The Journal of the International Society for Prosthetics and Orthotics

Prosthetics and Orthotics International

April 1995, Vol. 19, No. 1

The Otto Bock 3R60 EBS Knee.

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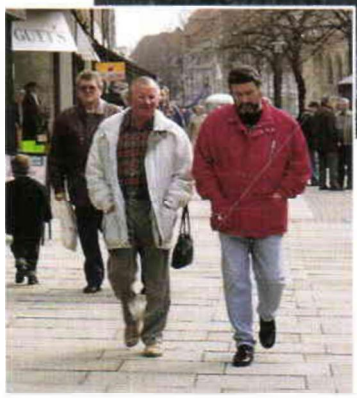

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Prosthetics and Orthotics International

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A full list of Standing Committee Chairmen, Task Officers and Consultants will appear in the next issue of the Journal.

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Secretary

Aase Larsson	Denmark

Prosthetics and Orthotics International, 1995, 19, 1–4

Editorial
ISPO Finances 1989-1994

The financial result of the year 1994 was a deficit of more than DKK 1,000,000, which is by far the largest in the history of the Society.

However, from the beginning of the year the Executive Board accepted a budget, which indicated a deficit of that magnitude, knowing that the recession and low interest rate in the financial market would make it impossible to finance the activities from the capital yield. Over many years it has been the policy of the Society to limit its activities related to international work within the limits of the capital yield. A plan for the year with a range of activities with heavy financial implications was presented, discussed and accepted by the International Committee at the interim meeting in Copenhagen, January 1994.

Implementation of this programme was made possible by the high profit from the Seventh World Congress in Chicago, and by the high surplus for the fiscal year 1993. In spite of the 1994 deficit the capital of the Society is still at the same level as that at the end of the 1992 congress year.

The high activity level of the Society is also made possible through extensive unreimbursed work by the Officers and Executive Board members with the good understanding and positive acceptance of their employers. Another factor has been regular contributions from the War Amputations of Canada. Further the SAHVA Foundation has continuously provided free office facilities and has promised this contribution also for the coming year. A large and valuable work load has been picked up by the secretaries and other staff members at the National Centre for Training and Education is Prosthetics and Orthotics, University of Strathclyde in Glasgow, Scotland.

The costs of the daily operation has been virtually unchanged, but the Society has accrued expenses of DKK 96,000 over the past two years related to promotional brochures for both the Society and the journal, Prosthetics Orthotics International. Three short-term courses on amputation surgery and related prosthetics were successfully completed in the developing world in 1994, and also a consensus conference on the Orthotic Management of Cerebral Palsy. These activities cost about DKK 500,000. The capital yield was negative, a deficit of DKK 373,000 for the first time in nine consecutive years.

Key-figures from the past two triennia are presented in Table 1. The income from membership fees and sponsors has been rather constant, about DKK 1,100,000, although the fees have been unchanged since 1989 at DKK 450 for members from the OECD countries and the like, and DKK 225 for others. The capital yield increased from about DKK 200,000 in 1989, to a peak of DKK 600,000 in 1993, but has this year dropped dramatically; on average, however, a yearly contribution of about DKK 400,000 has been made. The costs of running the Society, i.e. the Secretariat and the Executive Board, has been fairly constant around DKK 850,000 but in 1994 Society promotion and in particular the interim International Committee meeting added a further DKK 230,000.

The journal, Prosthetics Orthotics International, has been a cost item of about DKK 100,000 but thanks to a drive for advertisers by the Editors, this line item now seems to have levelled off. By and large it has been possible to run the Society, the journal and other publications within the revenue of the membership fees.

Since the start of the Society there has been a desire to influence education and patient care in the field of prosthetics and orthotics in particular. This could not be done without costs to the Society and hard unreimbursed work by its committed officers. On average, DKK 175,000 has been spent yearly over the past two triennia, as compared to DKK 75,000 yearly in the triennium, 1986-88. As mentioned in previous Editorials, ISPO has now been recognised internationally for its expertise in this field. Up to present the Society has established its influence and carried out its activities solely on

Table 1. ISPO accounting 1989-94

	1989	1990	1991	1992	1993	1994
Income	**1.034.989**	**1.150.259**	**1.129.242**	**1.207.374**	**1.077.166**	**1.077.862**
– members	899.545	1.017.829	991.546	1.151.504	1.045.108	1.050.147
– sponsors	135.444	132.430	137.696	55.870	32.058	27.715
Meetings, Other Organisations	**-135.565**	**-147.719**	**-209.681**	**-195.948**	**-220.534**	**-137.955**
Conferences, Workshops	**-41.024**	**-220.845**	**-4.628**	**-9.372**	**-12.983**	**-196.828**
Courses				**114.642**	**-54.982**	**-273.949**
Congresses	**-117.523**	**82.370**		**1.521.233**	**466.355**	**-59.747**
POI Journal	**-65.242**	**-84.584**	**-266.641**	**-72.504**	**-90.645**	**-3.648**
– income	306.270	311.618	414.744	456.250	487.387	576.528
- expenses	-371.512	-396.202	-681.385	-528 754	-578.032	-580.176
Professional Register	**-8.681**	**-32.934**	**-3.953**		**-9.293**	
Publications	**-106.018**	**3.695**	**-12.979**	**-29.800**	**-22.391**	**38.118**
– income	10.820	20.320	22.755	28.120	21.644	844
– expenses	-116.838	-16.625	-35.734	-58.000	-44.035	-38.962
Activity Result	**601.960**	**766.867**	**667.094**	**2.535.045**	**1.091.342**	**347.386**
Administration	**-998.111**	**-858.387**	**-833.988**	**-854.293**	**-864.659**	**-1.049.634**
– secretariat	-555.263	-536.342	-548.992	-543.301	-515.687	-549.019
– board	-392.056	-272.017	-253.705	304 512	-307.621	-247.865
– meeting expenses	-50.792	-27.835	-20.213	-6 480		-22.206
– society promotion					-41.351	-45.255
– International Committee		-22.193	-11.078			-185.289
Primary Result	**-396.151**	**-91.520**	**-166.894**	**1.680.752**	**268.034**	**-656.993**
Capital Yield	**209.424**	**258.371**	**387.244**	**412.633**	**614.754**	**-373.032**
– interest, maturity yield	294.728	324.595	322.960	419.025	614.754	438.275
– changes in value	-85.304	-66.224	64.284	-6.392		-811.307
Years Result	**-186.727**	**166.851**	**220.350**	**2.093.385**	**882.788**	**-1.030.026**
Assets	**3.732.140**	**3.829.983**	**4.190.597**	**6.215.429**	**7.029.128**	**6.037.788**
Fees – Daily Operation	-278.507	45.619	-126.015	194.827	58.120	-41.253
Fees + Sponsors – Daily Operations	-143.063	178.049	11.681	250.697	90.178	-13.538
Capital Yield – International Activities – Courses	32.835	-110.193	172.935	321.955	326.255	-981.764

the yields from its assets and profit making activities, such as congresses and courses.

Major steps have been taken in the past six years (Table 2). Since 1990 ISPO has actively entered the field of influencing patient care programmes by arranging a consensus conference on Amputation Surgery, followed by short-term courses from 1992 onwards. Further a consensus conference on the Orthotic Management of Cerebral Palsy was held in 1994 and plans have been made for a consensus conference on Appropriate Prosthetic Technology for Developing Countries. All such courses and conferences aimed in particular at the developing world have been heavy cost items for ISPO (DKK 930,000). These have been pursued with the full understanding and approval the Executive Board and the International Committee. In running them the Society has benefited from collaboration with other

Table 2. Costs accrued 1989-94 for international relationships and educational purposes

	1989	1990	1991	1992	1993	1994
Meetings, Other Organisations:						
Total	**-114.163**	**-147.719**	**-209.682**	**-195.949**	**220.533**	**-137.955**
United Nations			-6.674	-26.261		
World Health Organisations	-27.094	-16.503		-9.211	-17.120	
Interbor, Education	-24.868	-20.513	-19.172	-5.906	-9 834	
Interbor, Congress					-66.743	
World Orthopaedic Concern	-3.916	-4.640	-9.493	-10.229	-14.346	-6.113
ICRC					-5.073	
Rehabilitation International		-20.093		-52.240		-17.019
AAOP	-14.646	-14.664	-26.750	-53.579		-5.789
AOPA		-61.397	-62.259			
ISO		-4.975				-6.784
ARI, Zimbabwe	-43.639					
ACOPPRA		-4.934	-2.845		-5.508	
OT Berlin			-54.449			
Asian Conference			-28.040			
USAID					-80.228	-56.560
Education Committee				-23.853	-8.258	-31.159
Others				-14.670	-13.423	-14.531
World Congresses:						
Total	**-117.523**	**82.370**		**1.521.233**	**466.355**	**-59.747**
Conferences & Courses:						
Total	**-41.024**	**-220.845**	**-4.628**	**105.270**	**-67.965**	**-470.777**
AK Socket		-16.625				
Education, Strathclyde	-19.622					
CAD/CAM	-915		-19.614			
Amputation Surgery Consensus	-20.487	-204.220	31.106			
Consensus Report			-16.120	-9.372		
Amman					-12.983	-6.740
Amputation Courses				114.642	-54.982	-273.949
Cerebral Palsy Consensus						-190.088
Capital Yield	**209.424**	**258.371**	**387.244**	**412.633**	**614.754**	**-373.033**
Years Result	**-186.727**	**166.851**	**220.350**	**2.093.385**	**882.788**	**-1.030.026**

international bodies, such as the World Health Organization (WHO), the International Committee of the Red Cross (ICRC), and World Orthopaedic Concern (WOC). Similar to other Non-Governmental Organisations, ISPO has recently acquired funding, from external sources; the United States Agency for International Development (USAID) has contributed towards the upcoming consensus conference on Appropriate Technology, and it is the intention to raise equivalent funding for other work in the developing world, when possible.

