USAID's War Victims' Fund
1989-1994

	1989	1990	1991	1992	1993	1994	TOTAL (\$1,000)
Afghanistan		420					420
Angola			596				596
Armenia					318	830	1,148
Cambodia				830	202	575	1,607
El Salvador	900					1,000	1,900
Ethopia			1,235	1,000	730		2,965
Laos		860		500			1,360
Lebanon			2,173				2,173
Liberia						1,115	1,115
Mali				120			120
Mozambique	2,500	1,000		1,000	1,000		5,530
Red Cross		644					644
Sri Lanka			420				420
Uganda	1,807	600	225	250	500		3,382
Vietnam			1,350	1,000	2,250	980	5,580
Planning/Evaluation	85	250	150	275		500	1,260
TOTAL	5,322	3,774	6,149	4,975	5,000	5,000	30,220

War Victims Funds have been committed to programme activities in fourteen countries, from 1989 through 1994. Slightly more than \$30 million was committed in these years, with about 4% used for planning and evaluation. The number of countries funded in one year has ranged from four to seven. Total funding for a country ranges from \$5.5 million for Mozambique to \$120,000 for Mali. The Agency has assigned one person to administer the programme from the Office of Health in Washington, referred to in this report as the WVF Manager. The legislation includes a "notwithstanding" clause which exempts the Fund from other restrictions in the Foreign Assistance Act.

The programme is far flung and it is difficult to get good and comparable statistics. Even so it is possible to make some estimates of what is being accomplished. Probably the best indicator is the number of prostheses fitted to individuals over a year. Using the data that is available, at least 20,000 limbs are made and fitted over an average twelve month period. In addition thousands of medical professionals and technicians that have received training that has, and will continue to, improve the help they provide to disabled people.

War Victims Funds in fiscal year 1995 will be used in Angola, Laos, Mozambique, Sri Lanka, Uganda and Vietnam.

What follows is a summary of activities in each country where the WVF has provided assistance. This includes the name of the organisation that the funds were granted to, the amount of the grant, the duration of the grant, the objective of the project and some indications of accomplishments. The countries where the War Victims Fund has provided technical assistance and considered significant projects, but where a decision not to proceed was made, also need to be mentioned. These are: Eritrea, the former Yugoslavia, Honduras, Nicaragua, Peru, Rwanda and Somalia.

USAID's War Victims Fund: description of activities: June 1995

Afghanistan

American National Red Cross (ANRC), 1993-1994, \$200,000. The ANRC contributed funds from their agreement with USAID/Washington to ICRC for renovations in Jalalabad Hospital. This hospital is the primary source of

orthopaedic surgery and care for land-mine victims in eastern Afghanistan.

Handicap International (HI), 1990-1992, \$420,000. HI established four prosthetic rehabilitation centres attached to NGO hospitals inside Afghanistan. The grant provided funds for construction, equipment and supplies for the centres and training of the staff of each centre. Each centre makes canes, crutches, trans-femoral and trans-tibial prostheses. During their first year of operation these workshops produced 58 limbs and 350 pairs of crutches.

Angola

American National Red Cross (ANRC), 1991-1992, \$58,000. The ANRC sent an American prosthetist/orthotist to work with ICRC at one of its orthopaedic centres for 12 months. He made orthopaedic devices and trained Angolan technicians.

International Committee of the Red Cross (ICRC), 1991, \$596,000. Funds were used for equipment and supplies needed for the ICRC's prosthetic programme in Angola. In 1991 ICRC's workshops in Angola made 1,406 limbs, 6 braces, 1,024 pairs of crutches and 16 wheelchairs.

Armenia

World Rehabilitation Fund (WRF), 1993-1995, \$1,078,000. The WRF opened a prosthetic workshop in the capital of Armenia in 1990 in response to the devastating earthquake. Beginning in 1993 funding for this workshop was provided from the WVF. The reason was that the disabled people coming to the workshop were no longer earthquake victims, but were victims of Armenia's civil war. An American prosthetist is working at the workshop, training local people to take over his role. To make sure that the workshop remains open after the end of USAID support the WRF has successfully reduced the cost of making a trans-tibial prosthesis by 65% and is developing mechanisms to generate cash through the sale of prostheses. During April-June 1994 the workshop produced 122 prostheses and orthoses. Some 52% of these patients were war victims, mostly from anti-personal mines. Since the project's start in 1990 through December 1994 the workshop has fitted 1,445 prosthetic/orthotic devices and had over 11,000 patient contacts (physical therapy, gait training, exercises, stump care).

United Methodist Committee on Relief, 1994-1995, \$70,000. Funds are to bring approximately 60 women who were raped and mutilated during the civil war within Soviet Georgia to the plastic surgery unit in Yerevan, Armenia for reconstructive surgery.

Cambodia

American National Red Cross (ANRC), 1992-1993, \$118,000. Funds provided to ICRC were used for the construction of two buildings at the ICRC's centre in Battambang. This centre produces the component parts that are used by most groups making prostheses in Cambodia.

Vietnam Veterans of America Foundation (VVAF), 1992-ongoing, \$1,637,000. The VVAF independently began a project in Phnom Pehn that provides medical services to displaced families, helped people (and their families) with multiple disabilities find housing and work and made artificial limbs for amputees using the Jaipur prosthetic technology from India. In 1992 the WVF began supporting this project. This support allowed VVAF to train more prosthetic technicians, greatly expand prosthetic production and begin the only workshop in Cambodia that makes wheelchairs. In an average month in 1993 VVAF's workshop is making 140 limbs, several braces and 30 wheelchairs. Output has increased dramatically, from 150 limbs in 1992 to 1,221 in 1994. Wheelchair production went from 169 in 1993 to 336 in 1994.

El Salvador

World Rehabilitation Fund (WRF), 1994-ongoing, \$1,000,000. The USAID Mission in El Salvador has been involved with providing prosthetics and reconstructive surgery for victims of the civil war for a number of years. Over \$5 million of Mission funds have been used for these purposes. Together with the WVF, the Mission planned a new project involving a large grant to one organisation (WRF won the competition). This group will in turn give smaller grants to local groups providing rehabilitation services that include surgery, prosthetic and orthotic and vocational rehabilitation. The WVF contributed \$1 million to this \$3.8 million project.

Ethiopia

Handicap International (HI), 1993, \$115,400. Support of rehabilitation and orthotic

services for disabled persons (primarily refugees from Somalia) in Hartesheik Refugee Camp and surrounding areas.

International Committee of the Red Cross (ICRC), 1991-1994, \$1,650,000. WVF support has been used for supplies and equipment that allowed the four prosthetics/orthotics workshops that ICRC supports to make more legs than they would have otherwise. USAID support also allowed the opening of a fifth prosthetics/orthotics workshop. A month's production at the four workshops was approximately 100 prostheses.

International Labour Organisation (ILO), 1993, \$472,500. This \$1 million project was to re-integrate disabled war victims into broader society through vocational training and job creation. It was jointly funded by USAID and the Government of the Netherlands. ILO ran into problems starting the project and after several unsuccessful attempts to resolve the problems ILO returned the funds to USAID.

Medecins du Monde, 1992-1994, \$651,750. With USAID support Medecins du Monde:

- brought specialists in maxillo-facial, orthopaedic and plastic surgery to Ethiopia to work with disabled people whose injuries could not be resolved by local surgeons;
- renovated orthopaedic wards and surgical facilities in hospitals;
- improved teaching in the Department of Orthopaedic Surgery at Ethiopia's Medical School;
- ran outreach clinics from the Department of Orthopaedic Surgery;
- provided orthopaedic training to paramedical personnel in regional hospitals.

USAID Project Management, 1992-1994, \$75,350. USAID hired a full-time physician who managed the WVF grants.

Laos

World Vision Relief and Development (WVRD), 1990-ongoing, \$1,360,000. Given the extreme difficulty of delivering prostheses in rural Laos, where the need was, WVRD's project took a different tack. A first phase focused on upgrading orthopaedic surgery. Next WVRD helped the National Rehabilitation Centre (NRC) improve prosthetic production with training, supplies and equipment. The NRC also began working on outreach and started making wheelchairs. Since the

beginning, the greatest effort has gone into small income generating projects in rural communities where there were large numbers of amputees. The rationale was that the disabled could best be helped by providing employment. Efforts have ranged from the introduction of improved strains of cattle through a "cattle bank" (864 cattle distributed to almost 300 families in 6 communities - cattle have increased in number by almost 100 in first year) to raising produce for sale in urban areas (2.5 tons of garlic was harvested in 1994). A final component of this project has been mine awareness campaigns.

As a result of a 1994 evaluation, it was decided that WVRD would now focus entirely on prosthetics, especially outreach. Technicians from the Prosthetic Foundation of Thailand set up shop in rural areas of Laos and make legs on the spot. In the first round, 40 technicians fit 112 limbs in one week. Production at the NRC still has along way to go, but it is increasing. During April-June 1994, 38 legs were made, from October-December 1994, 71 were made.

Lebanon

World Rehabilitation Fund (WRF), 1991-ongoing, \$2,173,500. The WRF is supporting a long term effort by the WRF to improve the practice of prosthetics and orthotics in Lebanon with the expectation that it will again become the best in the region. The first phase of the project was training a new cadre of 26 professional prosthetists/orthotists at the American University of Beirut. They will be the backbone of the system for the next 20-30 years.

The second part of the project is focused on insuring the NGO workshops that these technicians return to function well, that civilian war victims have access to them, and that a system to monitor the quality of practice be one function of a professional prosthetist/orthotist association that will be started with WRF's help.

Liberia

UNICEF, 1991-ongoing, \$1,115,000. Liberia has been devastated by its civil war with thousands of civilians killed and disabled. There are few groups capable of providing rehabilitation services in Liberia and there is only a small USAID mission with limited management capability. Through this grant

UNICEF will help two groups that are providing rehabilitation (primarily prosthetics and orthotics). These are the Benedict Menni Rehabilitation Centre for Children in Monrovia and the Ganta Methodist Hospital in rural eastern Liberia. Both efforts involve training, equipment and supplies that together will improve quality and increase production of prosthetics and orthotics.

Mali

World Vision Relief and Development (WVRD), 1990-1994, \$120,000. The government of Mali asked the US Embassy to help with the treatment of people disabled in rioting in 1992. Rather than send just one person to the US for treatment, the WVF provided a grant to WVRD. This grant provided immediate help to many and improved the practice of physical therapy in Mali. WVRD provided the services of two physical therapists (PTs) for two years. The PTs worked with patients in the major hospital, trained practising PTs and helped revise the curriculum and train new PTs.

Mozambique

American National Red Cross (ANRC), 1992, \$15,000. Through a grant from USAID/Washington the ANRC sent ICRC equipment and supplies so they could include upper limb prostheses in their training of prosthetics technicians.

Health Volunteers Overseas (HVO), 1989-1993, \$883,200. HVO took on the job of improving the standard of orthopaedic surgery in Mozambique. A resident American surgeon trained local surgeons. Training was also conducted for surgical technicians, nurses and physical therapists.

Handicap International (HI), 1989-ongoing, \$1,385,000. HI is contributing to the rehabilitation manpower pool by training 30 physical therapy assistants and 20 orthopaedic technicians. HI also runs orthopaedic workshops, hostels and vocational training centres at five sites. HI's production figures for an average year are: prostheses (109), braces (75), crutches (2,000) and wheelchairs (16).

International Committee of the Red Cross (ICRC), 1989-ongoing, \$1,525,000. The WVF helped ICRC expand production in the four workshops they operate. Total production of

limbs at these sites were: 1990 (784), 1991 (898), 1992 (1,027), 1993 (696, January-August). The WVF funded the training of a new group of 23 technicians that graduated in April 1993 and were certified by the International Society for Prosthetics and Orthotics.

Save the Children Federation (SCF), 1990-ongoing, \$1,241,000. At several of the prosthetic workshops in Mozambique productivity is only limited by the scarcity of adequate living accommodation for amputees who have come in for treatment. SCF took on the job of building hostels in Maputo, Beira and Nampula.

USAID Project Management, 1989-ongoing, \$495,000. Funds have been used for evaluations, technical assistance, surveys, audits and for hiring, on a long term basis, local professionals to manage the project.

Sri Lanka

Friend in Need Society (FINS), 1991-1994, \$420,000. The grant to the FINS has allowed them to expand production in its four orthopaedic workshops. Technical assistance provided by USAID/Washington has introduced new technologies that have improved the quality and reduced the cost of the limbs and braces the FINS makes. Over the first two years of this grant the FINS made: 2,381 legs, 113 arms, 162 wheelchairs, 89 tricycles and over 617 braces.

Uganda

British Red Cross Society (BRCS), 1989-1994, \$610,000. The BRCS was working with the orthopaedic workshop in Kampala, the only source for prosthetics, orthotics, wheelchairs and other orthopaedic devices in Uganda. The production of these items was far below what was needed. For example in 1989 they made 6 prostheses and 12 orthoses per month (1993 figures show the workshop produced on a monthly basis 15 limbs, 80 braces and 40 wheelchairs). With the added support the BRCS renovated a building that is used as a hostel for patients coming to town for help (run by the Uganda Red Cross). The BRCS also took on training a new group of prosthetics/orthotics technicians as most of the current technicians making limbs and braces are close to retirement age. The first group graduates in September 1995. Some of these graduates will staff three

prosthetics/orthotics workshops which will be opened in up-country hospitals with the WVF's assistance.

Health Volunteers Overseas (HVO), 1989-ongoing, \$1,000,000. Late in 1989 a sub-group of HVO, Orthopaedics Overseas took on the task of improving orthopaedic surgery in Uganda. Initially this involved training 40 Ugandan surgeons in orthopaedic surgery. To ensure a continued supply of qualified surgeons. HVO established a postgraduate masters degree programme in orthopaedic surgery. HVO has also trained medical students, nurses and orthopaedic assistants who handle orthopaedic problems including surgery in up-country hospitals. Besides all the training, HVO has had an orthopaedic surgeon on site since the project began. The operating room that HVO renovated has been the site for over 3,500 operations performed by the HVO surgeon, HVO volunteers and Ugandan students.

Without USAID assistance, another of HVO's sub-groups, Anaesthesia Overseas has started a training programme in this discipline at the Medical School. Internal Medicine Overseas and Paediatrics Overseas plan to begin programmes in Uganda within the next year.

Vietnam

Health Volunteers Overseas (HVO), 1992-ongoing, \$750,000. Teams of volunteer US experts hold week long training seminars on various aspect of clinical rehabilitation. The seminars are held consecutively in the south and in the north. Some of the topics have been: trauma surgery, prosthetics, spinal cord injury, rehabilitation nursing and head injury.

Prosthetic Research Foundation (PRF), 1991-ongoing, \$775,000+. The PRF set up the first computerised prosthetic workshop in developing country in Hanoi. The limiting factor in production with this system is funds for component parts. The WVF has provided funds for these components thus allowing the PRF to at least double its anticipated production of limbs. PRF's workshop is producing over 1,000 limbs of very high quality per year. They are also running outreach programmes so people far outside of Hanoi have access to their limbs.