From the last quarter of 1993 and during all of 1994 interest rates in Denmark have changed rather dramatically, first tumbling, and toward the end of 1994 once more edging upwards. For a number of practical reasons the Society has been forced to revise its investment policies. Following the advice of conservative capital managers most of the capital has been invested in 6% bonds. The market value of these gradually decreased in parallel to the recently rising interest rates. The apparent "loss" in 1994 mirrors normal accounting practices, but is of no practical consequence provided the Society does not have to sell any of its bonds. The once established capital yield naturally stays fixed at about 6.8% of the nominal value, i.e. about DKK 450.000 per annum. However during the first quarter of 1995 the abnormally high activities of the society have necessitated sale of bonds at a nominal value of DKK 450.000. As a consequence of the ensuing reduction of capital yields it may be extrapolated, that with the other variables fixed, the entire capital of the ISPO would be gone within a period of about ten (10) years from now unless other steps are taken.

ISPO still has reasonable assets to help finance involvement in international activities, and it is the

intention not to increase the membership fees. However, it must be understood that a prudent cutback on activities combined with profitable arrangements, such as congresses and courses in the industrialised world, together with exploring alternate funding sources are prerequisites for continuing the Society's efforts. Sound finances are still the corner-stone for the Society's activities.

Bent Ebskov,
Chairman of Finance Committee
J. Steen Jensen,
Honorary Treasurer

Partial Foot Amputees

For some time the problems of partial foot amputees have been given increased attention in Sweden. As a result the Swedish Handicap Institute has started studies in this field and an expert group has been appointed. The chairman of the group is Lars Wärnberg, head of the test department of the institute, and Arne Litzén, Engineer, is in charge of the project.

The Institute believes it of great importance to take into account the experience from other countries. Therefore this notice.

The fore-mentioned expert group has during 1993 made inquiries of persons with partial foot amputations.

The group of partial foot amputees which has been studied, is defined as persons with congenital deformities, those amputated because of trauma including burn effects and injuries caused by frostbite and tumour. The level of the amputation will involve more than the great toe and leave the heel bone as the highest amputation level. Further the amputation should have been made at least two years ago. Diabetic amputees have not been included in this study as they need special treatment. The number of partial foot amputees in Sweden is about 300, but the exact number is uncertain.

To have these amputees' own experiences an enquiry has been carried out and interviews conducted. Further the technical staff at some orthopaedic workshops have been interviewed.

Thus answers from 32 amputees - 23 men and 9 women - have been received and nearly half were amputees after accidents.

The question, *Do you have limited walking ability because of intermittent or frequent pain* was answered *yes* by 27 amputees (85%). More than one third - 12 persons - have hard sores on the stump, sometimes or often. 19 said they have had callosities. More than two thirds have not had training in walking by physiotherapists.

Seven amputees have been interviewed. All declared that aches and pains in the stump prevent them from taking long walks or similar activities.

The answers given present the picture of this group having frequent difficulties in walking.

The expert group continues its work and through increased information, intends to improve the local services. For that reason an inventory of technical solutions and their indications is being made.

It is of greatest value for our continued work to have international support from scientists, investigators and experts in practical work and from consumers. Therefore an inquiry has been sent to some orthopaedic centres and experts in different counties. Information is being sought about the number of these amputees in the respective country, new technical solutions and new material. It has not been possible to reach all relevant sources, therefore we appeal to all readers with experiences in this field to contact us. We are eager to open channels for communication in this complicated area of orthopaedic technique. If you have an interest in this small sector, please let us know. Address: Lars Wärnberg, The Swedish Handicap Institute, Box 510, S-162 15 VÄLLINGBY, Sweden.

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ISPO Statement of Accounts, 1994

Auditors Report

We have audited the enclosed Financial Statements for the year 1994.

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, 1994 and of the result for the year.

Copenhagen, February 23, 1995
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 1994

NOTES		**1994**	**1993**
Society membership fees (note 1)		1.050.147	1.045.107
Sponsorship (note 2)		27.715	32.058
Meetings with other organisations (note 3)		(137.955)	(220.533)
Conferences, courses etc (note 4)		(504.500)	398.390
Prosthetics and Orthotics International (note 5)		(3.648)	(131.996)
Publications (note 6)		(39.118)	(22.391)
Activity result		392.641	1.100.635
Administration expenses (note 7)		(1.049.634)	(832.601)
Primary result		(656.993)	268.034
Interest (note 8)		463.168	604.222
Dividend (note 8)		1.128	1.128
Change in value of securities (note 8)		(837.329)	9.404
Financial Income		(373.033)	614.754
Net income (loss)	DKK	(1.030.026)	882.788

Balance Sheet as of December 31, 1993

ASSETS		**1994**	**1993**
Cash		63.915	1.451.287
Accrued Interest		113.385	124.435
Advertising receivable		160.016	104.190
Prepayment, World Congress 1995		83.040	83.040
Receivable Chicago World Congress		0	181.215
Other		173.032	40.482
Receivables		529.473	533.362
Securities (note 9)		5.444.400	5.035.908
Office equipment (note 8)		0	8.571
Total assets	DKK	6.037.788	7.029.128
LIABILITIES AND EQUITY			
Accrued expenses		128.227	91.737
Accrued printing cost		162.000	178.000
Prepaid membership fees		105.247	9.951
Prepaid subscription income		0	77.100
Short-term liabilities		395.474	356.788
Equity January 1		6.672.340	5.789.552
Net result		(1.030.026)	882.788
Equity December 31		5.642.314	6.672.340
Liabilities and capital	DKK	6.037.788	7.029.128

Notes to the Financial Statements

1. Society membership fees

Membership fees consist of payments from members.

		1994	**1993**
2. Sponsorship			
Contribution from:			
The War Amputations of Canada		27.715	32.058
	DKK	27.715	32.058

3. Meetings with other organisations		**1994**	**1993**
INTERBOR		0	9.834
Education Committee		14.829	8.258
RI-ICTA		17.019	0
Certification		16.330	0
BOA		14.531	0
USAID		56.560	80.228
World Orthopaedic Concern		6.113	14.346
Amer Acad Orth-Prosth		5.789	0
Other		6.784	13.423
WHO Geneva		0	17.120
ICRC		0	5.073
ACOPPRA		0	5.508
Lisbon 1993		0	66.743
	DKK	137.955	220.533

4. Conferences, courses etc			
Panama		(94.399)	
CP Consensus		(190.088)	
Slovenia		(107.779)	
Thailand		(71.771)	
Chicago		(40.463)	546.577
Bologna		0	(80.222)
Amman		0	(12.983)
Tanzania		0	(54.982)
	DKK	(504.500)	398.390

5. Prosthetics and Orthotics International			
Advertising		309.627	287.477
Subscriptions		266.901	199.910
		576.528	487.387
Printing and mailing		(515.571)	(530.514)
Production editor		(31.802)	(32.129)
Journal promotion		0	(41.351)
Meeting expenses		(32.803)	(15.389)
		(580.176)	(619.383)
Net result (loss)	DKK	(3.648)	(131.996)

6. Publications			
Booksales		844	21.644
Amputation Video		(33.222)	
Amputation surgery consensus		(6.740)	(44.035)
Total cost	DKK	(39.118)	(22.391)

7. Administrative expenses

		1994	1993
Executive Board and Officers			
Travel and hotel costs		247.865	307.621
Meeting expenses		22.206	0
Copenhagen IC – meeting		185.289	0
	DKK	455.360	307.621
Secretariat, Copenhagen			
Staff salaries		298.327	291.530
Labour tax		16.716	12.747
Data service		4.023	1.152
Meeting expenses		28.862	12.836
Postage and Bank charges		58.310	60.250
Telephone		0	4.301
Stationery		4.640	21.208
Office supplies		0	10.172
Auditing		45.000	41.250
Bookkeeping		786	29.031
Consulting fees		18.750	
Sundries		30.756	26.925
Knud Jansen medals		0	0
Depreciation		23.565	4.285
Bologna Court Case		19.284	
Society promotion		45.255	
Professional register		0	9.293
		594.274	524.980
Total	DKK	1.049.634	832.601

8. Office equipment

Computer equipment, at cost		123.196	108.203
Office equipment, at cost		26.220	26.220
Cost		149.416	134.423
Depreciation January 1		(125.852)	(121.567)
Depreciation December 31		(23.564)	(4.285)
Accumulated depreciation		(149.416)	(125.852)
Net book value	DKK	0	8.571

9. Securities

	Nominal value	Original cost	Year end value	Interest/ dividend
Bonds				
9% Realkredit Danmark 2026	1.216.000	1.191.648	1.112.032	27.472
6% Realkredit Danmark 2016	2.822.000	2.691.518	2.212.448	128.925
6% Danske Kredit Ann 2026	2.913.000	2.691.608	2.097.360	131.955
Matured or sold				60.303
Accrued Interest				113.385
Shares				
Den Danske Bank	94	30.891	31.114	1.128
Total	6.951.094	6.605.665	5.452.954	463.168

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Executive Board Meetings

11-12 July 1994, Dallas USA
20-21 January 1995, Moshi, Tanzania

The following paragraphs summarise the major discussions and conclusions of the last two meetings of the Executive Board. They are based on the approved Minute of the first meeting and the draft Minute of the second meeting, which has yet to be approved by the Board.

Standing Committee Chairmen and Task Officers Reports

The preliminary accounting for 1994 was presented to the Executive Board which showed a fairly large deficit, however this was expected due to the relatively high expenditure on the Interim Meeting for the International Committee, the three courses in Amputation Surgery and Related Prosthetics which were organised in Thailand, Slovenia and Panama and the Consensus Conference on the Orthotic Management for Cerebral Palsy.*(Honorary Secretary's Note: An analysis of the finances of the Society over the past six years can be found in the Editorial of this issue of the Journal as well as a full financial statement for 1994).* The Chairman of the Finance Committee, Bent Ebskov (Denmark), indicated that the investments of the Society had fallen over the past few years and were only attracting an interest of between 4 and 5% and that other means may have to be found to attract revenue for the Society's activities. The Honorary Treasurer outlined a proposed budget for 1994/95 which showed a deficit of DKK 490,000, however it did not include the outcome of the coming Congress in Melbourne. The Executive Board agreed that the annual membership subscription for the next triennium should be held at the current level of DKK 450 for the 25 countries of the Organisation for Economic Cooperation and Development (OECD) and other high income areas as defined by the World Bank and that all other countries should have a subscription of half that amount, that is, DKK 225 per annum.

The Chairman of the Protocol and Nominations Committee, Willem H. Eisma (The Netherlands), reported that it had discussed amendments to the Constitution in order to make the Education Committee a standing committee of the Society. The Executive Board discussed these proposals and agreed that they should be put to the International Committee. The Protocol and Nominations Committee also proposed the re-wording to the proposed amendment to Clause 2.5.1 with regard members or fellows who fail to pay specified fees. The Executive Board agreed that this proposed clause should go before the International Committee. *(Honorary Secretary's Note: These proposed clauses were subsequently published in the August 1994 issue of Prosthetics and Orthotics International).* As requested by the International Committee and the Executive Board, the Protocol and Nominations Committee had discussed the protocol by which the Executive Board should ask National Member Societies for suggestions for Executive Board nominations. The Executive Board agreed that National Member Societies should be approached to make suggestions for Executive Board nominations, one from the National Member Society itself and further suggestions from other countries. These suggestions would be taken into account by the Executive Board when preparing the slates of nominations.

The Chairman of the Education Committee, John Hughes (UK), reported on the activities of the committee. Courses in Amputation Surgery and Related Prosthetics were successfully run in Thailand, 14-18 March 1994; Slovenia, 26-30 September 1994 and Panama, 14-18 November 1994. The Education Committee were looking at possible venues for future courses.The Peshawar Institute for Prosthetic and Orthotic Sciences (PETCOT) Pakistan, had been inspected and the Executive Board agreed that it be recognised for training and education of Orthopaedic Technologists (Category II) for a period of three years. A preliminary inspection of the China Training Centre for Orthopaedic Technologists (CHICOT) had been made at the time of the final examinations for its future teachers. The Executive Board agreed that they had undergone a training equivalent to that of Orthopaedic

Technologists (Category II). The school could not be awarded Category II status at this early stage and it was recommended that further inspections be carried out in the future leading to ISPO recognition in due course. In association with INTERBOR, the programme of trials of the ABC Certification Examinations were proceeding. A trial examination in Australia had been conducted and plans were underway for a trial in Tanzania, where it seemed likely that both the technician examination and the practitioners examination would be undertaken. There was a need for careful consideration of language and cultural factors before arrangements could be finalised for a trial examination in Germany. The Education Committee was in contact with DANIDA with regard their interest in prosthetic and orthotic education in Africa. It was hoped that the Education Committee, in association with DANIDA, would attempt to establish the level of educational needs in prosthetics and orthotics in Africa with the intention of establishing long term collaboration with DANIDA in helping to provide for these needs.

The Honorary Secretary reported that membership of the Society in 1994 had fallen slightly to 2,445. The fall was attributable to the artificially large increase in the US National Member Society at the time of the Chicago World Congress. However, comparing membership levels over the past six years, the trend is for membership to steadily increase. New National Members Societies have been confirmed in Colombia, Panama, France and Hungary. A number of other countries were considering establishing National Member Societies including, Slovenia, Argentina, Mexico and Jordan.

The Chairman of the Publications Committee, Hans Arendzen (The Netherlands), reported that the teaching video tape on trans-tibial amputation was now ready for distribution. This video tape is now on sale at a price of USD 35 plus postage. The Executive Board agreed the Forchheimer Prize for 1992-1994 should be awarded to R.S. Gailey, D. Lawrence, C. Burditt, P. Spyropoulos, C. Newell and M.S. Nash for their paper entitled *The CAT-CAM socket and quadrilateral socket; a comparison of energy cost during ambulation* which was published in the August 1993 issue of **Prosthetics and Orthotics International**. This prize will be awarded at the World Congress in Melbourne.

The Task Officer for Standards, David N. Condie (UK), reported on the Society's activities in relation to the International Standards Organisation (ISO) and the European Standards Organisation (CEN). With regards the work of ISO TC168 - Prosthetics and Orthotics, some standards are passing from the Committee draft stage to the draft international standard for translation and voting. Some parts of ISO TC173 - Technical Systems and Aids for Disabled Persons, are now very close to publication. The working group concerned with CEN TC 293 - Technical systems for Disabled Persons, is progressing on its draft standards for powered wheelchairs and scooters and for manual wheelchairs. As far as prosthetics and orthotics is concerned, it has met twice in 1994 and is proceeding with the development of a level 2 standard for prostheses and orthoses.

The President reported on the arrangements being made to hold a Consensus Conference on Appropriate Prosthetic Technology for Developing Countries which is planned to take place in Phnom Penh, Cambodia, 5-11 June 1995. The Society has successfully registered with US AID as an international private voluntary organisation and US AID has agreed, through its war victims fund, to provide 75% of the costs of the conference. The purpose of the conference is to critically examine the different prosthetic technologies presently in use in developing countries. The organising committee comprises: The President; H.J.B. Day (UK), John Hughes and the Honorary Secretary. Invitations have gone out to all the major international and national agencies involved in providing prostheses in developing countries, representatives of developing countries and a number of resource persons. A programme for the conference has been prepared and it is anticipated that there will be approximately 70 participants. David N. Condie reported that the Consensus Conference on the Orthotic Management of Cerebral Palsy held in Duke University in November 1994 had been a success. It was expected that the report of the conference would be available by mid-1995. The discussions during the conference were mostly concerned with systems for delivery rather than orthotic systems and highlighted areas of ignorance in this field. Suggestions for taking this initiative forward would be made to the next meeting of the Executive Board.

International Consultants

The Executive Board appointed two consultants to the Middle East - Dr M.A.A. El-Banna (Egypt) and

Dr K. Abadi (Jordan). The first meeting of the Arab and Jordanian Conference on Physical Medicine and Rehabilitation will be held in Amman, Jordan, 26-28 April 1995.

Črt Marinček (Slovenia) reported that all attention in Central and Eastern Europe in recent times had been focused on the course on Amputation Surgery and Related Prosthetics which was held in Ljubljana, Slovenia.

Eiji Tazawa (Japan) was appointed as the second International Consultant to South East Asia. Both he and Seishi Sawamura (Japan) are attempting to identify key people in South East Asia who can help promote ISPO and its philosophies throughout the region. Seishi Sawamura reported on the discussions with representatives of the Indonesian Ministry of Health concerning the possible establishment of an Asian Prosthetics and Orthotics Centre in Indonesia. The plan for the centre includes a three year prosthetic and orthotic education programme, a prosthetic and orthotic patient care department, a research centre and a component manufacturing facility. The plans are still in their early stages and it is necessary to establish a clear picture of the need in order to ensure that the centre can continue to function successfully on a permanent basis after the Japanese involvement ends.

Juan Martina (Dutch Antilles) and Jose Gomez (Colombia) were appointed to become International Consultants for Central and South America. John Craig (USA) reported on the activities in Central and South America. As part of a twinning arrangement, ISPO (US) continues to subsidise ISPO membership fees from Central and South America. Panama and Colombia have successfully established National Member Societies and many other countries in the region are considering the possibilities of establishing National Member Societies. The course on Amputation Surgery and Related Prosthetics held in Panama had been a very successful event.

The Executive Board have revised the paper on the Goals and Functions of International Consultants which was subsequently circulated to all the Society's International Consultants.

International Organisations

Jan Ebbink (The Netherlands) has been elected as the President of INTERBOR and took office in May 1994. He informed the Executive Board that INTERBOR is presently being restructured and has formed 9 commissions -

Commercial and Social Economic
Financial
Strategy/Public Relations/Marketing
European Community
Education
Congress
Other Organisations
Developing Countries
Industry

The major collaboration with INTERBOR is through the ISPO/INTERBOR Joint Education Committee. In addition, ISPO is collaborating in the next INTERBOR Congress to be held in Oslo, Norway, 11-15 June 1996. Willem Eisma is representing ISPO on the Organising Committee and both he and David N. Condie represent the Society on the Scientific Committee for that Congress.

The World Health Organisation (WHO) has been actively collaborating in the Amputation and Related Prosthetic Courses in Thailand, Slovenia and Panama.

ISPO participated in the 6th European Regional Conference of Rehabilitation International (RI) held in Budapest, Hungary, 4-9 September 1994. On behalf of the Society, Hans Arendzen organised a session on prosthetics and orthotics.

Margaret Ellis (UK) was appointed as Task Officer to the International Commission on Technology and Access (ICTA). She reported that the ICTA Plan of Action which will follow the RI Strategic Plan 2000 is a positive one with objectives with each topic and she invited suggestions from Executive Board members for items to be discussed at future ICTA meetings.

Jan Bredie (The Netherlands) reported that the 12th Congress of the Internationaler Verband der Orthopädie Schuteckniker (IVO) will be held in Berlin, Germany, 15-17 June 1995. IVO has now established a sub-committee known as Section Europe concerned with regulations and standards in

Europe. He informed the Board that the possibility of a combined meeting between ISPO and IVO will be discussed at the next IVO Board meeting.

Harold Shangali (Tanzania) reported that he was attempting to establish a closer contact with the African Rehabilitation Institute (ARI) on behalf of the Society. He was asked to investigate the different possibilities open to ISPO with regards future collaboration with ARI.