Vietnam Assistance for the Handicapped (VNAH), 1992-ongoing, \$1,250,000. VNAH is working with the orthopaedic centre in Can Tho and opened a new centre in a suburb of Ho Chi

Table 2. How War Victims' Fund money was used in Vietnam

	1991	1992	1993	1994	TOTAL (\$1,000)
Prosthetic Research Foundation	275		500		775
World Vision	1,075		1,000		2,075
Vietnam Assistance to Handicapped		250	750	250	1,250
Health Volunteers Overseas		750			750
Vietnam Veterans of America				730	730
TOTAL	1,350	1,000	2,250	980	5,580

Minh City. They are providing training and have a unique system of contracting for the production of limbs at these orthopaedic centres. VNAH also sponsors outreach programs from the two centres. From the start of their project, through March 1995, VNAH has delivered 13,000 limbs and 682 wheelchairs.

Vietnam Veterans of American Foundation (VAAF), 1994-ongoing, \$730,000. VAAF is introducing the use of modern techniques of brace making at teaching hospital in Hanoi. This technology is of higher quality and less cost than the old metal braces. If successful it will be replicated in other orthopaedic centres in Vietnam.

World Vision Relief and Development (WVRD), 1991-ongoing, \$2,075,000. Prior to receiving support from the WVF, WVRD was working with the orthopaedic centre in Da Nang. WVF support allowed WVRD to work with three additional centres, establish outreach programmes and begin a programme of training and general improvements that has increased production at each centre by 10% each year and improved the quality of the legs being made. During the first three months in 1994 the four orthopaedic workshops the WVRD works in produce 1,124 legs, 269 arms, 206 braces and 761 pairs of orthopaedic shoes. Total production of prostheses and orthoses during 1994 in the four centres was 7,713.



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Report on ICRC technical orthopaedic programme for war disabled

A. GARACHON

International Committee of the Red Cross, Geneva, Switzerland

Introduction

In 1994, the International Committee of the Red Cross (ICRC) had been engaged in sixteen countries on behalf of war amputees and other disabled. Among these countries, three new programmes have started in Iraq, Georgia and Azerbaijan. Whereas the programme of Colombia has been completed at the end of the year and handed over to the ICRC counterpart.

During the year, 14,986 prostheses and orthoses have been manufactured for 10,221 disabled. A large majority of these disabled have been injured by mines.

ICRC orthopaedic programmes as at December 1994

COLOMBIA: Santa Fé de Bogotá

Beginning of the programme: 1992

After almost three years of collaboration with the foundation CIREC (Cirugía Reconstructiva), the management of the fabrication of local components has been handed over to our counterpart at the end of December 1994. After the establishment of locally made components during the first year introducing the use of polypropylene (PP) in lower limb prostheses, the second phase of the programme during 1993 has seen the development of this technology. Improving the component production, quality and quantity, giving short training courses, increasing the number of amputees fitted with the polypropylene prostheses, preparing the technical handing over together with the promotion of this technology in Latin America, were the principal activities in 1994.

All correspondence to be addressed to Alain Garachon, International Committee of the Red Cross, 19 Avenue de la Paix, CH1202 Geneva, Switzerland.

A technical development started at the end of 1993 has been continued throughout this year by the use of a machine to inject the polypropylene and the fabrication of aluminium moulds in the workshop. This technique has been used for more than one year and has proved to be efficient regarding productivity (quantity, quality and ease of training). More low cost moulds made of epoxy resin or aluminium were and are still fabricated in order to raise the standard of all parts necessary in the fabrication of prostheses.

An important improvement in the appearance of the prostheses has been the use of coloured polypropylene sheets since July. The white colour of the prostheses provoked much criticism and complaints. The components are injected with the waste of these sheets after being ground up in a specialised workshop at a very low cost: 100 pesos per kilo (820 pesos = 1 US Dollar). The purchase of a more sophisticated injecting machine together with a grinder mill is foreseen by CIREC in 1995.

In order to promote the technology used in CIREC, the Regional Committee of Rehabilitation in Medellin and the workshop of Managua were visited. A short training course (7-18 February 1994) was run for two technicians, one from CALI and the other from the San Juan de Dios Hospital, Bogota. During the courses organised by CIREC in Bogota (6-9 September 1994) and by ISPO in Panama (14-18 November 1994), several lectures on the polypropylene technology for lower limb prostheses were given. An illustrated catalogue of the polypropylene components has been widely distributed during ISPO meetings. A visit of CIREC by doctors and an administrator from the Social Security was organised (25 October 1994) after two previous meetings in

order to gain acceptance of the technology by this administration.

In 1994, 1,014 prostheses and orthoses have been manufactured. Twenty local workers and one ICRC expatriate are working in this programme.

SUDAN: Khartoum

Beginning of the action: 1990

This programme is led in collaboration with two partners, the Ministry of Social Planning (MOSP) and the Ministry of Defence (MOD).

The main objectives defined in 1993 were: to pursue collaboration with the local partners, to involve further the local authorities in their responsibilities and organise the administration of the centre, to motivate the local staff through organised training courses and incentives in order to improve the quality and efficiency of the orthopaedic activities, to develop thermoplastic techniques in prosthetics, to prepare the next project agreement, and to participate in the maintenance of the orthopaedic centre.

Not all the objectives have been achieved. The development of the new PP foot and the training programme are to be completed in 1995. These two goals were decided during the last semester of 1994. In April, the technical director, Mr. Taycb Babiker, and the leader technician, Mr. H. Kamis of the component workshop, attended a three-week technical course at the Addis Ababa orthopaedic centre.

During this course they were introduced to the current ICRC techniques in thermoplastics and methods of recycling PP scrap. Devices for the knee-joint and tools were made for the NACPO (National Centre for Prosthetics and Orthotics) of Khartoum.

At the Centre, a short term course of six months was set up and started on 15 October 1994. The programme is designed to upgrade twelve orthopaedic technicians who have been working in the centre for at least three years. One assistant technician was included to participate in the course. Two others were selected from the orthotics and component sections. From the twelve selected, six are military (MOD) and six are civilians (MOSP). At the termination of the six month course, a Certificate of Professional Competence will be granted under the supervision of the Sudanese Association of Orthopaedic Surgeons of Khartoum and the ICRC. There are 84

employees at the Centre from the MOSP (48) and the MOD (37).

KENYA: Lokichoggio at the Sudanese border

Beginning of the programme: 1992

The Lokichoggio orthopaedic workshop is attached to the ICRC surgical hospital on behalf of war amputees from South Sudan. It is organised from the ICRC delegation in Khartoum. Nine employees are working in the Centre. One of them is a qualified Kenyan prosthetist trained in Tanzania at the German Cooperation Training Centre of Moshi. One ICRC expatriate supervises the activities. Some 1,014 prostheses have been manufactured during the year in Khartoum and Lokichoggio for the Sudanese amputees.

MOZAMBIQUE: Maputo, Beira, Quelimanc, Nampula

Beginning of the programme: 1981

After 14 years of activities, the programme is now technically completed. During this period 7,600 prostheses have been manufactured; 23 Mozambican prosthetists have obtained in 1993 a Diploma in Prosthetics Category II according to ISPO (International Society for Prosthetics and Orthotics) levels; and polypropylene technology has been mastered.

In 1994, efforts have been made to find ways of ensuring the financial management of the programme, after the ICRC withdrawal, foreseen for 1995. Two possibilities have been considered: find another organisation to replace ICRC, or hand over the programme to its partner, the Ministry of Health, which could receive funds from outside sources.

There are 85 employees in the four centres and one ICRC prosthetist.

ETHIOPIA: Addis Ababa (POC), Debre Zeit, Mekelle

Beginning of the action: 1979 in Debre Zeit, 1990 at the Prosthetic-Orthotic Centre (POC) and 1992 at Mekelle

In Ethiopia, the programme is considered to be technically completed. The Ethiopian personnel are well trained and the polypropylene technology has been implemented with good results.

Apart from the production of prostheses, the ICRC has been engaged during this period in the process of self-financing of the programmes

in order to anticipate its withdrawal in 1995. At the POC, a special grant has been created with donations from different sponsors to ensure provision of prostheses for destitute patients. The POC has also started to export orthopaedic components to other countries such as Angola, Somalia, Kenya and Eritrea.

The management of the orthopaedic workshop of Mekelle has been handed over to the authorities of Tigray.

The Debre Zeit Rehabilitation Centre continues its activities under Ethiopian management with monthly technical visits from the ICRC. The Centre receives payment for orthopaedic appliances delivered to ex-army and army personnel.

The three Centres employ 96 workers and three ICRC prosthetists. The Centres have manufactured 1,257 prostheses and orthoses.

ERITREA: Asmara

The ICRC implemented an orthopaedic programme in Asmara from 1982 to 1985 and restarted in 1992

Our partner, the Social Affairs Authority, received a new director. This improved the management of the Centre and the co-operation in general.

Regarding local staff, eight prosthetists received sponsorship from WHO to attend different upgrading courses in Tanzania (3 years and 1 year). Another course started in Keren with a German NGO, "Johaniter Unfall Hilfe". Nine workers from Asmara attended this course which was divided in three periods of 4 weeks during the year.

Some 34 workers are employed in the Centre and the ICRC maintains one prosthetist.

During the year 583 prostheses and orthoses have been manufactured.

IRAQ: Baghdad, Basrah, Najef

This action started in 1994 according to an agreement of co-operation between the Ministry of Health (MoH) and ICRC.

During 1994 two buildings belonging to the MoH were renovated by the ICRC, one in Basrah and one in Najef. In late 1994, the ICRC opened a polypropylene component workshop in Baghdad.

To improve the qualification of the Iraqi prosthetists, a series of short-term upgrading courses on lower limb prosthetics and orthotics

was run by the ICRC over a period of three months. This action is motivated by a large number of amputees, civilian and military. The rehabilitation services of the country were considerably affected during the last two conflicts and consequently, could not cope with the needs. In addition, the international embargo contributed to reduce their effectiveness.

In 1994, the ICRC concentrated its efforts on the renovation of rehabilitation structures. The production of prostheses for the amputees will start in 1995. Two ICRC prosthetists are involved in this programme.

LEBANON: Sidon, Beit-Chebab

Beginning of the programme: 1983

After 3 years of relative independence, it was decided in 1992 to assign an expatriate prosthetist to the programme to introduce the use of polypropylene in the fabrication of prostheses and orthopaedic components, and to organise a theoretical training programme for the prosthetists of both workshops.

During the year, the following objectives have been achieved:

- Replacement of all imported orthopaedic components by ICRC supplied components in polypropylene made in aluminium moulds supplied from Geneva.
- Fabrication of the sockets of prostheses in polypropylene.
- Training periods in Ethiopia for the heads of both workshops.
- Implementation of an eight month training programme in arabic for eight workers from both workshops.
- Organisation of a six week practical training for 24 students of the American University of Beirut sponsored by the World Rehabilitation Fund.
- Organisation of a six week training in fabrication of small orthoses for 12 physiotherapists and occupational therapists from "Terre des Hommes".
- Participation of the ICRC in the establishment of a price list of Ministry of Health for the different orthopaedic appliances in order to provide the Lebanese workshops with reimbursement from the Social Security.

The final examination following the training will be organised at the beginning of 1995. In 1994 both workshops manufactured 685 prostheses and orthoses. Eighteen employees

are working in Sidon and Beit-Chebab under the supervision of one ICRC prosthetist based in Damascus.

SYRIA: Damascus

This project was implemented between 1983 and 1986 on behalf of Palestinian amputees by the Swedish Red Cross with the technical participation of the ICRC.

From 1986 until 1992, the project was run by the Palestinian Red Crescent and followed technically by the ICRC through regular visits from Lebanon and the headquarters whereas the Swedish Red Cross continued to finance the material.

As in Lebanon, the ICRC prosthetist based in Damascus since 1993, had the task of developing the use of polypropylene and organising a theoretical training programme for the Palestinian prosthetists.

During 1994, the following objectives have been achieved:

- Construction of a new orthopaedic workshop in Yarmouk, a Palestinian district of Damascus. This workshop is attached to a Palestinian surgical hospital and benefited from a financial contribution of the Swedish Red Cross.
- Installation of equipment and machinery in this new workshop.
- Setting up of a fabrication unit of polypropylene orthopaedic components: knee-joints, feet, alignment systems etc.
- Introduction of polypropylene in the fabrication of the sockets of the prostheses.
- Organisation of an eight month training programme for 7 prosthetists from the workshop. The final examination is planned for the beginning of 1995.

There are eleven employees in the Centre and one ICRC prosthetist who shares his time with Lebanon. In 1994, 252 prostheses and orthoses were manufactured for Palestinian and Syrian amputees, civilians and military.

AFGHANISTAN: Kabul, Herat, Mazar-I-Shariff
Beginning of the programme: 1987 in Kabul

Throughout the year, heavy fighting affected the orthopaedic activities in Kabul. The ICRC Orthopaedic Centre of Ali Abad, built in 1991, was hit by rockets and occupied by armed forces. Although attempts were made to reactivate it during interruptions in the fighting,

a decision was taken to set up another temporary workshop in the premises of the Wazir Akbar Khan hospital to manufacture orthopaedic components and prostheses. As a matter of fact, the number of amputees is bigger than ever. To meet the needs, a monthly production of 250 should be reached. Only 204 prostheses have been manufactured during the year.

Herat and Mazar-I-Shariff have fortunately not suffered from conflicts and have consequently satisfied a large number of amputees and disabled. In 1994, both workshops manufactured 1508 prostheses and orthoses. In August, a decision was taken to open a new orthopaedic workshop in the hospital of Jalalabad. At the end of the year the construction was completed. Production of prostheses is expected to start at the beginning of 1995.

There are 124 Afghan employees in the three workshops working with three prosthetists and one physiotherapist from ICRC.

PAKISTAN: Paraplegic Centre of Peshawar
Beginning of the action: 1982

The Paraplegic Centre was built in 1982 on behalf of Afghan and Pakistani paraplegics. It has been run since then by the Pakistani Red Crescent in collaboration with the ICRC. In 1994, the financial participation of the ICRC has been reduced and consequently the number of admissions.

The main problem remains in finding local or external funds to maintain the services open to paraplegics and the quality of care. During 1994, 248 paraplegics have been admitted to the Centre. Some 169 orthoses and 206 wheelchairs have been manufactured, and 87 surgical operations were performed at the hospital. Ninety employees are working at the Centre in collaboration with an ICRC doctor specialised in paraplegia.

CAMBODIA: Phnom Penh, Battambang
Beginning of the programme: 1991

The ICRC began its orthopaedic programme in the Kingdom of Cambodia in May 1991. At this time, there were two organisations in the country, HI and AFSC, providing prostheses to amputees who were victims of anti-personnel mines. Several meetings took place concerning the development and use of a common

technology that was appropriate for the country and the geographic location of workshops. In September 1991, the ICRC took over the HI workshop in Battambang. In October 1991, ICRC, HI and AFSC signed a letter of understanding. At the same time, a five year agreement was signed between the ICRC and the Ministry of Social Affairs, Labour and Veterans Affairs.

Simultaneously, the ICRC began to produce prostheses in the Battambang Orthopaedic Centre and to make components for the prostheses in the production unit for orthopaedic components in Phnom Penh.

October 1991 also marked the beginning of the construction of a new orthopaedic centre in Battambang. The centre became operational in September 1992. In February 1993 the physiotherapy building complex was inaugurated. Two dormitories with 120 beds were inaugurated in June of the same year. One year later, in June 1994 the new production unit for orthopaedic components in Phnom Penh opened its doors. These buildings were financed by the Swiss Disaster Relief Unit (SDRU).

The estimated number of amputees in the Kingdom of Cambodia in comparison with other countries is difficult as there are no completely reliable statistical data. The following figures are based on partial information, hypothesis and extrapolation:

Cambodia	1/236 to 425 habitants
Angola	1/470
Vietnam	1/1,250
Mozambique	1/1,862
USA	1/2,200 (trauma only)

Some sources suggest up to 60,000 amputees in the country and 600 new amputations per month caused by anti-personnel mines. We believe these numbers are exaggerated. The figures we provide are based on numerous evaluations completed by different NGOs and International Organisations. We believe there are around 20,000 amputees in the country and around 100 new amputations per month. This would indicate that around 25% of victims of mine accidents are Cambodians.

Between October 1991 and March 1995 the ICRC fitted 3,380 amputees and made 4,947 prostheses:

71%	trans-tibial
26%	trans-femoral
3%	upper limb

6%	women and children
0.5%	less than 10 years old
80%	men between 18 and 40
95%	victims of anti-personnel mines

Cost

The figures below include basic material, local employees' salaries, maintenance for the building and machines, and electricity:

trans-tibial prosthesis	US\$ 53.-
trans-femoral prosthesis	US\$ 60.-
arm prosthesis	US\$ 49.- (with hook US\$ 75.-)

All prostheses, orthoses, shoes, stump socks, crutches, walkers, wheelchairs etc. are distributed free of charge to the beneficiaries. Amputees and patients, staying in the dormitories in Battambang, are fed and lodged free of charge. These people stay an average of ten days if they are trans-tibial amputees, fifteen to twenty days if trans-femoral amputees and seven to eight days if arm amputees. In the case of polio victims, the duration of the stay depends on the type of orthoses provided. Some 88 orthoses have been made and 52 polio victims fitted since October 1993. The ICRC only accepts simple cases where a follow-up for the patient can be guaranteed.

Current activities

Sixty local employees work in the Battambang workshop and thirty in the Phnom Penh workshop. The Ministry pays them a salary of US\$10-20 per month. As this is insufficient to live decently, the ICRC pays a monthly indemnity varying between US\$50-75 per month according to the qualifications of the employee.

The production unit for orthopaedic components is the only workshop of this kind in the Kingdom of Cambodia and covers the needs of the whole country. The basic material used for the prosthetic components is polypropylene, used in sheets or recycled. Stainless steel is used for orthotic components. The following components are produced: knees, ankle parts, alignment systems in aluminium, steel, stainless steel and polypropylene: wrists, crutches, walking frames, joints for orthoses etc. Some 20,287 components were manufactured in 1994 and altogether more than 200,000 various components have been produced since October 1991.

All the components are distributed free of charge to the organisations involved in fitting amputees and polio victims in Cambodia and who request them. Currently, the following organisations receive components from the ICRC: HI, AFSC, AMCROSS, VI, CT, NSPO. ICRC also provides crutches and walking frames to the hospitals in Mongkol Borei and Kantha Bopha in Phnom Penh.

In Battambang, the provision of prostheses and orthoses continues for the disabled of the North-west provinces with the components produced by Phnom Penh and the artificial feet produced by Handicap International. The treatment of the Khmer Rouge amputees has stopped because of insecurity prevailing in areas between their strongholds and Battambang.

During 1994, 1,569 prostheses and orthoses were manufactured. There are 53 employees at the Centre and three ICRC collaborators (two prosthetists and one physiotherapist).

MYANMAR: Yangon, Mandalay, Pyin oo Lwin
Beginning of the programme: 1986

During the year 1994, polypropylene technology was introduced at Mingaladon (military workshop of Yangon) and Thamaing (civilian workshop of Yangon). The other workshops have continued to produce prostheses made of wood and epoxy resin, they will use polypropylene at the beginning of 1995.

In Mandalay (civilian workshop) the previous workshop has been transferred to a new building and put under the responsibility of the General Hospital Chief Surgeon. In this action, the specific role of the ICRC is to implement a joint programme with the Myanmar Red Cross on behalf of amputees coming from the conflict areas. These patients are selected by a member of the Myanmar Red Cross and referred to Mandalay and Yangon. In 1994, 198 prostheses were manufactured for this category of patient. The whole programme is due to be completed in 1995.

There are 99 employees working in this programme with the assistance of two ICRC prosthetists. Some 1,981 prostheses and orthoses have been produced during the year.

VIETNAM: Ho Chi Minh Ville
Beginning of the programme: 1988

In 1994 the last co-operation agreement was signed between the ICRC and its counterpart, the Ministry of Labour, Invalids and Social Affairs (MOLISA). The two main goals of the contract were the provision of prostheses to the destitute amputees and the preparation for the ICRC's withdrawal from the country.

The workshop of the Ho Chi Minh Ville Rehabilitation Centre has achieved a good production amounting to a yearly total of 3,345 prostheses or a monthly average of 280. Though the quality of the prostheses has still to be improved, these figures show in general that the transfer to polypropylene technology has been fruitful and destitute amputees, among others, have benefited from it.

The technology transfer can be considered as completed by the end of 1994. The whole production process is now entirely the Centre's responsibility. The use of polypropylene is spreading over the country to other centres and other organisations operating in the field of prosthetics. In November, three workers from Quy Nhon Centre and two from Da Nang Centre came to Ho Chi Minh Centre for a training course of four weeks with World Vision's financial help. Another course is planned to take place in February 1995 for workers coming from Ba Vi Centre, an orthopaedic centre located in the North and supported by the German Agency for Technical Co-operation (GTZ). It is also worth mentioning that one of our expatriate technicians was invited by GTZ to its training workshop in Wuhan (China) for a one-week technical demonstration of polypropylene technology. With the change to polypropylene, a substantial contribution was made to the national Vietnamese ability to take care of future prosthetic production as the ICRC centre is the only place where polypropylene technology is mastered in Vietnam.

On 31 December 1994, the total number of registered destitute amputees (since April 1992, starting date of registration) reached 8,608 among which 3,797 have been fitted with prostheses and 173 provided with wheelchairs by the ICRC project. Some 4,600 patients are still to be fitted. As no new information campaigns have been launched, registration has decreased to about 30 amputees per month. However, we should bear in mind that a large number of amputees still remain out of ICRC's

reach in remote areas within the eleven provinces of the project and a survey has shown that the local population of amputees would amount to over 23,000 people.

There are 27 employees in the Centre and two ICRC prosthetists.

AZERBAIJAN: Baku

In February 1994, two ICRC orthopaedic experts made a survey in order to evaluate the situation of the disabled (particularly amputees) in the Caucasus countries. In Azerbaijan, the survey concluded that there are approximately 9,000 amputees who are unable to benefit from reliable services, and if the ICRC decides to implement an action for them, an involvement of a minimum of five years should be considered.

In June 1994, the ICRC decided to start a programme in the Caucasus (Baku, Tbilissi and Gagra in Abkhazia). In August 1994, two ICRC prosthetists arrived in Baku in order to initiate the negotiations with the authorities and start work. A workshop was put at the disposal of the ICRC. It is located in an old rehabilitation centre which had been abandoned. The different parts of the workshop have an approximate area of 630m². Renovation has started and installation of equipment is planned for early 1995.

At the end of the year, a co-operation agreement has been signed between the ICRC and the Ministry of Labour and Social Protection (MOLASP) which appointed a head of project.

There are three ICRC prosthetists involved in this project.

GEORGIA: Tbilissi, Gagra

Following the survey in the Caucasus countries (mentioned above), the orthopaedic project in Georgia started in July 1994 with the arrival of two ICRC prosthetists. Its aim is to set up two orthopaedic centres, one in Tbilissi and one in Gagra (Abkhazia), for the amputee victims of the conflict.

In Tbilissi:

- A workshop has been put at the disposal of the ICRC in the Science Institute of Orthopaedics and Traumatology. The work of renovation has started at the end of the year. The Institute has provided accommodation for the patients within its premises.

- In December 1994, the Ministry of Health (MoH) and the ICRC have signed a co-operation agreement to define the tasks of both parties.
 - The MoH has assigned six employees to the workshop and the ICRC has recruited three field officers.
 - The fabrication of prosthetic components has started with the assistance of the technical coordinator from Geneva. A special thermoformable plastic (co-polymer of 80% polypropylene and 20% polyethylene) has been selected to resist low temperatures.
 - Production of prostheses will start in 1995.
- Two ICRC collaborators are working in this programme.

In Gagra:

- An agreement of co-operation has been signed in September between the Ministry of Health (MoH) and the ICRC.
- An orthopaedic workshop of 300m² has been set up in the Rehabilitation Centre of the town and its renovation is completed. The accommodation of the patients will be provided by the administration of the Rehabilitation Centre.
- Six employees have been assigned to the programme by the MoH. They work in collaboration with two ICRC prosthetists. A practical training has already started for these employees.

The Special ICRC Fund for the Disabled

The aim of the Fund is to develop rehabilitation activities on behalf of disabled in countries where the ICRC criteria are not applied.

For this purpose it has been decided to use the "Prosthetic-Orthotic Centre" (POC) of Addis Ababa to organise technical courses for prosthetists from developing countries. The courses, of a duration of approximately 4 weeks, concentrate on the use of polypropylene for the manufacture of prostheses and prosthetic components: knees, feet, etc. In addition to the courses, the ICRC provides the respective workshops of the trainees with the necessary equipment to put into practice what they have learnt in Addis Ababa. This equipment includes special ovens, moulds, welding apparatus, etc. These expenses are covered by the Fund.

In 1994, 26 prosthetists spent between two and five weeks at the training course

Table 1. Local personnel

Countries	Prosthetists, physiotherapists, nurses, trainees, doctors	Technical personnel, general services	Total
Mozambique	29	49	78
Ethiopia	20	76	96
Eritrea	5	29	34
Sudan	20	64	84
Kenya	7	2	9
Colombia	12	32	44
Afghanistan	40	84	124
Pakistan	54	36	90
Iraq	8	19	27
Vietnam	13	14	27
Cambodia	27	33	60
Myanmar	59	46	105
Syria	7	4	11
Lebanon	13	8	21
Georgia	12	5	17
Azerbaijan	10	2	12
TOTAL	336	503	839

department of the POC. They came from Ethiopia, Eritrea, Lebanon, Nigeria, Uganda, Chad, Sri Lanka, Somalia, Angola, Sudan and Zambia. No training can be efficient if follow up is not organised. Once back in their professional environment, the trainees face specific problems which cannot be foreseen during the courses in Addis Abada. In consequence, technical visits to centres which sent trainees to the POC and which received equipment, is seen as an essential activity for 1995. These visits will also be financed by the Fund.

Technical developments

During the year improvements have been made in the fabrication of the polypropylene components and of the corresponding moulds:

- A new polypropylene foot has been developed and tested in Ethiopia, the ASB foot (Addis Spring Blade).
- A new and more precise knee mould has been made in Geneva using a better quality of aluminium.
- A new version of the alignment device (PPCAS) which gives a better access to the central nut has been produced.

Personnel

At the end of the year, the ICRC had a total of 26 personnel from ten different countries in the programmes:

- 20 prosthetists
- 5 physiotherapists
- 1 medical doctor

A further 839 local personnel were used as outlined in Table 1.

Activities foreseen for 1995

- Restart the orthopaedic programme in Angola. A first programme based in Huambo was launched in 1979 and had to stop in 1992 because of the conflict which affected the country in 1992 and 1993.
- Organise the final examinations in Lebanon, Syria and Sudan.
- Develop the use of polypropylene components in Afghanistan.
- Hand over the programme in Myanmar to the ICRC counterparts.
- Organise technical visits to former ICRC programmes which have been handed over such as: Colombia, Chad, Lebanon, Syria and also to the rehabilitation centres which have sent trainees to Addis Ababa Training Centre.

The work of GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit GmbH)

S. HEIM

Chicot, Wuhan, Peoples Republic of China

GTZ is an implementing agency which operates within the development policy formulated by its owner, the German Federal Government. It was set up in 1975 to improve the state of human existence in the developing world. It has a general agreement with the German Federal Ministry for Economic Cooperation and Development (BMZ) under which it was assigned responsibility for implementing technical cooperation activities, in partnership with other governments and international organisations. In addition it supports development on behalf of other German government departments. The GTZ operates on a public benefit basis. Any surplus generated is used for purposes related to development.

The GTZ operates in more than 120 countries, with experts and management personnel working in administration and project service offices as well as in the projects themselves. It has three decades of experience in tailoring solutions to the specific problems in partner countries.

GTZ services include:

- providing advice to organisations in partner countries on the planning, implementation and assessment of their projects and programmes;
- selecting, preparing and assigning expert personnel and attending to their professional and personal welfare during their period of assignment;
- planning and implementing project oriented training and upgrading measures;

- specification planning and procurement of materials and equipment for the projects;
- granting non repayable financial contributions from technical cooperation funds.

It is important not to be over ambitious when working with partner governments in planning projects and defining objectives. GTZ has developed appropriate joint planning instruments, starting with the general orientation phase. This offers partner countries planning advice to assist them in designing a realistic project. The ZOPP (objectives oriented project planning) system has been integrated into a management concept. Similarly, participative methods of data collection and evaluation are used.

The assignment of experts must be done with care. Many local specialists in partner countries already possess sufficient expertise to develop appropriate solutions, and it is important to foster and use these skills.

The GTZ structure includes departments dealing with Finance, Management, Manpower and Commercial Affairs as well as the Planning and Development (P & E) departments which provide the professional input to the country departments which are responsible for implementing the activity in the respective countries. In the prosthetic field the Planning Department is P & E 412 — "Health, Population and Nutrition". This department, staffed by experienced, skilled professionals, has more than 25 years experience in the field of rehabilitation and technical orthopaedics for physically handicapped people. Projects have been instituted in Guyana, Tunisia, Egypt, Jordan, Togo, Tanzania, Zaire, Turkey, Pakistan, Armenia, Kazakhstan and more recently, China, Vietnam and El Salvador.

All correspondence to be addressed to Sepp Heim, Im Haggarten 5, D-78337, Öhningen 3, Germany.

Over the years the GTZ policy has shifted from direct fitting services to the expansion of projects and the development of techniques and technologies appropriate to the various countries. For this reason, GTZ devised a training system for the developing world which provides adequately trained professionals for whom there is always a need. However, other aspects of care included in the GTZ planning are:

- the concept of the clinic team;
- the need for rehabilitation on a national basis;
- the need for long term existence and survival of orthopaedic workshops;
- access to existing services for all disabled;
- cost calculation;
- staff development;
- quality assurance;
- materials and component production and supply.

There must be close collaboration with the host country, who must have the political will to succeed, if the aims of the project are to be achieved, and survival assured. GTZ's role is to support the local activity with advice and expertise.