The World Orthopaedic Concern (WOC) has been very active in participating in the Amputation and Related Prosthetic courses in Thailand, Slovenia and Panama and have funded a faculty member to attend each of these courses. In addition, WOC has participated in the Consensus Conference on Cerebral Palsy. The President of WOC, Garry Hough III, expressed his hope that collaboration between ISPO and WOC would grow and that each WOC region would share information with the local ISPO organisation in that area.

The International Committee of the Red Cross (ICRC) had collaborated in the courses in Amputation Surgery in Thailand, Slovenia and Panama. In addition, it was the ICRC's intention to participate in the Consensus Conference on Appropriate Technology in Developing Countries.

The President reported that he had been asked to nominate people for the evaluation of US Agency for International Development (US AID) funded projects. US AID are currently seeking prosthetists/orthotists for the evaluation of funded projects in Angola and Eritrea.

Congresses

Valma Angliss (Australia) reported that the arrangements for the Eighth World Congress to be held in Melbourne, Australia were at an advanced stage. The commercial exhibit was full and the scientific programme was almost complete. A full and varied social programme has been prepared. It was anticipated that the Congress would be well attended.

The Ninth World Congress will be held in Amsterdam, The Netherlands, 28 June-3 July 1998. The Secretary General, Hans Arendzen, reported on arrangements for the Congress. Congress Organisers had been appointed and an Organising Committee has been formed. Further plans will be presented to future Executive Board meetings.

Invitations for National Member Societies to host the Tenth World Congress in 2001 are being sought. There will be an opportunity for National Member Societies to make a short presentation indicating their interest at the next meeting of the International Committee.

Nominations for Fellowship

The Belgian National Member Society has nominated Edmond Deschoolmeester and Xavier Berteele for Fellowship of the Society. The Executive Board unanimously approved both these nominations for Fellowship.

The Blatchford Prize

It was agreed that the Blatchford Prize should be awarded to Össur Kristinsson (Iceland) in recognition of his outstanding contribution in the field of prosthetics. The prize will be awarded at the Congress in Melbourne

Executive Board 1995-1998

The Executive Board that will take office at the World Assembly in Melbourne is-

S. Sawamura (Japan)	President
N. A. Jacobs (UK)	President-Elect
D. N. Condie (UK)	Vice-President
H. G. Shangali (Tanzania)	Vice-President
G. Fitzlaff (Germany)	Member
J. Halcrow (Australia)	Member
B. M. Persson (Sweden)	Member
C. M. Schuch (USA)	Member
M. L. Stills (USA)	Immediate Past President
J. Steen Jensen (Denmark)	Honorary Treasurer
B. McHugh (UK)	Honorary Secretary

N.A. Jacobs
Honorary Sectretary

Prosthetics and Orthotics International, 1995, 19, 13–14

International Center for Orthopaedic Education (ICOE)

Editors Note: At the last meeting of the Executive Board it was decided to disseminate the following information about the International Centre for Orthopaedic Education provided by the American Orthopaedic Association.

When one looks at how short and some long-term international post-training educational experiences are currently arranged, be they observerships, clinical clerkships, research or service experiences, it is apparent that these arrangements are haphazard at best. Most of these experiences are arranged on a "word of mouth" basis or by personal contacts, journal advertisements, chance meetings or prearranged relationships between institutions, countries or individuals. The individuals seeking an educational (clinical or research), teaching, or service experience, therefore, lack complete information on what experiences are available. Similarly, the offerers of these experiences may have only limited numbers of applicants because of the lack of awareness by interested or qualified individuals of these experiences. It is thus clear that a problem exists: there is currently no system to match educational needs with available resources.

The **International Center for Orthopaedic Education (ICOE)** has several preliminary goals. These include providing a central facility to coordinate and to facilitate international exchange in postgraduate orthopaedic education, and to coordinate postgraduate educational, teaching, and service experiences between countries. These exchanges are truly worldwide exchanges, not just between North America and the rest of the world.

The **ICOE** data base contains information on international postgraduate educational (clinical and basic research), teaching, and service experiences and the needs and resources of concerned individuals, associations and organizations. By having these data bases in a centralized facility, educational needs can be better matched with educational and man-power resource needs of worldwide orthopaedic associations and organizations. These needs can, for example, take the form of visiting professor programmes, instruction in new technology or even the provision of care to needy areas. By having the **ICOE** in place, organization and development or these important worldwide orthopaedic exchanges will be greatly enhanced.

The **ICOE** data base lists the educational (clinical and basic research), service, and teaching experiences of the various offering units. These offering units include orthopaedic departments, individual orthopaedic surgeons, hospitals, orthopaedic associations, countries, organizations, orthopaedic-related companies, etc. The data base includes the basic demographics of the experience as well as information such as the contact person, FAX number, etc. The educational, teaching, or service experience may be in one of many clinical or research areas. It could be a short-term observership, a short or long-term clinical experience, working in a research lab learning new techniques or it could be a "hands on" operative experience. Another type of educational experience may be attending a meeting or conference. The clinical, educational and service experiences are classified according to the recognized specialties of orthopaedics.

Research experiences include study in biomechanics, gait, metabolic bone disease, biochemistry, or molecular biology. Research experiences also include clinical research in one of the various disciplines of Orthopaedic Surgery.

Service experiences in the data base include working in a rural hospital for a short-term, Locum Tenens, a clinical rotation or a fellowship. This type of experience may even include doctors from two countries exchanging practices for a short time.

Teaching experiences include sponsored visiting professorships, the teaching of residents,

orthopaedic practitioners, general practitioners, nurses, physical therapists, or orthotists in another country. The teaching experiences available through such organizations as World Orthopaedic Concern or Orthopaedics Overseas are examples.

The data base contains information concerning the duration of the experience and the number of positions available per year. Other information addresses whether housing is provided or is available.

The data base also includes any special requirements for the educational or service experience. These include whether certain examinations need be passed, special licences be obtained, and if visas to enter the country for short or long-term experiences are necessary, etc.

The applicant data base contains parallel information. This data base includes information about the candidate's preferences and qualifications. Other information included is pervious training, language competency, academic appointment, resources available (funds), references, etc.

The offering unit and applicant forms were mailed to all international, national, regional, and local orthopaedic associations and organizations for distribution to their membership. In May, 1994, the **ICOE** will begin to match postgraduate applicants with available educational, teaching, or service experiences. The **ICOE** is available by mail and telephone and shortly will be available by modem.

The **International Center for Orthopaedic Education** is an exciting project with unlimited potential. This project will serve to promote important educational interchanges and ultimately result in better delivery of health care to patients.

To list your educational (clinical or research), teaching, or service experience; to obtain an application to seek a postgraduate educational, teaching, or service experience; or for further information about the **ICOE**, please contact:

Stuart L. Weinstein, MD, Chairman
The American Orthopaedic Association
The International Center for Orthopaedic Education
6300 North River Road, Suite 300
Rosemont, Illinois 60018-4263
Telephone: (708) 318-7349 FAX: (708) 318-7339

Prosthetics and Orthotics International, 1995, 19, 15–19

President's Report

MELVIN L. STILLS

It is a pleasure to present the report of ISPO's activities over this triennium.

The Society has continued in its efforts in education, dissemination of information, membership, and cooperation with other agencies and organisations.

Over the triennium the Society has continued to attract new members, and new National Member Societies have been formed in Colombia, Panama, France and Hungary. ISPO members in at least six other countries are in the process of forming National Member Societies. The Society now has members in 75 countries and has 26 National Member Societies.

Under the leadership of Hans Arendzen, the Publications Committee has published a new membership brochure. This full colour brochure is designed to give basic information about the Society through pictures and a brief written text. This uniquely designed brochure permits additional material to be inserted from the National Member Societies. Photographs were provided through the National Member Societies and individual contributions. A special thanks goes to Wieland Kaphingst for the photographs he provided.

Although our membership continues to increase, we still have peaks and valleys due to the increased membership during World Congress years, as a result of a reduced registration fee for Society members, and then a decline usually follows the Congress. We retain more members each year, but we still do not have the membership numbers we should have. We hope that the membership brochure will help provide information and aid in recruiting new members. It was costly to produce, but hopefully over the next triennium, it will pay for itself.

Membership of any organisation or society is a personal commitment requiring sacrifice. For some, ISPO is their only opportunity to receive scientific orthotic and prosthetic literature and to belong to a professional body. ISPO provides these members with a venue to exchange knowledge. For us in the developed world, ISPO membership gives us the opportunity to be part of a more global network. We have our own national and local societies, but today in this highly mobile society, we must know the rehabilitation health care our colleagues on the other side of the globe are providing. We thank our loyal members of the Society and welcome those of you who have only recently become members of the Society.

Over this triennium we have honoured two individuals by conferring fellowship status. The Belgium National Member Society has nominated Edmund Deschoolmeester and Xavier Berteele. These nominations were unanimously approved by the Executive Board. I am also pleased to report that Professor Willem H. Eisma has been elected as an Honorary Fellow of the Society. This is in recognition of his outstanding contribution to the Society in particular and rehabilitation in general.

Much of ISPO's activity is related to education. The Education Committee under the leadership of Professor John Hughes has been extremely active. This triennium had an outstanding start. The World Congress in Chicago was probably the largest prosthetic orthotic and related topics scientific event to date.

During the last triennium ISPO held a very successful consensus conference on amputation surgery. Information from that conference was the basis for the development of a series of instructional course. The first trial course was held in Groningen, The Netherlands, in January of 1992. This instructional course has now been repeated four times in the developing world, in Tanzania, Thailand, Slovenia, and most recently, Panama. These were costly instructional courses to run, but from the

beginning we knew they would have to be subsidised. It is the consensus of the Executive Board that it is ISPO's obligation to provide these courses in the developing world. Expense was reduced by generous support from manufacturing, by payment for participant attendance from aid agencies and by private non-governmental organisations meeting some of the faculty's participation expenses.