The stages in project planning are:

- project idea;
- request for support;
- first technical evaluation;
- planning meeting of local and German experts.

The operation and planning of a GTZ project can be illustrated by an account of their involvement in China. At the request of the Chinese Government, the Federal Republic of Germany is assisting through GTZ in organising a Training Centre for Orthopaedic Technologists in Wuhan (CHICOT). Wuhan is situated on the Yangtze river and is the capital of the Hubei province whose population is 62 million.

The school is a Central Government Pilot Project intending to improve the care of physically handicapped people in several ways:

- training the mid-level qualified prosthetics and orthotics professionals;
- upgrading the 1400 self-trained prosthetics and orthotics workers to a higher level, with a final examination leading to a national certificate of competence;
- allowing more citizens access to prosthetics and orthotics services by improving the technology;
- reducing the costs for patients attending for prosthetics and orthotics treatment by providing accommodation;

- to advise the Ministry of Civil Affairs regarding prescription, quality control, team work etc;

- organising "workshops" and seminars on special fitting techniques. Hand orthoses, the orthotic treatment of paraplegia and silicone roll on sockets have been the subjects of such courses in the last year.

The four year training is based on the recommendations of ISPO and WHO. External examiners from the international community will take part in the examinations ensuring a standard in Wuhan which is consistent with that of training schools in other countries. This will enable external students to gain recognition of their training in Wuhan. The local staff will also benefit from professional contact with the external examiners.

The clinical work is central to the training. The school has a relatively large fitting and workshop area and permanent staff. It is now in the second year of operation and the workshop is treating about ten patients per week, providing:

- lower limb prosthetic services, mostly for trans-femoral amputations;
- upper limb prosthetic services;
- lower limb orthotic services for polio, stroke and paraplegia;
- spinal orthotic service, mostly for scoliosis.

At present we try to bring in cases who present fitting problems so that we can demonstrate proper techniques to other factories and centres, as well as providing clinical training for the students. The work is based on those techniques used in Germany, for example trans-femoral socket shapes used are the German socket as well as flexible techniques and some ischial containment sockets. CHICOT has produced guidelines for dynamic alignment and also a formal written record of check-out to be kept in the records.

In China there is little contact between medical services and technical fitting centres, and so there are problems associated with poor stump shape and preparation, and there is usually little possibility of stump refashioning. The school is attempting to organise training seminars for medical personnel, with so far, little improvement.

Every province in China has one central prosthetic factory usually situated in the provincial capital. Some of these factories also

produce components which result in a large number of locally produced components being available in China at reasonable cost. However, the quality of the components vary, some factories try to reach an ISO standard, but others are inferior, with no great incentive to improve as the expectation of durability of a prosthesis is fixed by the Ministry at 2-3 years.

In China, as in other countries, the majority of amputees are denied access to prosthetic fitting because:

- they have no cost carrier, and they may be unable to afford to purchase a prosthesis;
- the prosthetic fitting centres is far away with inadequate or expensive systems of transportation.

CHICOT initiated two projects to try and improve matters as part of the assignment agreed by both governments:

1. The polypropylene prosthesis, as used by ICRC in Ho Chi Minh City in Vietnam, was introduced. The rural population liked it but the urban amputees did not accept the shape nor liked the hard socket. A soft leather socket has proved more acceptable in the humid climate of Hubei Province. The use of polypropylene has resulted in a saving in cost of 10-30% against that of the Hubei steel and plastic "low cost" prosthesis. In

addition the new type follows biomechanical principles and its durability is greater.

2. To reduce the additional costs of fitting for travel and accommodation which the patient has to bear. For example, three visits from Xiangfan plus living costs in Wuhan can cost Y 1272. The price of a low cost trans-femoral prosthesis is Y 1500. By using the IPOS CASCD system we are able to fabricate the prosthesis in Wuhan from measurements taken in Xiangfan and sent by fax. The prosthesis is finished with a shaped foam cover and sent out by mail. Some 85% of the prostheses produced in this way have not required any further adjustments. The socket shape provides greater comfort than those sockets produced to individual casts taken by inexperienced craftsmen. At present we can make 5 or 6 sockets per day, and are starting a new trial supplying prostheses to the University Institute in Beijing.

This project of using CAD CAM techniques to improve socket and alignment will, if successful, reduce direct costs to patients by providing the prosthesis locally, and overcome the lack of skilled manpower.

The results of CHICOT's work will be documented and made available to all those engaged in prosthetic supply in China.

Handicap International

P. SIMON

Handicap International, Phnom Penh, Cambodia

Introduction

Although Handicap International has more than ten years experience working for and with disabled people in developing countries, we do not want to give an account of our programmes in the world, with figures or statistics, but will explain our understanding of the situation which determines the implementation of our projects.

Dynamic organisation of the situation of handicap

Let me first remind you of some useful WHO definitions and propose a dynamic organization of the concept of handicap (Fig. 1).

An **impairment** is considered as a loss or abnormality of psychological, physiological or anatomic structure or function.

A **disability** is any restriction (resulting from an impairment) or lack of ability to perform an activity in the manner or within the range considered normal.

A **handicap** is a disadvantage resulting from an impairment or disability that limits or prevents the fulfilment of a role that is normal relative to age, sex and culture factors.

A general situation, a global context determines the development of specific pathologies. Mine accidents or poliomyelitis in Cambodia, car accidents in France, etc.

These pathologies, combined with the context, will bring the patient to some kind of impairments e.g. mine accidents produce amputations. These impairments will produce a restriction of the patient's ability, described as a



Fig. 1. Dynamic organization of situation of handicap

disability. At this point, we come back to the starting point of the circle due to the fact that a combination of the disability and the context will produce a situation of handicap. We prefer to say "situation of handicap" instead of "handicap" because many factors will act to modify, in a positive or negative way, the handicap.

A situation of handicap is not a definitive state but a flexible and evolving situation.

Starting from this concept, it is clear that different actions can be taken to act positively on this situation of handicap. It is possible to act on the context to avoid pathologies:

- mine clearance operations
- mine awareness programmes
- vaccination campaigns, etc.

We can also act on the pathology to avoid an impairment; this is one of the objectives of physiotherapy treatments. Sometimes, if we pay attention to the context, we will have a better impact on the patients' situation of handicap with environmental adaptations than with "high tech" devices (David Werner's example of the donkey). Moreover, medical and rehabilitation teams should adapt their attitude and treatment according to the environment, the poor capacity

All correspondence to be addressed to Pascal Simon, Handicap International, 53 Bd Preah Sothearos, Phnom Penh, Cambodia.

of follow up, maintenance and financial resources to support lifetime treatment.

Appropriate technology

If we keep in mind that there is no short cut to progress, implementation of services by the progressive development of well adapted technologies and training of local personnel will provide part of the answer. In general, there is no simple way to provide adequate treatment for physically disabled people. It is particularly difficult in developing countries where the health system is often unable to meet the most urgent and basic needs of the population.

Within this difficult context, it is essential to determine the most appropriate means of providing durable assistance for the disabled people. It is difficult to claim that only one technical solution suits a specific situation. Considering the whole situation of a population, the general context can make us more aware of the needs of the people and the adequacy of the proposed solution based on the local absorption capacity. Sometimes a simple device, not manufactured according to academic standards, but which can be locally repaired, could have a great advantage. Only continuous research, deep consideration of the exact need of the population, critical evaluation of services, progressive implementation of services and repeated adjustment based on experience, will meet with success.

Global and comprehensive approach

Rehabilitation is a long process, and orthopaedic and assistive devices represent only a step in this process (Fig. 2).

Handicap International is always very keen not to focus only on the technology aspect of rehabilitation. The technology has to be at the service of the rehabilitation process and not the contrary.

For that reason it is important to keep a global and comprehensive approach to the rehabilitation process, hoping to achieve an improvement of the social and economical situation of the patient.

Situation in Cambodia

In Cambodia, the Ministry of Social Affairs, Labour and Veterans' Affairs is in charge of the vulnerable groups, including disabled people. The organizations working in this country have



Fig. 2. The rehabilitation process

to participate, with the Ministry, in the establishment of a National Plan to try to face the needs in the field of rehabilitation.

For Handicap International, the key points of this plan should include decentralisation of services, standardisation of technology, establishment of a logistic network, no duplication of services, long term viability, transfer of technical knowledges, management capacities and financial resources to local personnel and local authorities.

Handicap International programmes in Cambodia

Handicap International currently runs six programmes which illustrate the Handicap International wish to follow and develop the comprehensive approach mentioned herewith.

1. Six orthopaedic centres manufacturing prostheses (in six provinces).
2. Physiotherapy school (Phnom Penh and provinces)
3. Paraplegic and tetraplegic rehabilitation centre (Battambang)
4. Social and economic rehabilitation programme (in eight provinces)
5. Management support to CMAC (Phnom Penh and three provinces)
6. Training of sport teachers for disabled people (Phnom Penh and Battambang)

Orthopaedic workshops

Handicap International has been active in Cambodia since 1982 in implementing the manufacture of prosthetic devices and walking aids. The assistance programme aims to help victims of war who have lost limbs in the minefields of Cambodia, as well as other amputees and disabled people.

Handicap International has opened prosthetic workshops in 6 provinces: Takeo, Kampot, Kompong Thom, Kompong Cham, Pursat and Siem Reap, which are situated in the most mined areas of Cambodia. This programme is run in close collaboration with the Ministry of Social Affairs, Labour and Veterans Affairs, which is officially employing the prosthetic technicians. Four of these workshops are using the polypropylene technology, which will also be introduced in a fifth centre in 1995, in a way of standardisation of technology throughout Cambodia. The six workshops supervised by Handicap International are now producing, 1,500 prostheses a year altogether, as well as crutches and wheelchairs.

The primary objectives of increasing production levels and of improving the quality of prosthetic devices are being achieved through the increased deployment of expatriate staff in the provinces and through increased supplies of materials. However, professional orthotist-prosthetist expatriates are still supervising the local staff in the workshops in order to improve their skills and knowledge. Emphasis has also been placed on strengthening links between the hospitals and prosthetic workshops. Physiotherapists, trained in Phnom Penh by Handicap International, in collaboration with the Ministry of Health, and based in the provincial hospitals are currently performing the gait training in the rehabilitation centres. The number of expatriates is now decreasing. However, Handicap International plans to stay some years more until the Ministry of Social Affairs, Labour and Veterans Affairs have the capacity to take over the programme.

Foot factory in Phom Penh

In 1991, the American Friends Service Committee (AFSC), the International Committee of the Red Cross (ICRC) and Handicap

International (HI) agreed on a strategy regarding the technology, the level of training and the salary policy. This common strategy was initiated because of the opening up of the country and the arrival of several NGOs. AFSC, ICRC and HI were concerned with the need for a coherent aid policy. The Comprehension Letter signed by these three organisations resulted in the following decisions:

- AFSC is in charge of the training of prosthetic technicians (1 year training course).
- ICRC is in charge of the production of the prosthetic modular components.
- HI is in charge of the production of prosthetic feet.

Different options were considered to secure the future autonomy of the artificial foot production. A Cambodian private company based in Phnom Penh and specialised in the production of inner tubes for bicycles has been identified as the most promising appropriate option. The factory has been producing feet since 1992. Today more than 10,000 pairs of SACH feet have been provided to the majority of the agencies working in the field of prosthetic device production in Cambodia: American Friends Service Committee, American Red Cross, Cambodia Trust, the International Committee of the Red Cross, and the National School of Prosthetics and Orthotics. Handicap International has also exported the foot to Laos with World Vision International, and to Vietnam and Thailand, in the Sirindhorn National Medical Rehabilitation Centre based in Bangkok.

The foot is made in 3 sizes:

Large size:	25 cm length	800 gr weight
Medium size:	23 cm length	600 gr weight
Small size:	17 cm length	320 gr weight

The materials are available locally: recycled polypropylene and rubber from the Cambodia province of Kompong Cham. With the investment in the last two months in twelve new aluminium moulds made in Phnom Penh, a belt sander and a floor drill, the project is totally independent of any NGO. Handicap International is only the customer of the factory, however we still support and improve the project regarding the control of the quality to offer better services to the disabled people.

The rehabilitation of the amputee in the developing world: a review of the literature

T.B. STAATS

UCLA Prosthetics Education and Research, Los Angeles, USA

Introduction

For this presentation, 388 references were reviewed including journal articles, progress reports, field assessments, internal documentation, books, newspapers and magazine articles. Many of the amputee-involved organizations very graciously sent additional materials and a collection of articles was provided from RECAL at the University of Strathclyde. A general point about collecting literature on the rehabilitation of the amputee in the developing world is that search parameters should include landmines, recent wars, humanitarian programmes, leprosy, as well as amputation, prosthetics, orthotics and wheelchairs. All these areas will lead to information on the subject.

This paper is organised into seven sections including: cause and incidence of amputation in the developing world; action triggers for amputee rehabilitation; amputee rehabilitation programmes in the developing world; cultural, geographical, and economic impediments to amputee rehabilitation; rehabilitation triage; prosthetics profession culture building; and outcomes in amputee rehabilitation and prosthetics production.

The cause and incidence of amputation in the developing world

Cause of amputation

The cause of amputation in developing countries depends on their stage of development. They may be at war and in

decline, or in post-war development or at peace. In war zones and post-war zones, the greatest number of amputations result from the fighting and landmine explosions. In other countries traffic accidents and work accidents are common causes of amputation.

Landmines leave a deadly legacy that continues for decades after the war. Several publications by *Physicians for Human Rights* offer a good background on this subject as does a recently published book entitled *War of the Mines*. Many magazine and newspaper articles have been written about landmines that include brief discussions of prosthetics projects, particularly in articles about Cambodia, Vietnam and Africa (Angola, Mozambique and Uganda).

Traffic accidents result in amputation in all developing countries. The "motor-cyclification" of the developing world coupled with overloaded buses, trucks and assorted animal drawn carts, crowd inadequately maintained roads. Poor vehicle and driver safety leads to numerous accidents. The resulting injuries confront less than adequate or non-existent medical services and often end in infections and amputation. Train accidents are reported to cause 14,000 amputations per year in India. Accidents in the workplace, especially farming, cause many amputations when occupational safety is ignored.

Other causes of amputation include diseases such as leprosy and tumours and in some areas snakebites are mentioned. Amputation due to vascular disease and diabetes are not reported as important causes of amputation in most parts of the developing world. However, in Micronesia, where modernization and change of diet have increased it has led to a rise in obesity as well as

All correspondence to be addressed to Timothy Staats, UCLA Prosthetics Education and Research, Room 22-48 Rehab., 1000 Veterans Avenue, Los Angeles, CA 920024, USA.

an increase in the number of amputations. Some other tropical diseases contribute to the number of amputations in the developing world. Whereas in the modern world, infections are treated immediately, the villager in a rural developing country may go to a local medicine man who, using small cuts to relieve pain and indigenous cures, may cause infections that lead to amputation by the time the person finally reaches a hospital.

Incidence of amputation in the developing world

The numbers of amputees in the developing world are truly staggering. Vietnam is commonly reported to have 200,000 amputees; Cambodia, 36,000; Angola, 15,000; Uganda, 5,000; Mozambique, 8,000 and so on. The accuracy of these figures may be questioned since most field survey research is incomplete. However, even if one were to divide the estimated number of amputees in half, it would still represent an awesome problem of amputee rehabilitation. Reports of crowded rehabilitation centres in Vietnam, Ethiopia and Angola may confirm that amputee estimates in the developing world are low, since they rarely include comprehensive counts of amputees in rural areas.

The incidence of amputation in populations have an accepted base figure in the modern world of 1-2 amputees per 1000 people in the population for all causes combined. This includes: vascular, traumatic, tumour, disease and congenital causes of amputation. Since the cause of amputation is different and life expectancy is lower for people in developing countries than for people in the modern world, the ratio probably remains similar. However, amputations performed for traumatic injury in the developing world are significantly higher than in the modern world. Estimates of the incidence of traumatic amputation (per capita) have been reported as shown in Table 1.

Table 1. Per capita incidence of amputations from trauma

Cambodia	1 amputee per 256 people
Angola	1 amputee per 470 people
Somalia	1 amputee per 1000 people
Vietnam	1 amputee per 2500 people
USA (for comparison)	1 amputee per 22,000 people

These numbers are only estimates based on partial surveys and assumptions. They are useful for the purpose of discussion.

Action triggers for amputee rehabilitation

There are a number of factors or imperatives that initiate amputee rehabilitation programmes in the developing world. For instance, the famine in Ethiopia went unnoticed by most of the world until a television broadcast forced it in front of the world. A similar set of "action triggers" seems to apply to amputee rehabilitation.

The media and public awareness imperative

Whenever war or landmines cause large numbers of deaths and injury of civilians and soldiers, public awareness from the media attracts attention and brings humanitarian assistance. Some organizations are charter bound to attempt to enter these zones of conflict to assist the injured. As experienced international humanitarian organizations, they are able to focus personnel and resources sooner than smaller organizations. It is often reports to the media by these organizations that bring news of disasters to the rest of the world and triggers action.

The moral imperative

Governments, in war zones or post-war zones, are preoccupied with maintaining civil order and providing essential public services. In these regions medical rehabilitation in any form is a luxury, if it is available at all. It seems to be morally correct to help those who cannot help themselves. We see this in earthquake relief, in refugee assistance, and in helping handicapped people, especially the victims of war. Civilians in war zones are often left without social or medical infrastructures for first aid and primary medical care. In reality, there are many other injuries, more serious than amputation, but the amputee and prosthetic rehabilitation captures the imagination. When problems are overwhelming, it is easier to select one problem to work on than to attempt to correct the entire situation. This makes people feel they are helping and address the moral imperative.

The political imperative

The expertise and manpower required to build an amputee rehabilitation programme and to produce prosthetic devices, in volume, is a

priority that cannot be met in poor developing countries. It is often a concern of government officials responsible for the welfare of their handicapped people. They are pressured by the presence of too many amputees and other disabled people that may represent a destabilizing factor for a government whose war has continued too long. The local markets and streets become crowded with begging amputees and other disabled people. The presence of amputees without prostheses not only demonstrates the cost of war, but also the government's inability to care for its people and its wounded heroes who fought in the war.

During war, borders may be closed or access to regions denied, masking the suffering of citizens and the magnitude of problems. On the other hand, human suffering and evidence of maiming can be used as a propaganda weapon for or against a government, or to request and attract humanitarian assistance. The increased public display of severely handicapped people can trigger a government to do something. When a government's resources are drained, the needs of handicapped people may be impossible to finance. This can open international borders to offers of assistance from international humanitarian relief organizations. To address the needs of the physically handicapped war injured can therefore be a political imperative. Unfortunately, there is commonly no political imperative in low profile developing world countries.

The amputee volume imperative

As war drags on for years, the number of amputees increases and becomes an economic problem since many of these people are unable to work. In some countries the number of amputees is so great it is considered an ecological as well as economic disaster. This is the amputee volume imperative. The economy in the countryside is crippled by the inability of the population to feed and care for themselves and care for their disabled people. This causes incalculable economic disruption. In countries that are already politically unstable, unemployment and underemployment will contribute to the inability of government, a family, and the amputee to survive. When governments realize they are burdened with huge numbers of amputees as well as other disabled people, the volume imperative opens

the closed borders and increases cooperation between governments and international humanitarian relief agencies.

Amputee rehabilitation programmes in the developing world

There are many kinds of programmes for the amputee in the developing world. They may be listed in summary as follows:

1. Government run Programmes (GRP)
2. Government to Government Programmes (GGP)
3. Non-government Organizations (NCO)
4. Private Voluntary Organizations (PVO) and Religious Service Organizations (RSO)

Government run programmes are those started and run by governments usually as part of hospitals or rehabilitation centres. While many of these exist in developing countries, most were initiated with foreign aid assistance. Government to Government programmes are common during wartime. A host country, such as the USA, or the former USSR may have built facilities and trained personnel for rehabilitation projects. For instance during the Vietnam war many prosthetists in the North were trained at East Bloc centres and in the South, facilities and training were provided through the United States Agency for International Development (USAID). Many of the early amputee rehabilitation centres in the South of Vietnam were supervised by the World Rehabilitation Fund with USAID funding. Many of these facilities remain today as do the trained personnel.

In post-war eras non-governmental organizations play an important role in providing amputee rehabilitation in developing countries. These include organizations such as:

1. International Committee of the Red Cross (ICRC)
2. Operation Handicap Internationale (OHI or HI)
3. Vietnam Assistance for the Handicapped (VNAH)
4. Vietnam Veterans of America Foundation (VAAF)
5. World Rehabilitation Fund (WRF)
6. Medical Aid for El Salvador (MAES)
7. Cambodia Trust (CT)
8. Prosthetic Outreach Foundation (POF)

These organizations often receive funding for their amputee rehabilitation programmes from foreign aid sources such as the USAID War Victims Fund, Governments of Germany, Sweden, Norway and of many other countries. The World Health Organization and the United Nations will also provide financial assistance funnelled through this type of agency. Many also receive private donations and grants. Representatives from these organizations can more appropriately describe the goals and purposes of their organizations.

There is a distinction between private voluntary organizations and religious service organizations involved in amputee rehabilitation. The following have been listed for the purpose of discussion, but the distinction as to their classification will not be discussed. Some of these organizations are listed:

1. World Vision Relief and Development (WVRD)
2. American Friends Service Committee (AFSC)
3. Catholic Relief Services (CSR)
4. Wings of Calvary

There are undoubtedly many other organizations not mentioned here. Those listed were revealed in the literature and are provided as illustrations of these important groups. For instance, many countries have their own Red Cross or Red Crescent organizations that may have amputee rehabilitation programmes separate from or in conjunction with the ICRC. In many developing countries religious organizations operate medical clinics with amputee rehabilitation as one element of the service they provide.

Cultural, geographical, and economic impediments to amputee rehabilitation

Cultural impediments to amputee rehabilitation

The attitude towards the amputee in the developing world relates to the culture and social structure in each country. There may even be differences within different regions of a single country. Some examples of these attitudes include such places as Ethiopia where the concept of "alms for the poor" is part of the culture and tradition. Giving money to disabled people is considered "lending money to God" and will be taken into consideration and help

the donor upon reaching heaven. In other countries, losing a limb is part of Karma. Karma is neither good nor bad, rather fate. In personal relationships the implication for the amputee can be devastating, since they may be considered unfit to marriage due to the inability to support a family or may be considered social outcasts or bringers of bad luck.

When considering very poor rural areas, everyone in the village must work to grow enough food to survive. Anyone who cannot work, is a burden on the family and the community. In the cities, the amputee may have more difficulty finding work, since it may be thought they are taking work away from an able-bodied person. Little consideration or thought is given to what the disabled person can do because the availability of rehabilitation is so unusual. This is especially true in developing countries where unemployment is high and those who are employed make very low wages. Many beliefs and misconceptions about the amputee and other disabled people stem from a lack of knowledge and old traditions.

Some humanitarian relief projects offer community education programmes designed to show the potential of the amputee to work. The former beliefs or social customs and superstitions about disability and amputation are challenged and must be reconsidered. This change of attitudes by both the able-bodied population and the amputee has been quite effective.

Geographical impediments to amputee rehabilitation

Amputees in rural conditions rarely have the luxury of public or private transportation. Infrequently operated rural buses or riding in the back of a truck might be options, but more commonly they must simply walk. In bad weather, travel into or out of many rural areas is often impossible and dangerous.

Travel may also be hindered by the danger of landmines and traffic accidents, which represent a very real impediment to amputee rehabilitation. Without medical care in close proximity and with the nearest village a day or several days walk away, it is understandable that simple injuries can lead to amputation and severe injury and death. It is understandable why amputees in rural areas of the developing world rarely benefit or even know about

rehabilitation. A stick or a crutch or a homemade peg leg is all they may know. Furthermore, many rural people do not like to come to the cities and are afraid of them. It is common for many organizations to locate their first efforts at prosthetics rehabilitation centres in cities, only to find that people in the outer provinces will not come to the centres. Outreach programmes are attempted, either to go to the villages, or to bring the amputee to the rehabilitation centres.

Economics as an impediment to amputee rehabilitation

The rural amputee may be poor and when considering the cost of a prosthesis, which may represent a years earnings, may decide to do without. To feed the family or own a cow may be more important than owning a prosthesis. Even if the amputee finds out that it is possible to have a prosthesis, it may be beyond his comprehension that it could be free of charge. In the literature there is a report of a woman who assumed that she would have to sell her house to afford a prosthesis. In societies where annual income may be less than \$100, it is understandable how this thinking might occur. They also are not used to being served by foreigners and many rarely see a foreigner.

Rehabilitation triage

Rehabilitation triage is the decision to provide the amputee rather than other disabled people with assistance. For the prosthetist, it seems naturally important to provide prosthetic rehabilitation for the amputee in the developing world. When looking closer at the problem of disability in the developing world, other problems such as poliomyelitis, blindness, malaria, or hunger and shelter may be more important. With limited financial resources, humanitarian projects may focus on the amputee. If an organization were to try to help every disabled person who crawled into their limited facilities, they would find themselves short of funds quickly. Since results affect future funding, it is no surprise that highly visible amputee rehabilitation programmes are chosen. It is noted that in most countries orthotics problems outnumber prosthetics problems by a 10 to 1 ratio.

As an adjunct to amputee rehabilitation, many organizations provide crutches and

wheelchairs for amputees who cannot wear prostheses. It is not unusual to see other disabled people benefit from the distribution of wheelchairs. Rehabilitation triage as a concept is receiving more attention as amputee rehabilitation efforts reach maturity and the severe problems of other handicapped people are identified. Whether or not it is right or wrong it is common practice to limit activities. This same argument might be made about those who help the blind or those who work with displaced children. Why don't they make prostheses?

Prosthetics profession culture building

Building a cadre of trained amputee rehabilitation personnel is a goal of many organizations and governments. This will result in sustainable programmes after the departure of the non-governmental agencies. The concept of building a sustainable future is brought up time and again in the literature dealing with amputee rehabilitation in developing countries.

Financial realities and technological choices in amputees rehabilitation

In developing countries limited financial or personnel resources are available for amputee rehabilitation. When a country receives offers of assistance, government officials often have little or no knowledge of amputee rehabilitation or prosthetics technology. The organizations offering amputee rehabilitation may suggest a programme and prosthetics technology in which they have experience. If the organization has already developed an amputee rehabilitation programme in one country, it is likely to attempt to replicate the previous experience and activities in the new country. The government officials are presented with the credentials and prior experience, and barring the logical presentation of competing organizations and without an understanding that there are many choices, it is hard to fault the selection in this manner. The organizations, for their part, offer what they do best. Agreements are reached, programmes are started, and prostheses are manufactured.

It is hard to fault efforts to help physically disabled people in poor or war devastated countries. However, some amputee rehabilitation results have been marginal. The choice or selection of prosthetics technology is

problematic in the post-war developing world. Rather than appropriate technology criteria, it is often the prosthetics technology that is presented or available that is the technology of choice. Any measure of appropriateness in terms of culture, climate or topography are often a secondary consideration and may be based on false premises. The cost of developing these programmes, to learn how to implement the logistical elements, to import manufacturing materials, secure personnel, operate public relations campaigns to finance and maintain programme activities are all factors that cast these projects into a mould that is inherently difficult to break. In other words, choice or selection do not represent the reason that a prosthetics technology is found or used in developing countries.

Building a prosthetics professional culture

Those organizations involved in amputee rehabilitation programmes must always evaluate their efforts and constantly look for ways to improve. There have been cases where the most sophisticated prosthetics technology is introduced into a developing country without regard for the existing culture of the prosthetists. When unemployment or underemployment is a problem, building and maintaining the professional culture of the local prosthetists would seem to be more important than to experiment with new or complex technologies. Any country or agency that authorizes amputee rehabilitation must attempt to evaluate what is being offered and be willing to reject projects that do not fit into their country or to select what it thinks is best to build its rehabilitation culture. However, it is very difficult to refuse free assistance.

In Cambodia some cooperative progress has been made to standardize the amputee rehabilitation and prosthetics service. In the words of Benoit Denise of Operation Handicap International, "the idea to use one technique over another is because you want to create a network that you can develop and hand over to Cambodians when NGO's leave. It's more important to see it from this point of view than to see it in terms of a rivalry between which materials is more appropriate." This statement offered a promising new era of understanding

and cooperation among organizations doing amputee rehabilitation in the developing world.

Outcomes in amputee rehabilitation and prosthetics production

The demands on a prosthesis in the developing world are often more difficult to meet than in the modern world. One measure of success used by many organizations is the number of artificial limbs it has delivered. This reports to funding agencies and contributors that many amputees have been helped and money has been properly spent. In the case of prostheses, this is not necessarily true. What is often overlooked is the evaluation of results for the amputee in the village, far from the workshops where the limbs are manufactured. Prosthesis durability is a critical issue in appropriate technology and is often overlooked, misunderstood, or possibly accepted as a natural limitation. Solving the durability question should be a top priority in future amputee rehabilitation programmes in the developing world. In the developing world, the true measure of good amputee rehabilitation is not only good prosthetic technology and technique, but durability over a period of years. Probably an even stricter measure of durability of five to ten years in rugged outdoor living and working situations, in a variety of climates would address the true needs of the amputee living in rural conditions. This is rarely understood by modern or third world prosthetists until they visit amputees in their living and working situations.

In conclusion, the issues raised in the literature on developing country amputee rehabilitation are complex. The literature reveals a constantly changing environment and evolutionary progression to provide better prosthetics technology. The literature's weakest aspect, taken of the whole, is that it does not provide information in a form the average person would find useful.

REFERENCES

A full list of the literature reviewed in this article is given in Appendix 2 of the Report of the Consensus Conference on Appropriate Prosthetic Technology in Developing Countries.