ISPO relies heavily on those who have a reputation of giving, including private individuals, employers, Universities, industry, and volunteer organisations. Without this support, these courses and future courses could never be provided. Thousands will ultimately benefit from the training provided. Hopefully, future instructional courses on amputation surgery and related prosthetics can be provided in the industrial world at a profit.

Another outcome of the consensus conference on amputation surgery was the production of a teaching video on trans-tibial amputation surgery. Produced by Amar Jain in association with John Guy, copies of this video are now available.

The Society has conducted another successful consensus conference during this triennium. Under the leadership of David Condie, a consensus conference on the orthotic management of cerebral palsy was conducted at Duke University in the United States in November of 1994. This consensus conference brought international experts on the treatment of cerebral palsy together to discuss treatment outcomes, and a report is now being prepared. This conference will hopefully give guidance for future development in this topic as well as providing material for a series of instructional courses. ISPO was unsuccessful in securing outside funding for this conference, and so the cost was shared by the participants and ISPO.

The Society had hoped to conduct a consensus conference on the treatment of poliomyelitis also during this triennium. Unfortunately, we simply ran out of time and resources. We were unsuccessful in securing outside funding, and due to an already full schedule of events we elected to delay any further discussion or planning regarding this important conference.

We were successful in finding funding for a consensus conference on appropriate prosthetic technology for the developing world. The United States Agency for International Development (USAID) has provided ISPO a grant that will cover nearly 80 per cent of the cost of this conference. The conference is planned for June of 1995 in Phnom Penh, Cambodia. This international event will bring together experts in the delivery of prosthetic services with the majority either working or having experience in the developing world.

The intent of this conference is to provide funding agencies and service providers a clear description of what is appropriate prosthetic technology. Cambodia was chosen as a venue because of the high amputee population and the number of agencies providing services in that country.

ISPO continues to provide advice to other international organisations and agencies. During this triennium the Society has achieved Category II consultative status with the Economic and Social Council of the United Nations and official relations with the World Health Organisation, as well as being registered with the United States Agency for International Development as a private voluntary organisation. These achievements are in recognition of our efforts to bring quality care to the world's disabled. We do have an influence on the decision makers. ISPO's message is clear regarding prosthetic/orthotic and rehabilitation engineering services. There are no short cuts to education, everyone deserves quality care, and if care is given, it must be of acceptable standards.

ISPO has also been active with the German Agency for Technical Cooperation (GTZ) and has assisted in the evaluation of the GTZ training programmes in Yerevan, Armenia; Peshawar, Pakistan; and Wuhan, China. These training programmes are designed to train professionals at the Category II level.

With the support of the American Board for Certification in Orthotics and Prosthetics, the Society has conducted trial certification examinations in the United Kingdom and Australia. Further examinations are suggested for Germany and Tanzania. The examination in Germany would aid in evaluating the translation of technical terminology as well as examining the effect of a different style training programme. The examination in Tanzania would aid in providing an evaluation of the examination of a Category II trained graduate.

These examinations have not been used to test individuals, but are a test of the examination process. The Canadian certification model is another that will need to be looked at. Fortunately, the Canadian examination has already been translated into French, and I have had the assurance from our colleagues in Canada that they would assist us in the further development of an examination process.

Certification examinations must be the initiative of the local National Organisations. ISPO can help in the development and administration of an examination, but true success will be the result of local effort. It is felt that ISPO's role would be the recognition of a credible and defensible examination.

There are other prosthetic orthotic training programmes being developed and proposed in many areas of the world. ISPO's goal is to assist where it can and to provide the guidelines necessary for the development of a quality programme. An evaluation process is in place for ISPO recognition of the Category II type training programmes.

ISPO has also aided in identifying experts to conduct evaluations of USAID War Victim Fund funded projects in Mozambique, Sri Lanka, Vietnam and Laos. The Society has also identified experts to provide short term training programmes in Vietnam. Thus far, eight different certified prosthetists have volunteered their time and talent to provide further prosthetic training in Vietnam.

The Society continues its efforts in the development of international standards through the work of the International Standards Organisation (ISO), and the Standards Organisation of the European Union (CEN). ISPO members are active on ISO-TC-168 Prosthetics and Orthotics, ISO-TC-173 Technical Systems and Aids for Disabled Persons, and CEN-TC-293 Technical Systems for Disabled Persons. Many ISPO members are active in these committees and David Condie acts as the task officer for standards, coordinating the efforts of the Society in this regard.

The Society has expanded the role of International Consultants to the Executive Board. These professionals working in geographic areas of the globe not represented by ISPO National Member Societies can provide a conduit of information to and from the areas not previously represented. They provide the Executive Board with information regarding prosthetic, orthotic and rehabilitation activities. They can also help identify other individual professionals who can be mobilised to help further the Society's mission. Our current international consultants include Črt Marinček, consultant for Central and Eastern Europe; John Craig, Rosie de Saez, Juan Martina, Jose Gomez, consultants to Central and South America; Oleg Feldman, consultant to Russia; Dr. K. Abadi and Dr. M. A. A. el Banna, consultants to the Middle East; and Dr. Seishi Sawamura and Eiji Tazawa for Southeast Asia.

Cliff Chadderton is the consumer consultant to the Executive Board. Mr. Chadderton, as Chief Executive Officer for the War Amputations of Canada, has provided a commemorative edition of *Amputation* for the World Congress. This publication is intended to inform consumers of recent advances made in prosthetics. At this point I must also recognise and thank the War Amputations of Canada for their continued financial support to the Society.

The Society continues to further its relationship with other International Organisations. It has participated in a number of international meetings during this triennium. ISPO does not simply attend meetings, but participates in the scientific programmes. As President, I have represented ISPO at the Rehabilitation International Conference in Nairobi, Kenya; the Interbor Congress in Lisbon, Portugal; and the Japanese ISPO meeting in Tokyo, Japan. We have had official representatives at many other important international scientific events.

The International Committee at its last meeting in Chicago clearly informed the Board of its desire to hold an interim meeting during this triennium. An interim meeting was held in Ballerup, Denmark, the 21st and 22nd of January, 1994. This meeting followed an Executive Board meeting held at the same location two days previously. Invitations were extended to all National Member Societies and to the identified International Consultants. All the National Member Societies participated except for Austria, China, Sweden, Denmark, Israel, Korea and Switzerland. It was emphasised that this was an interim meeting of representatives of the National Member Societies, and as such, this meeting did not

provide a policy making forum.

Committee chairmen and task officers made individual reports, and their presentations were thoroughly discussed.

There were excellent discussions among all participants of this meeting. National Member Societies had an opportunity to make presentations regarding their activities and were asked to provide information on education and training for prosthetists/orthotists and research efforts in prosthetics and orthotics in their country or area.

Twinning programmes were discussed and ideas were exchanged. The United Kingdom, United States and the Netherlands are providing successful twinning programmes. It was agreed that these activities need to be expanded in order to assist our colleagues who simply do not have the resources necessary.

Election procedures to the Executive Board were presented. Methods to ensure professional and geographic balance were thoroughly discussed. This will be an agenda item at the 1995 International Committee meeting.

The financial status of the Society was presented to the meeting. Due to successful Congresses, membership, donations and sound investment, the Society has sufficient operating capital. It was noted that with the commitment to education that the Society would expend 25 per cent of its income to run the training courses. The support of SAHVA, the War Amputees of Canada, individual members and institutions was discussed. It was agreed that the Society survives in part because of the unrecognised support it receives.

The expense of this interim meeting was high, although every effort was made to hold expenses down. The International Committee must weigh the cost of such meetings against the expenditure of funds for consensus conferences, special publications, or instructional courses. It was agreed that a great deal of information was shared, and that it was a very productive meeting and beneficial to the Society's growth.

A full report of this meeting was published in *Prosthetics and Orthotics International.*

The Society does continue in its growth and influence. The membership is its greatest strength. The individual member and his or her daily activities can do more to reduce disability associated with disease and trauma than the Society can as an organisation. The Society must continue to find new ways to mobilise its assets and influence change.

I began my triennium on the heels of the very successful Seventh World Congress. I feel fortunate to end my triennium here at this successful Eighth World Congress. This is our Silver Jubilee and we must take time to remember and give thanks to those who had the courage, vision, and fortitude to create this Society. This generation and the generations to come will benefit from their wisdom. They did not do this for themselves or us, they did it to improve the lives of those with physical challenges. A great deal of thanks goes to each and every member of the Australian Organising Committee and especially the Secretary General, Valma Angliss. Unfortunately, the only reward is the satisfaction of a job well done. I urge all the visitors to Australia to let the local Australian organisers know how much you appreciate their hard work and wonderful hospitality. I would like to thank all the members of the Society, the members of the International Committee, and the Executive Board for the confidence shown over this past triennium. Your Executive Board has worked hard to accomplish the goals and directives of the Society. I believe we have accomplished most of what we set out to do.

Each of the Executive Board members has taken responsibility and worked to the best of their ability. I am very grateful for their support and unselfish dedication. Each Task Officer, Committee Chairman and Committee Member has given 110 per cent. President Eisma told you during his Presidential report that there is a danger that activities may overwhelm the Society. If it were not for the efforts of those elected volunteers, Task Officers and Committee Members, that could easily happen. Much of what happens during a triennium is a carryover from the efforts of previous Boards and Committees. I hope this outgoing Board has assisted in the planning of future events.

There is so much to do, in so many areas, in almost every corner of the globe, that we must recruit more help. We need more people willing to give of their time, talent and resources if the needed change is to occur. Every contribution helps in the battle against disability.

You have elected a new Executive Board, and under the capable leadership of Dr. Seishi

Sawamura, a great many important events will take place over the next triennium.