Prosthetics in the developing world: a review of the literature

D. CUMMINGS

Texas Scottish Rite Hospital for Children, Dallas, USA

Introduction

Publications about prosthetics in the developing world reflect the multiple concerns of health care providers working in those countries. Following a RECAL search of related literature from 1961 to 1994, over 130 publications were collected and reviewed. Although each geographical region, country, province or city poses unique challenges, there is much overlap in the literature and most of these publications may be grouped into the following general categories:

key publications;
prosthetics in the developing world;
technical publications;
war-related injuries and prosthetic and orthotic issues;
paediatric prosthetic-orthotic care in developing countries.

Key publications

In the course of reviewing the literature, several publications which seemed to summarize the body of available literature were identified and used as the foundation for the outline above. These key articles also serve to highlight important recurring themes and issues throughout the literature.

In a review of prosthetics and orthotics in developing countries Sankaran (1984) introduces some general principles. These include a discussion of the types of devices and specific components tolerated in the developing world, quality of amputation surgery, cost, training, and production factors, and the need

for devices to enable patients to squat, kneel, and sit on the floor. This overview is followed by a large table listing over 500 cities around the developing world where prosthetic/orthotic centres are located, including a brief notation of the type of work performed in each centre.

Along the path to developing and implementing appropriate prosthetic/orthotic care, one must consider multiple factors. Poonekar (1992) identifies a list of prevailing factors affecting prosthetics and orthotics in India, but these could apply to much of the developing world:

1. Economic factors
2. Social factors
3. Cultural factors
4. Climatic factors
5. Locally available forms of technology
6. Time and distance constraints
7. Psychological factors
8. Materials and resources
9. Religious factors
10. Appropriate technology.

He feels that for an appliance to be appropriate in India, it must be:

1. Low cost
2. Locally available
3. Capable of manual fabrication
4. Considerate of local climate and working conditions
5. Durable
6. Simple to repair
7. Simple to process using local production capability
8. Reproducible by local personnel
9. Technically functional (not gratuitously "high-tech")

All correspondence to be addressed to Don Cummings, Texas Scottish Rite Hospital for Children, 2222 Welborn, Dallas, TX 75219, USA.

10. Biomechanically appropriate
11. As lightweight as possible
12. Adequately cosmetic
13. Psychosocially acceptable.

The establishment of prosthetic/orthotic programmes to aid developing countries is often accomplished through a profusion of governmental and non-governmental agencies. These programmes are generally of three types: 1) research programmes aided by financial support in collaboration with institutions, agencies or organizations in a developed country, 2) programmes that introduce devices or techniques into established orthotic and prosthetic centres in a particular country, and 3) programmes designed to establish centres in countries or regions where there are no organized prosthetic/orthotic programmes. In a discussion of a practical plan for such projects Peizer (1977) suggests a three-step process. First, a programme should bring together representatives of the host country and the sponsors for comprehensive planning meetings. Even at this early stage, he suggests that input from ISPO can be helpful in regard to training, evaluation, and planning. The second phase involves site visits, ideally utilizing ISPO representatives to evaluate the capabilities, personnel, equipment and other needs of the host country. In the third step, the programme is actually designed in great detail based on the information gathered during the first two stages.

Peizer feels that this approach will help avoid many common problems. He continues his discussion with a detailed explanation of how an expert teaching team should be selected and then prepared for training missions, and how the host country can benefit most from their efforts. He emphasizes that training should be provided by experienced educators who understand the conditions under which their students must practice, and that all efforts should be geared toward a technology transfer that can actually be integrated into the host country's health care system.

From a broad perspective, any approach that involves training of new prosthetists using conventional techniques faces an uphill battle. Murdoch (1990) cites conservative estimates that 3 to 4 million people in the developing world require a prosthesis, and that care for this number would require equipping and training

50,000 to 100,000 prosthetists. Proponents of CAD CAM (Computer Aided Design-Computer Aided Manufacture), suggest that by boosting efficiency and productivity of existing prosthetists, automated manufacture of prostheses combined with modular components may help diminish this shortfall. This approach is currently being tested in Hanoi, Vietnam by the Prosthetic Research Foundation (Smith *et al.*, 1992).

At the heart of most of the literature is the dilemma of how to provide and implement appropriate prosthetic/orthotic care in the developing world, where at least 80% of those needing such care are urban and rural poor who cannot afford it. There are two very different and often conflicting approaches to the problem: the "top-down" approach of buying and implementing technology packages from the west, and the simplistic approach of traditional, primitive technology. Sethi (1989) feels that something is missing from this debate:

. . . a distinction is not being made between science and technology. We are confusing expensive gadgetry with good science. This often is not so. It requires some very sophisticated thinking to arrive at a simple solution. It is much easier to work out a complicated and expensive solution. Indeed, whenever one encounters an expensive and complicated technology, one can take it that the basic issues have not been understood. Expensive *gadgetry* often possesses impressive "Symbolic Value" as opposed to "Use Value". What we want is more, and not less science in the developing world (p. 118).

He goes on to explain that the scientific approach should be used to evaluate technology being used and designed for the developing world, but that this approach is also subject to failure if it ignores the lifestyles and cultures of the patients being served. As an example, he traces the development of the Jaipur foot in India. He feels that the component's success lies in its gradual method of development which involved continuous interaction between the developers of the component, those who would fabricate it using cost-effective locally available materials, and the amputees who wore the foot

day in and day out.

Vossberg (1988), supports a similar approach when he analyzes orthotic/prosthetic techniques in Colombia. He discusses three different levels of service available in Colombia (the government-controlled workshop, the workshop supported by non-government organizations, and the private workshop), and how each is impacted by the various forms of available orthotic and prosthetic technology. He feels that appropriate technology "... ranges on an intermediate level between a stagnant, inconsistent, labour-intensive technology and an imported, capital-intensive industrial mass-scale technology" (p. 99). Unless it can be sustained and made affordable to most patients after funding and technical support are removed, the imported "high-tech" approach appears ultimately to ignore the large poor sector of the population; whereas the artisan or primitive technology approach takes a step backwards by placing the burden of practice of a highly specialized profession in the hands of "a considerable number of self-proclaimed or short-term trained technicians..." (p. 98).

In order to provide truly appropriate technology that copes with present and future demands, Vossberg (1988), lists a number of policy guidelines that should be considered:

- formulate new ideas and examine approaches, methods and techniques in the field of prosthetics and orthotics, which could best be applied in a distinct environment
- create a new type of orthopaedic technician who is able to initiate ideas for indigenous designs and detail their construction criteria to the production engineer
- replace a technology which is characterized by high costs and over-sophistication by one which is acceptable in terms of cost-benefit and effectiveness, technical appropriateness and environmental adaptability
- exchange the feasibility studies and research in the area of appropriate technology to intensify communication and cooperation among the concerned institutions (p. 100).

In a related publication about appropriate technology transfer, Vossberg (1985), lists practical principles of technical training and counselling in a developing country:

- give ample time to study and understand the social environment
- investigate traditional methods and materials

- define the programme's priority areas
- on the basis of these findings, develop indigenous appliances
- test these in conditions which are typical of the country
- specify the appliances by means of illustrations and descriptions
- propagate the philosophy of an appropriate orthopaedic technology (p. 84).

Prosthetics in the developing world

In 1976, the member countries of the World Health Organization (WHO) agreed to include rehabilitation in their goal of "Health for all by the year 2000". Because it was later stated that up to 90% of all disabled persons in developing countries were largely neglected, the organization decided on a rehabilitation model appropriate for use as a supplement for existing institution-based services in developing countries. This rehabilitation model has come to be known as community-based rehabilitation (CBR) (Mitchell *et al.*, 1989). Numerous articles surveyed dealt specifically with various aspects of CBR, and much of the literature dealing with prosthetics and orthotics in developing countries has been permeated with many of the concepts and terms originating in CBR.

Ideally, CBR services consist of three levels that interact to provide appropriate rehabilitation services:

1. Community level
 - services delivered by volunteer community workers, families of disabled persons, community agencies and organizations.
2. Intermediate level
 - personnel who have health-related, but not disability-specific backgrounds, e.g. general practitioners, nurses, midwives, teachers, social workers and auxiliary workers.
3. Specialized or tertiary level
 - specialists in rehabilitation medicine, special education, vocational rehabilitation and social services. (Periquet, 1989, p. 95).

Although there are numerous variations of CBR, all appear to have the following general principles in common:

1. Community resources from the nucleus for CBR delivery.
2. CBR is based on simplified and appropriate technology.
3. An effective referral and support system

should exist.

4. CBR should use the existing social and community infrastructure (Mitchell *et al.*, 1989, p. 145).

CBR appears to be here to stay for a while, and is generally an efficient, cost-effective approach to awareness and prevention of disabilities and to delivery of rehabilitation service, particularly in rural areas with no previous access (Periquet, 1989). This approach will undoubtedly continue to influence development of prosthetic services, training schemes, and cooperation between members of the rehabilitation team in developing countries. Some questions that remain to be answered are whether or not prosthetics and orthotics fit the CBR model, and if so, on which level of CBR service?

Although prosthetic rehabilitation is consistent with the WHO's goals, there are other reasons why even impoverished countries have a vested interest in developing prosthetic care. Staats (1993), observes three "action triggers" that create a powerful incentive for a country to address the needs of its untreated amputee population.

The first of these he calls the "media imperative" for action. The high profile nature of amputation, particularly those that are war related or that affect children, easily captures the hearts and imagination of the media, and through them, potential donors and humanitarian groups. The traumatic, disfiguring nature of amputation, followed by the positive results of prosthetic fitting are often dramatic, and carry a unique appeal for the media. As a result, virtually any sustained news coverage about disease, disaster, war or the aftermath of war includes at least visual documentation of the plight of the amputee. There can be tremendous political pressure, therefore, for a nation to address this highly visible problem.

This political pressure is the second action trigger discussed by Staats. He explains that since a government cannot afford the demoralizing impact upon its citizens of seeing its war veterans or civilian victims devoid of medical and prosthetic care, there is again tremendous pressure for a nation to provide prosthetic treatment or to accept outside help in this area. Finally, in some countries, Staats has observed that the sheer numbers of amputees are so high as to represent a political, economic

and social disaster. Hence, in addition to media and political pressure, there also exists a volume imperative for action. Staats concludes by observing that since prosthetic care will largely remain a humanitarian effort in most developing countries – meaning that most amputees will have limited access to prosthetic care during their entire life – primary goals for prostheses should be for comfort and durability.

As a developing nation begins to address the needs of its amputee population, it will often begin to discover that "a properly rehabilitated patient usually costs a government less money than a disabled person totally dependent on government support" (Stills, 1993, p. 45). Surveys of developing nations indicate that most of these nations realize that as they develop, the physical and social rehabilitation of disabled countrymen is an essential part of a modern community. But differences in the degree and quality of care between countries are often huge. The survey by Saugmann-Jensen (1959) suggests that these differences are more related to disparity in politics and financial potential, and not to differing views on whether or not prosthetic care is justified.

Political and financial differences as well as variances in climate, population distribution, transportation, communication, medical infrastructures, educational systems, and multiple other factors combine to create stark contrasts between countries' abilities to develop and provide prosthetic care. However, one common aspect of orthopaedic care in developing countries is that prosthetic centres in the capital and other large cities are largely staffed by prosthetists trained and employing techniques acquired abroad. In smaller remote communities and rural areas, most care is substandard and offered by unqualified staff (Kaphingst and Heim¹, 1985). This apparent widespread disparity can only be improved through appropriate education.

Component production is emphasized in a chapter by Kaphingst and Heim² (1985), who discuss current prosthetic education and training in the developing world. The authors conclude that because of staff shortages, large patient numbers, lack of components, and immense practical and financial challenges, prosthetists in developing countries must be very creative, and probably need *more* and not less training. They recommend that training in the developing

world should not be simplified, rather it should focus on more specific manual skills, and component production should be part of the curriculum.

In a series of three articles on the subject, Fishman (1986, 1987) describes what he feels are the three most serious challenges to appropriate prosthetic care in developing countries:

- a) the low or marginal educational status and limited potential of the individuals selected to receive the training;
- b) the corresponding role, bench-work oriented, instruction most often devoid of texts, visual aids, examinations, or trained instructors; and
- c) the consequent inability of those completing the training
 - i) to comprehend and apply the scientific (biomechanical) rationale to prosthetic-orthotic fittings, and
 - ii) to manage the logistical complexities (personnel, space, supplies, budgeting, scheduling, transportation, security, etc.) of organizing and maintaining a facility that can consistently provide prosthetic/orthotic appliances (Fishman, 1986, p. 36).

Fishman (1986) suggests a three-tiered approach to tackling these challenges; improved educational opportunities, widespread availability of locally-made components (engineers and component manufacturers should be consulted for this), and ongoing improvement of facility management techniques and basic prosthetic orthotic skills.

Numerous publications concerned with the state of prosthetics and orthotics in the developing world focus on specific challenges, statistics, demographics and clinical results in individual countries, and a few larger volumes serve as references to services in many countries. Although these each have merit, time and space do not allow an individual review.

Technical publications

Numerous technical publications were reviewed and grouped into the general categories of: 1) fabrication techniques, 2) prosthetic feet, 3) general technical aids, 4) thermoplastics, and 5) CAD CAM. A brief synopsis of each publication is included, followed by the authors' names.

Fabrication techniques

1. Detailed text on alternative techniques for design and fabrication of trans-tibial prostheses. Includes alignment, anatomy, casting, modification, sockets (leather, aluminium, resin, and wood construction), suspension systems, and fabrication of feet (including SACH and Jaipur designs). This is an excellent text for prosthetists in developing countries as well as for prosthetists wishing to learn about methods and materials used in the developing world (Alternative limbmaking, 1989).
2. Complete manual for local production of an exoskeletal single axis knee component complete with manual lock and extension assist options. Includes drawings, photographs, and schematics (Telchow and Gehrels, 1984).
3. Tilting stubbies for bilateral trans-femoral amputees to connect and interchange with their full-length prostheses (Balakrishnan, 1981).
4. Use of cane and bamboo as alternative construction materials for prostheses, orthoses, and assistive devices (Banerji and Banerji, 1984).
5. Design of a "hanging stump" ischial bearing ring prosthesis for residual limbs in bad condition or otherwise unfittable limbs (Chand *et al.*, 1985).
6. Kinematic analysis of knee-ankle design parameters for Afro-Asian cultures where patients kneel, squat and sit cross-legged. Includes a description of a six-bar linkage system designed to facilitate squatting (Chakraborty and Patil, 1988).
7. Description of an AK prosthesis designed to facilitate squatting, and cross-legged sitting. (Chaudry *et al.*, 1981 and 1982).
8. Design of a trans-femoral prosthesis permitting squatting through modifications to conventional knees and/or adjustable knee and ankle flexion stops (Guha *et al.*, 1977).
9. Design of a trans-femoral prosthesis to enable squatting using a modified Lang single axis knee (Madhavan *et al.*, 1977).
10. Fabrication of trans-tibial and trans-femoral prostheses using indigenous materials in India. Of interest is the use of a mixture of polyester resin and cork granules for fabrication (Girling, 1968).
11. Use of locally-made components to

fabricate prostheses. The design include a SACH foot, figure 8 cuff, and a single-axis knee design (Girling and Cummings, 1972).

12. Design of a simplified low-maintenance prosthesis for use in Thailand or other countries where patients walk in water or mud (ie rice paddies). The design incorporates a laminated foot cut short to a "Chopart" configuration with no rubber components. This design purportedly aids patients walking in water or mud and resists water damage, mildew and rotting (Kijkusol, 1986).
13. Use of a peg-leg prosthesis for leprosy patients in rural areas (Kulkhari and Mehta, 1982).
14. Design of an inexpensive endoskeletal prosthesis using the Jaipur foot, conduit pipe and a hinge joint. The article also presents cost and durability concerns, and the challenges of squatting, and sitting cross-legged with a prosthesis (Mohan *et al.*, 1992).
15. A discussion on the use of local materials to fabricate prostheses and orthoses in developing countries with an emphasis upon concerns for children's devices (Oshin, 1981).
16. Fabrication of an aluminium open-ended trans-tibial prosthesis for use with the Jaipur foot. The entire process of fabrication reportedly requires about one hour, and relies upon the skills of local artisans. The article emphasizes the advantages of a highly efficient locally staffed and supplied delivery system (Ring and Sethi, 1981).
17. A general approach to providing prostheses to rural or urban poor in developing countries. The article addresses specific challenges such as barefoot walking, sitting cross-legged or squatting, hot environments, and uneven terrain. The author compares and contrasts traditional SACH feet, Muller solid rubber feet, and the Jaipur foot (Sethi, 1974).
18. Modification of the Jaipur system for trans-tibial amputees by use of high-density polyethylene irrigation pipe instead of aluminium for the socket and shank (Upadhyay *et al.*, 1988).
19. Fabrication of a laminated PTB style prosthesis for use in India. Requires use of

plaster, an adjustable pylon, and thermosetting resin (Wollstein, 1972).

20. Basic techniques for an epoxy laminated PTB prosthesis. The technique described includes a directly-applied socket, plastazote liner, laminated hollow cone shank, and rubber tyre sole. A similar technique for fabricating a non-articulated trans-femoral prosthesis is described (Pfaltzgraff, 1976 and 1966).

Prosthetic feet

1. Use of tyre sidewall to construct a crutch "foot" (Broadhurst, 1988).
2. A comparison of various SACH feet with emphasis on the advantages of the Vellore SACH foot design, which includes a tyre rubber sole to improve durability and enable limited barefoot walking (Lazarus *et al.*, 1983).
3. Design of a new all terrain foot, interchangeable with the Seattle foot. The design has application for any prosthetic user who ambulates on uneven terrain or in water (Matthews *et al.*, 1993).
4. Design of a solid rubber foot ending at the MP joint area and including a proximal tapered cone into which the socket and shank, generally aluminium, are glued. The foot is intended to benefit barefoot walkers, and provides greater adjustability to uneven terrain than traditional SACH feet (Muller, 1957).
5. Performance measurement of the Jaipur foot (North *et al.*, 1974).
6. Development of the Jaipur foot (Sethi, 1972).
7. Design and development of the Jaipur foot. Focuses on the need for multi-axial ankle adaptation for uneven terrain and typical rural Indian life (Sethi *et al.*, 1978).
8. Rationale for the Jaipur foot and development of same (Technology for developing countries, 1993).

Technical aids, equipment, seating systems etc

1. Discussion of Community Based Rehabilitation and appropriate technology (Appropriate technical aids for disabled people (Bombay Seminar), 1988).
2. Unique reference manual for fabrication of mobility aids, (ie seating, positioning, beds, chairs, and walkers), using local

“primitive” materials such as bamboo, string, simple nails, etc. Because this manual uses simple drawings to depict what can be fabricated and virtually no text, it is immediately useful to local artisans with no need for translation (Caston, 1982).

3. Discussion of local production (in Africa), of assistive devices and equipment. Includes information on how to set up a workshop, a description of the Jaipur programme and how to replicate it elsewhere, and descriptions of local production of orthoses, prostheses, chairs, wheelchairs, and assistive devices for children (Appropriate aids and equipment for disabled in Africa, 1988).
4. Design of an anthropometer for use in developing countries. The article describes fabrication and use of a tool for research and prosthetic/orthotic measurement (Davies and Shahnawaz, 1977).
5. Use of plywood, metal hinges and screws to fabricate positioning splints for patients with recent onset of polio (Varma, 1988).

Thermoplastics

1. Cost benefits of thermoplastics (where available) are discussed (Oberg, 1991).
2. General criteria for use of thermoplastics as opposed to wood, iron, aluminium, or leather (Thermoplastics in prosthetics and orthotics, 1993).

CAD CAM in the developing world

1. Design and development of CAD CAM for use in developing countries. The paper focuses upon non-contact, laser imaging, software for socket modifications, moulding tool production for manufacture of lightweight plastic components, and field testing of results. The authors' concept is to use a remote residual limb scanner to send data by modem to a centralized automated fabrication facility (Walsh *et al.*, 1989).
2. Implications of CAD CAM use in developing countries. The paper includes rationale for and result of a trial CAD CAM facility in Hanoi, Vietnam (Smith *et al.*, 1992).
3. Report of an ISPO workshop on CAD CAM in prosthetics and orthotics (Murdoch, 1988).

War-related injuries and prosthetics and orthotics issues

In the aftermath of a war, countries face a great struggle for economic and social rehabilitation, and literally tens of thousands of patients may require orthopaedic appliances. In some countries like Cambodia, Afghanistan, Mozambique, Burma, Somalia, Ethiopia and Angola (to name a few), land-mines, bombs, and other ordnance may lie in a dormant state for years before causing injury. In Cambodia, for instance, it is reported that in 1990 alone, as many as 6000 people lost a leg or foot to mine explosion (Stover and Charles, 1991).

Without assistance from abroad, there appears to be very little hope that prosthetic-orthotic care will be established until many years have passed. If fighting continues for an extended length of time, it is of course virtually impossible to provide adequate prosthetic-orthotic care within the country. Angola, for instance, after more than thirty years of war is reported to have the highest per capita percentage of amputees in the world, and although the problem is being addressed, continued fighting makes service to rural amputees virtually impossible (in Focus, 1993).

Groups like the International Red Cross (ICRC) often begin initiatives to help disabled war victims in countries like Eritrea before the fighting is over (in Focus, 1993). This early relief generally requires the assistance of a team of expatriate specialists with a systematic and highly modular approach. Over time these specialists can help develop a network of workshops and provide training to local health care workers and gradually return the prosthetic-orthotic care into the nations' hands.

Most of the literature reviewed focused on the challenges of providing prosthetic care in the primitive conditions and overwhelming need following a war. More information regarding methods, techniques, appropriate materials and the establishment of long-term centres is needed.

Paediatric prosthetic/orthotic care

There is really very little published about paediatric prosthetic/orthotic care in the developing world, and certainly this is an area that needs to be more adequately addressed in the future. What is available, seems to indicate

that children with congenital limb deficiencies are just about as common in developing countries as in the developed world, but there is very little expertise available both surgically and prosthetically to deal with their problems. In many cases, children with congenital limb deficiencies that would be converted to amputations in more developed countries are simply left untreated.

Sliman *et al.* (1991) discuss surgical treatment of children with longitudinal deficiencies seen at the El Kassab Institute in Manaba, Tunisia. Children with lower limb deficiencies receive amputations and prosthetic fitting when indicated, but children with upper limb deficiencies receive no prosthetic intervention. The inattention to upper limb fitting is not surprising, given the incredible ability of children to adapt, limited acceptance of arm prostheses even in developed countries, and the high degree of complexity of arm prostheses as well as the need for extensive occupational therapy to provide adequate long-term results (United Nations, 1974).

Although a formalized treatment approach for children exists in a few centres, there is an apparent lack of awareness in many parts of India, (and one can assume most of the developing world), regarding surgical treatment and/or prosthetic fitting for children (Sharma, 1991). Cost factors alone undoubtedly affect a nation's ability to provide orthopaedic devices to a population that will quickly outgrow them and require subsequent replacement. The challenge is further complicated by the high incidence of childhood pathologies in developing countries (including polio, cerebral palsy, osteogenesis imperfecta, spina bifida, club feet, inherited disorders, war injuries, and many others), and the inadequate infrastructure to care for these problems surgically, or to provide adequate rehabilitation. Nevertheless, developing countries are becoming aware of the socio-economic implications of leaving children untreated, and there is growing interest in providing prosthetic-orthotic care as well as adequate surgical intervention for this population (Hanekon, 1988; Fernandez-Palazzi *et al.*, 1991; Oshin, 1981).

Conclusion

Much of the available literature emphasizes appropriate technology, but there is often great

disparity between what is considered truly appropriate. In part, this term appears to have arisen from the Community Based Rehabilitation (CBR) movement, and once again, it is unclear how prosthetic care fits in with the CBR model. Although the debate over appropriateness is an essential part of the growing process, some consensus would greatly assist current and future organizations in planning and implementing prosthetic-orthotic services and training centres.

In education, much has been accomplished toward establishing standards, but it appears that in actual practice, education in most developing countries ranges from the formal to the chaotic, and that accepted standards are rarely adhered to. The reasons for this are multiple, but one area of weakness in the literature appears to be in cohesive educational packages of texts, and illustrations designed for training in developing countries. Undoubtedly such materials exist and are utilized by various organizations, but are not readily available in this area.

The debate over appropriate technology is evident in the technical literature as well as where publications range from primitive methods to CAD CAM. Although CAD CAM and "high-tech" approaches have been the subject of controversy, it should be noted that such projects have arisen as a result of the overwhelming shortage of adequately trained individuals. Certainly the controversy over costs and sustainability are justified, but progress must start somewhere, so the burden of proof remains in the hands of such projects and their developers.

A great deal of technical literature has been written, and the large volume of literature intended for developed countries should not be overlooked as it can frequently be applied to the developing world. Gaps exist, however. There are few outcome studies, and very few documented component production techniques for developing countries. There appears to be a significant need for durable prosthetic feet as well as other components that can be manufactured in-country, and the many facilities currently fabricating their own components should collaborate with other facilities to compare results in order to aid the quest for the ideal, low cost, durable, locally manufactured system.

Perhaps above all, the literature emphasizes the enormity of the challenge of providing adequate prosthetic-orthotic care in the developing world, the many ongoing efforts to address the needs of amputees in these countries, and the need for much more communication between countries and the various programmes that are in existence.

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A full list of the literature reviewed for this article is given in Appendix 2 of the Report of the Consensus Conference on Appropriate Prosthetic Technology in Developing Countries.

Conclusions and recommendations

The conclusions and recommendations arising from the Consensus Conference on Appropriate Prosthetic Technology for Developing Countries were the result of detailed discussions in both syndicate and plenary sessions. Summaries of these discussions can be found in the published report.

Establishment and organisation of projects

1. The factors to be considered in setting up a prosthetic project in a developing country were discussed and agreed. These include:

- need to go in/motivation;
- needs assessment/surveys;
- participation;
- co-ordination;
- resources/financial responsibility/capacity;
- sustainability;
- marketing/advocacy;
- external context;
- planning/factors in planning;
- national plan/structure;
- training/education.

2. Every programme must be built up on the demonstrated ability of providing a system of service, training and sustainability.

3. The principal criterion in considering setting up a project is that it has been proposed or supported by the national government.

4. There should be a relationship between the government, donors, NGOs, technical and professional organisations (e.g. ISPO) and the consumers (or users) of the service.

5. There should be a relationship between agencies providing prosthetic services and other agencies providing surgical/medical or education/training services within the existing framework(s) of the national programme.

6. Consideration should be given to combining prosthetics and orthotics programmes.

Assessment of need

7. The factors to be considered in assessing need when proposing a project were specified and agreed. These include:

- what are the existing prosthetic/orthotic services, associated clinical services and

- social services in the host country?
- are there other outside services (NGOs) in the country? Are they in need of help?
- is the host government interested in outside participation and have they requested help?
- what is the magnitude of the problem? Number - location - severity;
- what is the level of social/economic development?
- security and logistics;
- what is the cost?
- what is the priority and commitment of the host government and its allocation of resources?
- are there local road and transport systems?
- what is the level of the local technology?
- are there particular needs due to the environment?

Interagency co-operation

8. In order to optimise the use of resources co-operation between agencies working in the same country or region is strongly encouraged. This might include collaboration in bulk purchase, sharing facilities and the development of a common database.

Sustainability

9. All prosthetic projects should contribute to the development of a long term sustainable national service to provide prosthetic services for all social groups. The requirements and the steps which should be taken to ensure this were identified as follows:

- commitment of host government;
- advocacy/empowerment of beneficiaries, e.g. bring conferences, etc. to the places where the problems are;
- development of national plan on the part of the government and should include or address management, technical, financial aspects;
- must have provision for updating and evaluation;
- training before leaving;
- donor/implementing organisation should facilitate/initiate discussions, brainstorming,

development of options, etc. with the host government;

- provide equipment;
- steps should be taken to minimise brain drain;
- human resource development;
- projects/activities/programmes should be flexible and adaptable, contain a system which formalises feedback, identifies weaknesses, evaluates and provides for adjustment.

Cost information

10. The problems associated with interpreting costs information were discussed and it was agreed that cost presentation should be standardised by individually identifying capital costs, administration costs, materials, labour etc.

11. Some proportion of the cost of the prosthesis should be paid, where possible, by the patient to give a perception of its value. Services should, however, be available to all regardless of the ability to pay.

Evaluation

12. The criteria to be considered when evaluating an ongoing or completed project were specified and agreed. These include:

- infrastructure;
- staff;
- local staff development;
- funding;
- patient knowledge;
- population;
- range of devices;
- quality of services provided;
- quantity of services provided;
- materials used;
- application of prosthetic principles;
- workplace safety;
- delivery system;
- local componentry;
- quality of materials used;
- integrated team approach;
- short term versus long term viability;
- dynamic alignment;
- degree of function;
- sustainability;
- integration into a National Service.

It was further agreed that there was a need to develop methods to provide performance indicators and outcome measures.

Community Based Rehabilitation (CBR)

13. It was agreed that there is a range of simple to more complex CBR models, i.e. from totally voluntary village workers to more structured attachment to health/social system. The role of CBR in a structured prosthetic service was outlined as follows:

- outreach;
- patient education and referral;
- increased accessibility of services;
- simple monitoring of status of when repairs and replacement are needed;
- basic maintenance;
- provision of communication channel to the national system;
- local access and accessibility;
- social access;
- CBR stimulates the local population to help the disabled;
- contribution to the development of appropriate technology;
- feedback and information gathering.

The inclusion of CBR provides a splendid opportunity to involve disabled persons in the provision of services.

Involvement of disabled persons

14. Disabled persons should be consulted in the planning of activities.

Acute or conflict situations

15. Prosthetic services in conflict situations are a critical need and should be provided whenever safety and security can be reasonably assured.

16. Projects in conflict situations should be designed to provide maximum availability of, and access to, appropriate devices and services and be amenable to long term follow-up services.

17. Initial response should be limited to temporary camps of dislocated people or refugees in somewhat secure/safe areas. Simple technologies may be used for immediate fitting. However, even in these conditions, sustainability should have priority. Relief programmes should provide the maximum input for the maximum number of people in a short period of time. The time available in which to work may often present itself as a "window of opportunity".