In closing I must thank my family and my wife Sue for their support and understanding during some difficult times. I thank my employer, The University of Texas Southwestern Medical Center at Dallas, and my chairman, Dr. Robert Bucholz, for the time permitted to work for the Society and the support provided. I have a full clinical practice that has been difficult to manage with the frequent absences over this past three years. Susan Kapp and her fine faculty at the University of Texas Orthotic/Prosthetic programme has provided me with the highest quality technical support but more importantly simple, honest friendship. I am very indebted to the school for their support.

I have three more years to serve this Board and Society. I look forward to my new role as Immediate Past President. I would like to thank you again and I sincerely wish Dr. Sawamura and the incoming Executive Board the very best success.

ISPO – FRANCE

The Society is pleased to announce the formation of a new National Member Society in France.

Following is a list of its officers:

President:
Mr Jean-Pierre Lissac
10 quai Maréchal Joffre
69002 Lyon
France

Vice-President:
Centre de Reeducation et D'Appareillage
2 rue due Parc
94460 Valenton
France

Secretary:
Mr F. Rigal
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THE KNUD JANSEN LECTURE

Advances in prosthetic and orthotic education and training in developing countries: a personal view

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Introduction

I am grateful to have the opportunity to follow in the line of those other presenters of the Knud Jansen Lecture all of whom have influenced and helped the field of orthopaedic technology development. It is difficult, however, for me to realise the honour of standing here today.

As a child of the last big war in Europe, I became fully conscious of the problems of disability in human beings. My father, who was influenced in the principles of prosthetic technology by Professor Sauerbruch, introduced me in my youth to the problems of the profession.

Chance joined in the game when, in 1966 in Tunisia, I met Professor Mohammed Kassab - an orthopaedic surgeon who, with great enthusiasm, wanted to lead his country towards orthopaedic technological independence. His professionalism, his passion and his will led to the formation of an ideal working relationship oriented towards the development of orthopaedic technology.

The professional relationship with ISPO, with its far-sighted founders and large number of experienced specialists, contributed greatly to my understanding of the problems of insufficient or non-existent orthopaedic technology facilities in the new African countries. These problems were mostly related to the lack of sensitivity for the process of independent development and the need to turn away from the direct transfer of the technical developments from the European industrial countries to Africa. That is, there was a need to adapt known technologies to local conditions ensuring that they followed valid biomechanical concepts. In addition it was realised that the romanticised transfer of the long outdated European stages of development in orthopaedic technology was not useful in the creation of patient care systems in Africa.

This is how the work began which has essentially influenced me ever since.

Historical aspects

The inter-regional UN seminar in Holte, Denmark (United Nations, 1969) organised by the International Committee for Prosthetics and Orthotics (ICPO) the predecessor to ISPO, led to many excellent results, namely:

- foundations for the training of prosthetists and orthotists;
- details of the premises required for training; and
- job descriptions for prosthetic and orthotic personnel.

These results continue to be an essential part of professional development today. In the opening of that seminar, Dr Knud Jansen expressed hope for a suitable social status of the prosthetist/orthotist, his integration into the fitting team and the need for appropriate training. Fully aware of the matter, he pointed out the total absence of orthopaedic technological professions and structures in the "new, previously colonial countries" after the Second World War.

Industrial countries had old, traditional training structures into which even a relatively new profession such as the orthotist/prosthetist could be integrated. The best examples of that were the creation of the structure of university education in the US, and later the establishment of Scottish education at the University of

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Strathclyde in Glasgow. Other countries already had traditionally grown education courses with fixed prerequisites, a guarantee of recognition of the course, integration of the profession as well as of professional advancement. These standards and structures were lacking in Third World countries at the time of their independence and were not considered as being required or of having any priority.

At the time of Holte, the situation and environment for orthopaedic technology in the non-industrialised world was found to be very vague and without clearcut objectives. A great number of religious and private philanthropic groups, with a great deal of idealism and helpfulness, as well as international organisations such as UN and WHO, tried to alleviate disability due to epidemics, war conflicts and the like with orthopaedic fitting.

Representative of many and worth mentioning as making an important contribution at that time were:

- the World Rehabilitation Fund, mainly through the work of Juan Monros;
- Terre des Hommes; and
- UN/WHO through the work of Werner Wille.

However, it was only Wille who recognised the necessity for a structured training as a realistic help in the long run, an idea which he implemented in the WHO project in Teheran in the 1960s and 1970s.

In Uganda, Professor Ronald Huckstep when faced with the patients with poliomyelitis at the centre of his work, consequently, arrived at a long-lasting adapted technology which was suitable for mass fitting. The absence of a manpower training strategy that would have been essential in the long term, caused his long-running success to silt up again. Despite further international assistance, Uganda still has considerable problems with a continuous orthopaedic technological fitting system.

Several good attempts in various countries of the developing world worked well as long as they were receiving financial aid and specialist and professional input from the sponsoring countries or organisations. Trained local specialists, mostly from the technical field, were able to bring short term benefit, yet had:

- no social status;
- no entry qualifications for a later integration into the hierarchy of the developing public health system; and
- insufficient professional attributes or training in order to be fully accepted as a contributing partner in the clinic team.

The result was frustration with many of the individuals leaving the profession as soon as there was an opportunity and the consequent loss of the financial investment and organisational effort.

All things considered government is responsible for the care system for the disabled in any country and cannot be ignored. It is therefore important to identify this structure and to be integrated with it. Integration indeed also means that right from the beginning, the responsible foreign donors turn their attention to the objectives of the governmental public health structure of the country concerned and share in the development trends for the whole population. Care activities designed for the benefit of selected groups are detrimental to the general development.

For instance in many parts of the developing world, prostheses are offered much cheaper than those that can be made locally in governmental workshops, due to donations and third party intervention from the rich countries. It is obvious that these prices can be lower since there are no expenses for donated material, the workshops and tools were gifted and the foreign specialists provide their services free of charge as they are paid by the donating agency. The result is a severe disturbance of the long term governmental structural organisation. Such was the situation in the early 1970s in many developing countries.

Personal experiences in Tunisia

Until 1966, Tunisia had suffered three poliomyelitis epidemics with about 4,500 victims in need of orthopaedic fitting. The Governmental structures used were organised in the same way as with the former colonial power. Only one workshop existed for the supply of orthopaedic devices. It was situated at the French Embassy and it only occasionally accepted civilians for fitting with prostheses.

The newly formed Tunisian social security system, in the process of being organised, spent an average of $5,000 for orthoses for people with poliomyelitis to be fitted in France. An increasing number of victims from work and traffic accidents were also entitled to orthopaedic devices by law. Consequently, in

1966, the creation of a national fitting centre began - the Centre d'Appareillage Orthopédique (CAO).

The first organisational phase, partly with foreign assistance, led to useful results. Just as in many young countries, necessary structures were missing, including:

- statutes and administrative legislation for the care of the disabled;
- cost carriers (public, private, charitable);
- cost regulation;
- definition of scope of duties; and
- medical specialist prescription and checking of devices.

Only in 1977 was it possible by decree to establish administrative codes of practice, financial rights and responsibilities, budgets and staff planning as foundations for continuous existence and further development of an orthopaedic technology system.

In order to achieve this, the new institution, CAO, had to show professional competence, economic planning and integration into the public health system structure.

The latter was particularly important in view of the background struggle between the Ministry of Social Affairs as the major cost carrier and the Ministry of Public Health in its role as the beneficiary.

During the initial phase, an economic development of a governmental fitting workshop is largely dependent upon the recognition of the need for this by the previous cost carriers such as the Church, Terre des Hommes, Embassies and others. Habits which had become cherished by, and impressive to the public, such as fitting patients in Europe, had to be given up in favour of fitting with local devices in a governmental institution. Fitting in Europe was often linked to emotional difficulties. Children suffering from poliomyelitis, who in some cases had been absent from 1 to 2 years presented problems, such as in readjusting to the social environment, including family and school, and the long term maintenance and modification of devices manufactured abroad.

Therefore short term emergency assistance given abroad must be offered together with long term planning and the establishment of a fitting structure close to the patient and within the traditional social and economic environment.

A country-wide availability, reaching all areas, together with adapted standardised fitting techniques required the establishment of local workshops, regular consulting days held jointly with the public health services and the production of a kind of "device catalogue".

The decrease of direct overseas fitting with devices led to a new dependency. The availability of local specialists previously trained was not enough to guarantee the number of devices that were required nor the quality of the fitting of devices. The lack of key personnel with a sufficient background knowledge for a wide spectrum of different tasks became evident.

Auxiliary personnel for limited tasks were available as everywhere. Mid-level and high-level leadership personnel were, however, missing. The latter, the number of which was relatively small, could be trained in schools of prosthetics and orthotics in Europe. For the mid-level personnel, nowadays known as orthopaedic technologists or Category II professionals, special training courses were created within the orthopaedic workshops. It was possible to integrate professionally both groups into the work, however, this was done without governmental recognition vis-à-vis the development of personnel, since the premises for integration into the governmental wage structure were still missing.

Another five years were needed to solve this problem.

It is often easier to cope with professional difficulties than with related service structure problems. If administrative integration proposals are not considered and therefore neglected, the long term survival of a project will become doubtful.

The results of organisational efforts can be evaluated by means of various criteria, however, the effect on the disabled remains, in my opinion, the most important factor.

In order to illustrate this the following data should be considered:

- the number of fittings in Tunisia increased from 40 in 1966 to 2,771 in 1990;
- the governmental budget of the CAO rose between 1971 and 1990 by 187%;
- in 1968, only 2 cost carriers existed - in 1990 there were 7; and
- in 1966 the workforce consisted of 9 technical workers; in 1991, there were 132 personnel

including 106 qualified prosthetic/orthotic professionals.

The decisive factor, however, is the reintegration of the disabled into his/her family, profession and society with a totally or partially regained earning or work capacity and, for younger patients, the possibility to go to school thanks to an adequate prosthetic/orthotic fitting.