18. In the absence of a professional infrastructure the use of prosthetic kits for mass distribution in these situations was not recommended.

Appropriate technology

19. Appropriate technology is a system providing proper fit and alignment based on sound biomechanical principles which suits the needs of the individual and can be sustained by the country at the most economical and affordable price.

20. A dialogue should be established between donors and governments to reach a consensus on the technology (or technologies) to be adopted.

Materials

21. A number of factors should be considered when choosing materials for prostheses. These factors include:

- cost;
- availability;
- adjustability;
- durability;
- cultural requirements;
- biocompatibility;
- worker safety;
- sustainability;

- climate;
- terrain;
- ease of repair;
- equipment available.

22. The advantages and disadvantages of the use of different materials in different environments were tabulated (Table 1).

23. It was considered that there should be unanimous acceptance by all the groups involved of the materials to be used in a country. This would lead to similar education and training requirements for personnel permitting their movement within the country.

24. ISPO should produce recommendations on the use of polypropylene.

Components

25. Prosthetic feet, joints and suspension systems are the major contributors to a reduced prosthetic life-span. The foot is the component of the prosthesis that fails most frequently. Easy replacement of the foot, possibly by the amputee, should be considered an important design feature.

Table 1. Advantages and disadvantages of the use of different materials

Material	Advantages	Disadvantages
Wood	Biocompatible Generally available Simple tools Easy to repair locally	Deteriorates in wet climates
Leather	Moulds easily Generally available Biocompatible Easy to repair locally	Deteriorates quickly Deforms Requires reinforcement Hygiene problems
Mild steel	Easy to weld Strength Generally available Easy to repair locally	Corrodes Fatigues Heavy
Aluminium	Light Generally available	Fatigues
Laminating resins	Current accepted technology Cosmesis Water resistant Strength	Worker safety (carcinogenic) Difficult to repair locally Short shelf life Requires imported materials Fatigues Requires equipment
Thermoplastics	Lightweight Water resistant Strength Recyclable Long shelf life	Imported Requires equipment Difficult to repair locally

26. Programmes should maintain records of patients attending for prosthetic repairs giving details of failure and duration of use.

27. An important part of appropriate technology in respect of affordability and sustainability is related to the local manufacture of components.

28. Quality control issues are regarded as critical in the developing world and should be used to assure product/programme standards. Ultimately quality is measured by functional provision and longevity.

29. The need was identified for simple standardised mechanical testing.

30. The testing and documentation of products, prior to their introduction was seen as an obligation of NGOs.

Workshop safety

31. Workshop safety in developing countries gives rise for concern. Maximal safety of installations and machinery is mandatory although the ability to control work practices is limited.

Clinic team

32. Whenever possible a clinic team approach, including the patient, should be adopted when providing prosthetic services.

33. The social services should be included in evaluation and follow-up of patients.

Socket fit

34. Acceptable socket fit should provide the amputee with comfort and function. Modification of socket fit with respect to culture and occupational needs must be considered.

CAD CAM

35. Since multiple technologies are used in the developing world it is not logical to exclude CAD CAM and thereby discount its current use and future potential.

36. CAD CAM may be a suitable technique in appropriate circumstances but it might divert funding from more effective techniques.

Education and training

37. The need to educate and train personnel for developing countries following ISPO guidelines was endorsed.

38. Specialised training courses should be provided for prosthetists from industrial countries to prepare them for work in developing countries.

Information

39. The ISPO database of information on prosthetics and orthotics is now located in the National Centre for Training and Education in Prosthetics and Orthotics, University of Strathclyde, Glasgow, Scotland.

Calendar of Events

10-19 May, 1996

8th International Mobility Conference, Trondheim, Norway.

Information: IMC 8, Tambartun National Resource Centre, N-7084 Melhus, Norway.

12-16 May, 1996

1st Mediterranean Congress of Physical Medicine and Rehabilitation, Herzliya, Israel.

Information: Congress Secretariat, c/o Ortra Ltd., PO Box 50432, Tel Aviv 61500, Israel.

28-30 May, 1996

4th British Course on Revision Surgery of the Hip and Knee, Stratford-upon-Avon, England.

Information: MetaPhor Conferences and Exhibitions, 21 Kirklees Close, Farsley, Pudsey, West Yorkshire LS28 5TF, England.

7-12 June, 1996

RESNA '96, Salt Lake City, Utah, USA.

Information: RESNA, Suite 1540, 1700 N. Moore St., Arlington, VA 22209, USA.

9-13 June, 1996

10th Nordic-Baltic Conference on Biomedical Engineering, Tampere, Finland.

Information: Soile Lonnqvist, Ragnar Granit Institute, Tampere University of Technology, PO Box 692, Tampere, Finland.

11-14 June, 1996

4th International Conference on Human Services Information Technology Applications, Rovaniemi, Finland.

Information: NAWH, Husita 4 Bureau, PO Box 220,00531 Helsinki, Finland.

12-15 June, 1996

13th Interbor International Congress of Prosthetics and Orthotics, Oslo, Norway.

Information: Congress Secretariat, XIII Interbor Congress, Conference AS, PO Box 7609 Skillebekk, N-0205 Oslo, Norway.

23-26 June, 1996

12th International Meeting of the International Society of Technology Assessment in Health Care, San Francisco, USA.

Information: c/o KREBS Convention Management Services, 555 DeHaro Street, Suite 200, San Francisco, CA 94107-2348, USA.

24-28 June, 1996

1st World Congress on Neurological Rehabilitation, Newcastle, England.

Information: WCNR Secretariat, Hunters Moor Regional Rehabilitation Centre, Hunters Rd., Newcastle upon Tyne NE2 4NR, England.

25-29 June, 1996

14th International Symposium of Biomechanics in Sport, Madeira, Portugal.

Information: ISBS '96 Secretariat, Rde Alfandega, 78-5,9000 Funchal, Portugal.

25-29 June, 1996

23rd Annual Meeting of the International Society for the Study of the Lumbar Spine, Burlington, VT, USA.

Information: International Society for the Study of the Lumbar Spine, c/o Sunnybrook Medical Centre, Room A309, 2075 Bayview Avenue, Toronto, Ontario M4N 3M5, Canada.

28-30 June, 1996

International Summer School on 3D Analysis of Human Movement, Lyon, France.

Information: Dr. P. Allard, 3D Analysis Secretariat, Centre de Recherche, Sainte-Justine Hospital, 3175 Cote Ste-Catherine, Montreal, PQ, H3T 1C5, Canada.

12-16 August, 1996

3rd Paralympic Congress, Atlanta, USA.

Information: 3rd Paralympic Congress, Atlanta Paralympic Organizing Committee, Youth and Community Programs, 1201 West Peachtree Street NE, Suite 2500, Atlanta, GA 30309-3448, USA.

28-31 August, 1996

10th Conference of the European Society of Biomechanics, Leuven, Belgium.

Information: Biomechanics and Engineering Design Division, Katholieke Universiteit Leuven, Celestijnenlaan 200A, B-3001, Heverlee, Belgium.

9-11 September, 1996

Instructional Course on Gait Analysis, Dublin, Ireland.

Information: Ms. Ann Jenkinson, Gait Laboratory Manager, CRC, Vernon Ave., Clontarf, Dublin 3, Ireland.

10-12 September, 1996

2nd Annual National Conference of the Institution of Physics and Engineering in Medicine and Biology, Leeds, England.

Information: The Secretariat, IPEMB Annual Conference, 4 Campleshon Rd., York YO2 1PE, England.

12-14 September, 1996

5th Annual Meeting of the European Society for Movement Analysis in Children, Dublin, Ireland.

Information: ESMAC, Gait Laboratory, CRC, Vernon Ave., Clontarf, Dublin 3, Ireland.

16-20 September, 1996

18th World Congress of Rehabilitation International, Auckland, New Zealand.

Information: Convention Management, PO Box 2009, Auckland, New Zealand.

18-21 September, 1996

50th Annual Meeting of the American Academy for Cerebral Palsy and Development Medicine, Minneapolis, USA.

Information: AACPD, 6300 N. River Rd., Suite 727, Rosemont, IL 60018, USA.

13-16 October, 1996

1st International Conference on Priorities in Health Care, Stockholm, Sweden.

Information: Priorities in Health Care, Stockholm Convention Bureau, PO Box 6911, S-102 39 Stockholm, Sweden.

14-19 October, 1996

Eurospine '96, Zurich Switzerland.

Information: ESS Secretariat, J Ricchert Schild, c/o Schaltess Klinik, Legghalde 2, CH-8008 Zurich, Switzerland.

21-23 October, 1996

International Conference on Quality of Life and Assistive Technologies, Montreal, Canada.

Information: Denise Mauger, 6300 Darlington Ave., Montreal, Quebec HS3 2J4, Canada.

31 October-3 November, 1996

18th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Amsterdam, The Netherlands.

Information: Wim Rutten, Program Co-chair, Dept. of Biomedical Engineering, Faculty of Electrical Engineering, University of Twente, PO Box 217,7500 AE Enschede, The Netherlands.

1997

13-18 February, 1997

American Academy of Orthopaedic Surgeons Annual Convention, San Francisco, USA.

Information: AAOS, 1650 King St., Suite 500, Alexandria, VA 22314, USA.

8-9 March, 1997

Annual Scientific Meeting of British Association of Prosthetists and Orthotists, Blackpool, England.

Information: The Secretariat, BAPO, Dunoon and District General Hospital, Dunoon, Argyll PA23 7RL, Scotland.

31 August-5 September, 1997

8th World Congress of the International Rehabilitation Medicine Association, Kyoto, Japan.

Information: Japan Convention Services Inc., Nippon Press Center Bldg., 2-1, 2-chome, Uchisaiwai-cho, Chiyoda-ku, Tokyo 100, Japan.

8-12 September, 1997

Dundee 97: International Conference on Wheelchairs and Seating, Dundee, Scotland.

Information: The Secretariat, Dundee 97, Dundee Limb Fitting Centre, 133 Queen St., Broughty Ferry, Dundee DD5 1AG, Scotland.

14-19 September, 1997

World Congress on Medical Physics and Biomedical Engineering, Nice, France.

Information: Nice 97, SEE-48, Rue de la Procession, F 75724 Paris Cedex 15 France.

23-25 October, 1997

25th Annual Scientific Meeting of ISPO UK National Member Society, Scotch Corner, near Darlington, England.

Information: Mrs. P. McLachlan, Orthotic Dept., Perth Royal Infirmary, Western Ave., Perth PH1 1NX, Scotland.

1998

28 June-3 July, 1998

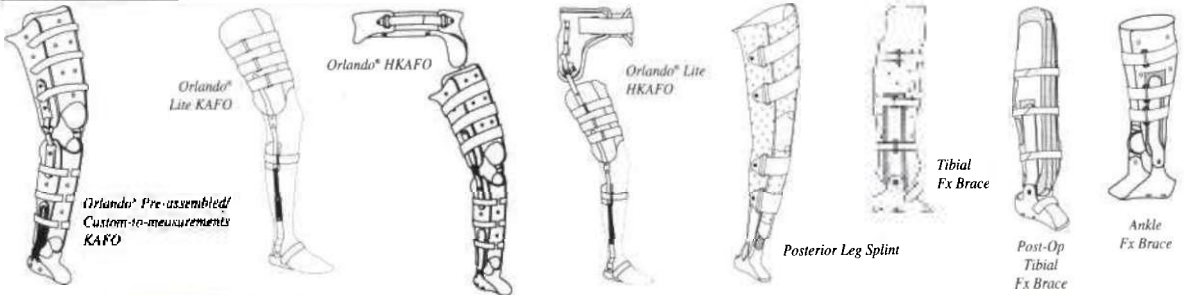
9th World Congress of the International Society for Prosthesis and Orthotics, Amsterdam, The Netherlands.

Information: Congrex (Holland) B.V., Keizersgracht 782, 1017 EC Amsterdam, The Netherlands.

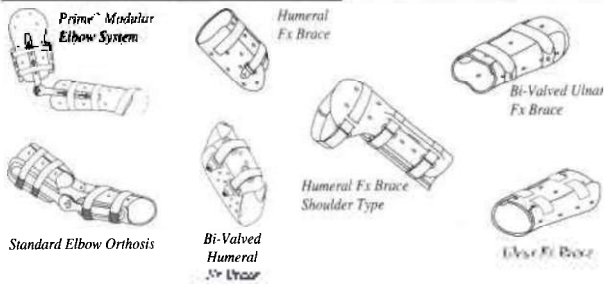
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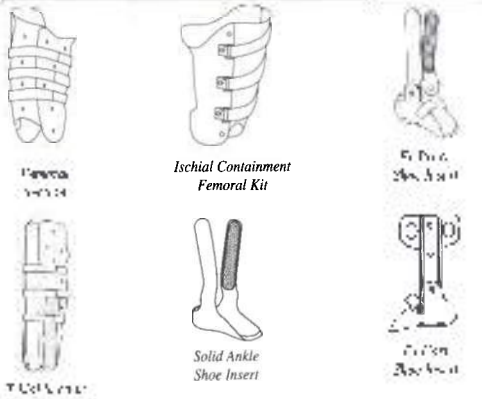
LOWER EXTREMITY FX BRACES



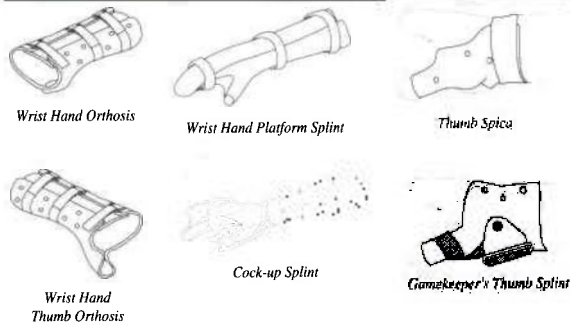
UPPER EXTREMITY FX BRACES



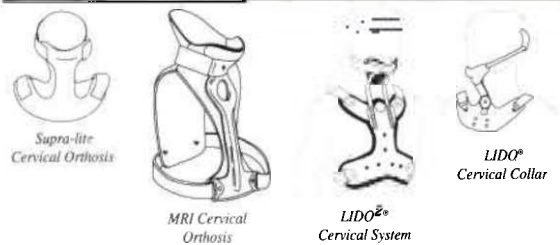
LOWER EXTREMITY COMPONENTS



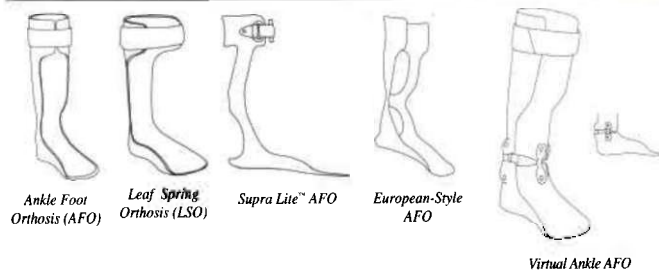
WRIST-HAND-THUMB ORTHOSES



CERVICAL ORTHOSES



FOOT ORTHOSES



SHOULDER ORTHOSES