This regained earning capacity actively leads to the economic relief of society, family, social insurance or other governmental institutions.

Fundamental concepts regarding development

The target groups considered for orthopaedic technical help unmistakably comprise the greater number of disabled – usually those who do not have a substantial income and who are not covered by the developing system of social security.

As undiscriminating transfer of highly developed sophisticated technology is as wrong as the propagation of a long outdated primitive technology: a wooden leg from Napoleon's era remains a product from the early times of orthopaedic technology, even if plastic could perhaps be used instead of wood today.

The better solution is the introduction of more basic knowledge of modern techniques into the traditional possibilities of the region, or the combination of both. The best assumptions in this regard are to produce motivated, adaptable, well-trained professionals who will remain in the profession for years to come. They will become the decisive factor for further development. Even if considerable use is made of local resources and traditional handcrafts for the supply of basic prosthetic and orthotic devices, there is no way to escape the advance of the orthopaedic technology profession and the specialist orthopaedic technologist. Clear guidelines, such as initial reasons for the training, training curriculum, duration of training and examination content for the purpose of governmental recognition are of paramount importance.

The development of national fitting structures is a governmental task in the first place and can only be carried out in a country through political will. Only this guarantees a country-wide system giving access with equal rights to fitting possibilities for all disabled and which offers affordable devices with an appropriate cost-effective ratio according to the income average.

Private institutions mostly address themselves to selected and relatively small groups, such as private patients, a small geographical spread of patients or victims of natural or man-made disasters.

Thus the state has a leading and supervisory function for social and economic burdens, quality, and to pay regard to all the necessities of life.

Orthopaedic technology should not restrict itself solely to the fitting of particular groups - such as disabled war victims and there possibly only the wearers of prostheses. An example of our experiences in Vietnam is of interest in this regard. The appropriate Ministry for Work and Social Affairs, MOLISA, is also responsible for the orthopaedic fitting of war victims and therefore is prostheses oriented. A badly required cooperation with the public health services for the fitting of civilian victims does not exist. Other governmental institutions feel that they are also not competent – very little is happening. The normally very positive attempts of foreign voluntary organisations to meet the needs have, however, turned into a hindrance rather than an improvement for the development of orthopaedic technology in this country, due to the absence of a specific country-wide structure.

The fitting output also implies that the disabled can re-integrate into his social environment and, above all, that repairs and renewals of devices must be guaranteed. In Malawi for instance, alongside the governmental, long-term fitting system, there exists an adapted fitting structure, Malawi Against Polio, with a different fitting background and philosophy. Thus, the disabled can be re-integrated into his normal environment in the sense of a true rehabilitation, and in the sense of a fitting appropriate to his particular situation. Rehabilitation should not mean that the disabled person must adapt to his device!

Transfer of the concepts to Togo and Tanzania

The demands placed on the specialist in developing countries are not smaller, but rather considerably higher than that required by his counterpart in the industrial world. Not less, but

Fig 1. CNAO, Lomé, Togo.

more knowledge and science than in industrial countries are required there. The transposition of the fundamental concepts of kinesiology and ergonomics for the special needs of the disabled in a very different environment is necessary in order to design and manufacture the devices, combine locally available resources with the worldwide standard of development, and take into consideration traditional technologies. With the subsequent projects in Togo and Tanzania, the attempts were made to move forward on the experiences gained in North Africa.

The establishing phase of the Centre National d'Appareillage Orthopédique (CNAO), Togo took place during the period 1972-80.

The establishing phase of the Tanzanian Training College for Orthopaedic Technologists (TATCOT), Tanzania was in the period 1982-88.

A comprehensive and comparative study of disabled fitted with devices in Togo as well as in Tanzania, carried out by Professor George Neff, confirmed among others the following assumptions:

- devices made using local technology and with available maintenance and repairs could be used longer and more intensively;
- the necessity for maintenance of the devices was proven by the fact that more than 50% of the devices were defective and required maintenance;
- the lack of maintenance considerably limited the use of the devices and shortened their life. This led to a lack of economic and physical integration for the disabled;
- for children and adolescents, a timely re-adjustment of the devices to onsets of growth is of great significance for the state of health and/or the avoidance of further physical damage;
- in addition to an often limited possibility to visit the workshops or the absence of such workshops, a lack of consciousness for timely
  - maintenance was an essential reason for the defective condition of the devices;
- the fitting of lower limbs has absolute priority! All other devices in the individual cases are indeed also necessary, however, as far as numbers are concerned, they are only of secondary importance. In addition, the basic need to ambulate is of paramount importance in developing countries; and
- it was also interesting to notice that apparently male progeny take precedence when children are sent for the fitting.

In addition to the professional knowledge gained and the confirmation of a number of assumptions, these surveys were of great value for the planning of future projects and investment in training and supply with regard to social and development policies.

Consequently, a national fitting system (the CNAO) has been established in Togo, in

Fig 2. Self help in the community

association with the collaboration of churches and other voluntary organisations. The CNAO has found considerable interest among all persons concerned. Problems arose only in the establishment of its financing.

The state, backed up by the rudimentary beginning of a social insurance system, was able to provide only a basic guarantee, i.e. the disabled had to be directly or indirectly responsible for sharing the costs. Regardless whether this participation was claimed in the form of a working contribution for the workshops or as a percentage in money, it met with the resistance of individual religious groups which did not want their patients to be subjected to an assessment by the governmental social service.

A comprehensive fitting structure which managed to offer a broad range of devices and regular availability, gradually prevailed. At distant regions, religious and other organisations came to the rescue with transportation, organisation of consulting days, and simple repair possibilities in the sense of the presently propagated WHO philosophy on Community Based Rehabilitation (CBR).

The participation of patients in the fitting costs proved positive, however, as it considerably increased the self-interest in the longevity of the devices.

From before 1972, when no fitting structure existed in Togo, until 1992, a national country-wide fitting system with several workshops developed. It oriented itself toward providing devices adapted to the local cultural, climatic and economic environment based on orthoses and prostheses from industrial countries.

Local developments, adapted to the environment, in this and in other projects are, for instance:

- leprosy shoes (Togo);
- poliomyelitis device without shoe, with wooden sandal (Tanzania);
- club foot orthosis (Tanzania);
- ICRC foot (Vietnam);
- Jaipur foot (India);
- the direct lamination socket for the lower leg, a fitting following amputations due to leprosy (Tanzania); and
- ICRC polypropylene components.

In order to make such developments, it is

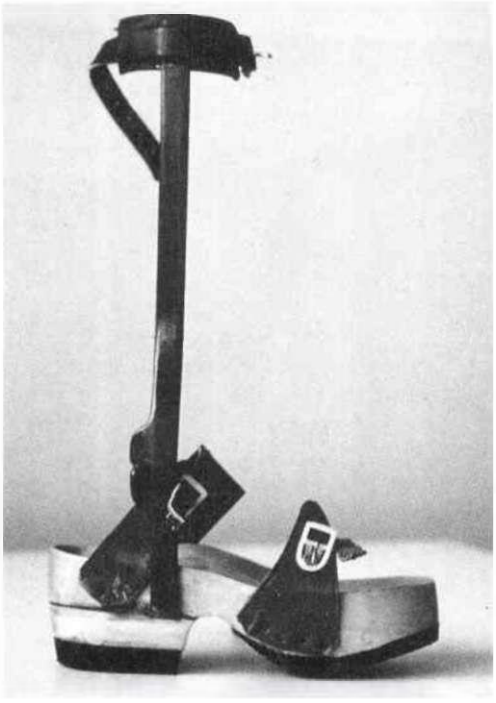

Fig 4. Corrective orthosis on wooden shoe.

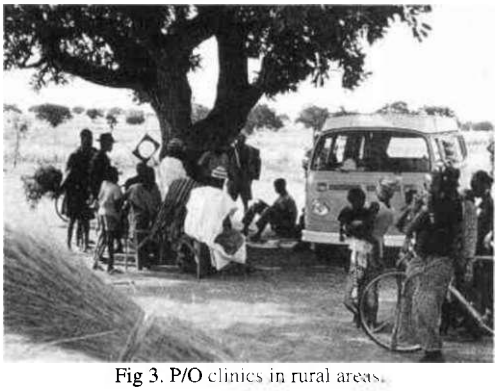

Fig 3. P/O clinics in rural areas.

Fig 5. Direct lamination technique.

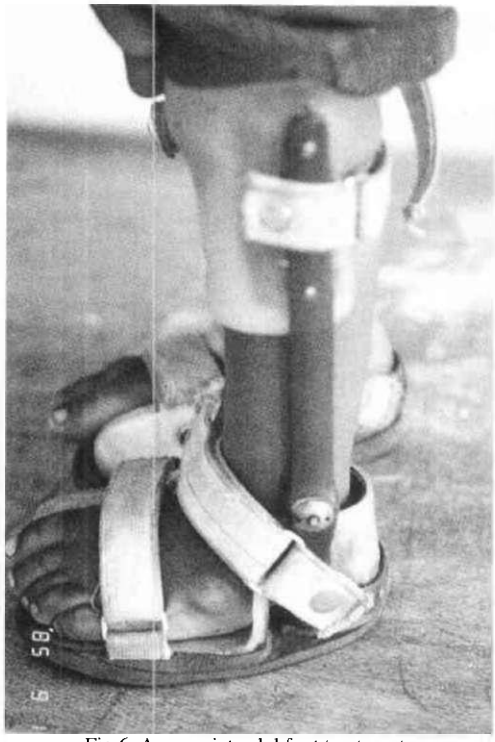

Fig 6. Appropriate clubfoot treatment.

necessary to provide local specialists with the background and the intellectual level required to understand concepts in prosthetics and orthotics, e.g. how to stabilise joints; why joint function necessitates parallelism of splints; or how to design the alignment of a prosthesis or an orthosis so that the patient may use it safely in his environment and at his work.

The use of specific materials for these purposes is of secondary importance. The specialist, however, must be in the position to make the necessary locally defendable choice and even to improvise, if need be.

Ariadne's clew, that is the need for suitably trained professionals, determined to the largest extent the development concepts in developing countries.

Attempts, often very good, conducted by the United Nations, World Rehabilitation Fund, International Committee of the Red Cross, Terre des Hommes and others, to train qualified personnel, mostly failed because there was:

- no adequate nor permanent government supported training budget;
- a lack of entry qualifications to the training course;
- no formal recognition of the final outcome of the training course;
- a lack of recognition of professional profile;
- a low social status of the trained specialists; and
- only limited specialised technical knowledge in the trained personnel

The higher and better qualifications of physicians and other paramedical professions has led to an attitude of higher expectation towards the orthopaedic technological team member and his knowledge.

A three-year training concept has been developed via the projects in Tunisia, Togo and Tanzania, as a development of the training programme started by Wille in Teheran. The recommendations in Holte, in 1969, with regard the training curricula in prosthetics and orthotics have constituted the professional framework with a strong influence by the German dual training system, i.e. practical experiences combined with structured classroom education.

Region-oriented training objectives and professional profiles are crucial to the training programme. The above-mentioned criteria for the adaptation of the fitting technology to local situations constitute the basis of the central direction of the practical work. However, the three-year specialist training should meet internationally recognised standards. The "orthopaedic technologist" has been the significant outcome of this long term development.

The practical education intentionally includes exposure to component manufacture as part of the training. The instruction in component manufacture is a solid basis for the adjustment of devices to particular local conditions.

The quality of training can be objectified only indirectly, that is not by examination at the end of the course but by later assessing the standard of work provided to the patient, as well as assessing the continuity and development of the profession. Over 80% of the graduates from CNAO, Togo and TATCOT, Tanzania are still practising within the profession, usually occupying leading positions. The much looked for multiplication effect where trained personnel can pass on their experience is thus well on its way to being accomplished.

A survey made in 1987 among former students from Togo and Tanzania showed that:

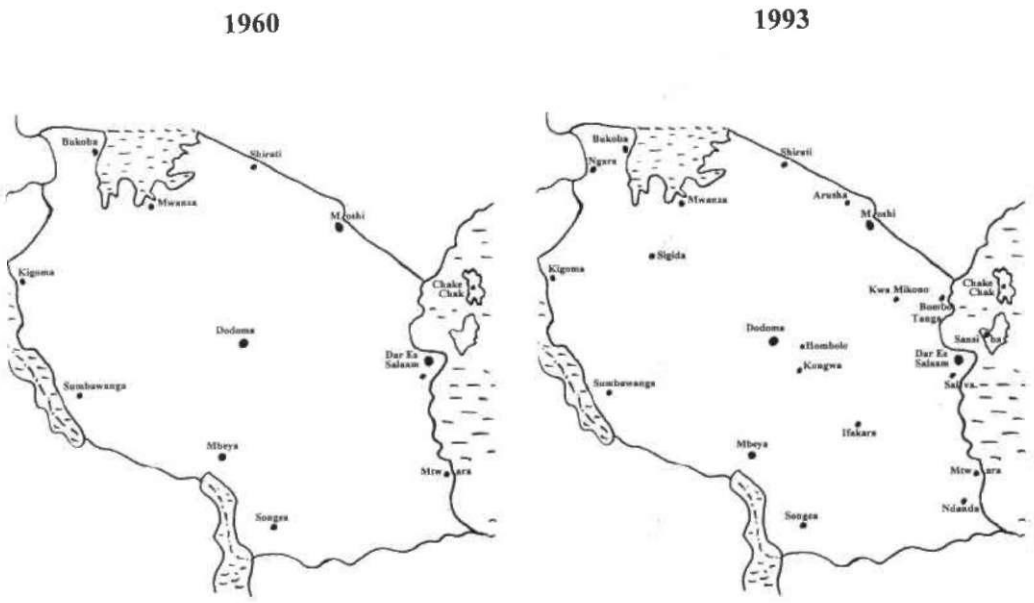

Fig 7. Prosthetic and orthotic workshops in Tanzania in 1960 and in 1993.

- 100% has a better professional chance in the wake of the training;
- 78% had a professional improvement; and
- 71% said they had a responsible and leading position.

In Tanzania, so far 163 graduates from 19 English-speaking countries have been graduated. During the same period, 121 orthopaedic technologists have been trained in Togo for the French-speaking area.

Objectives and perspectives

As a result of the experiences gained so far, it has been possible to confirm the areas that are considered to be cornerstones when organising an orthopaedic technological care system. These are:

- a guarantee of the necessary professionals in the clinic team, as a development potential;
- organisation of a national country-wide rehabilitation service for the general population;
- integration into the national rehabilitation services; and
- long-term survival of the orthopaedic workshops.

Advice on the professional structure with regard to the specific conditions peculiar to a country should be required for any project attempt in the future, in order to ensure a sound economic basis and a possibility for staff development in the future.

A relapse into national or regional isolation of the professional manpower must be avoided, for instance with continuing help and advice through:

- personnel exchange;
- short courses on new techniques;
- refresher courses;
- attendance at conferences; and
- exchange of information.

Organisations such as ISPO, INTERBOR, national professional groupings, partnerships, and, not to forget, personal relationships, lend their services in this respect.

Development also rests on information exchange and its transfer into practice. Teamwork must evolve which will result in better communication and improvements in fitting technologies, material testing, and design of devices through the application of solid fundamentals. The transfer of information amongst the prosthetic/orthotic specialists must develop into a professional habit. Newsletters and regular information papers are excellent aids for long term planning and personal developments in this regard. However, they must reach the specialist on the spot and be affordable!

In this respect, the inter-disciplinary work

too, is of great importance. The exchange of information on the purpose and practical outcome in the field of patient treatment and fitting constitutes an excellent basis for the development of orthopaedic technology.

Cooperation for development and results

The development of a closer cooperation between several organisations with similar objectives such as the International Committee of the Red Cross (ICRC), the German Agency for Technical Cooperation (GTZ), ISPO and WHO eventually led to a workshop held in Moshi, Tanzania in 1984. The subject of the workshop was education, training and clinical services in prosthetics and orthotics in developing countries (ISPO, 1985).

The major outcomes of the workshop were:
- to establish the training needs for developing countries;
- to develop the concept of the mid-level professional, the Orthopaedic Technologist; and
- attempt to categorise the different professionals working in the field of prosthetics and orthotics.

This process continued in the ISPO workshop held in Jönkoping, Sweden in 1985 (ISPO, 1987) and continued in the WHO consultation held in Alexandria, Egypt in 1990 when the international trends were analysed and the manpower needs defined (WHO, 1990)

As a result of all these seminars, the professional title, Orthopaedic Technologist, has been accepted internationally which describes a Category II or mid-level professional who has undertaken a three-year specialist education and training course in a developing country. A development of almost 20 years, some 22 years after the Holte Conference, had come to a conclusion and henceforth determined the direction of education and training in prosthetics and orthotics in developing countries in the future.

In the meantime, the ISPO had established a professional educational standard ensuring quality through the examination and recognition of training centres and training courses. The foundations for nationally oriented development had been improved in the long term. A series of related workshops organised by the United Nations Centre for Social Development and Humanitarian Affairs in Tanzania, Togo, Guinea and Jordan (University Rehabilitation Institute Ljubljana, 1988; 1989; 1993; 1993) support the developments and recommended:
- intensive international cooperation;
- comprehensive information exchange;
- improvement of the professional status of the professionals; and
- the spread of appropriate technologies.

The use of thermoplastic materials such as polypropylene has more and more superseded the use of traditional materials such as wood, leather, aluminium and steel. In large areas of the world natural resources diminished or developed high prices. In the meantime, polypropylene has become a true alternative for the following reasons:
- it is a low cost material;
- it has only 3-5% waste;
- it needs considerably less use of machines and tools; and
- it is hygienic.

Polypropylene is presently used to manufacture all kinds of lower limb prostheses including those for trans-tibial, trans-femoral, ankle, knee and hip disarticulation and partial foot levels.

Should it be possible to diminish the working time for measuring and casting work by means of using the CAD CAM technology for trans-femoral socket manufacture, then another step will have been accomplished towards a fitting of higher quality, while simultaneously reducing the costs.

A centralised fitting and fabrication system, without expensive patient travelling and the ensuing high costs, opens new prospects for a cost-effective system of fitting devices – even in developing countries.

Summary of development 1968-1993

At the present time in the China Training Centre for Orthopaedic Technologists (CHICOT) in Wuhan, China, all the basic elements that enable the organisation of a national training and education course and its recognition have been brought together. These include:
- a compulsory professional image, the orthopaedic technologist;
- internationally determined training curricula;
- an internationally recognised and established training and examination procedure;
- possibilities of higher level courses for

leadership personnel; and
- upgrading courses for senior workshop personnel, aimed towards orthopaedic technologist level.

CHICOT exhibits the means for the improvement of the general fitting quality in the country, taking into account the social acceptability:
- the ICRC polypropylene technique;
- the knitting together of CAD CAM centralised fitting and fabrication techniques with the needs of the rural population;
- simple fitting with plastic orthoses; and
- improvement of fitting techniques within the professional team.

CHICOT – as a training centre of the Central Government – advises the relevant Ministry in Beijing with regard to:
- changes in the structure of the appliance delivery system;
- proposals related to basic appliances for the future cost carriers;
- cost calculations;
- introduction of new fitting techniques in order to widen the choice available; and
- advising the management of prosthetic and orthotic centres.

All the aforementioned fields of activity have a causal relationship with the improvement or the initial organisation of an orthopaedic technological fitting system. This coincides with the present strategy of the GTZ – as far as projects in orthopaedic technology are concerned.

The influence of the trained African professionals on their respective home countries can already be seen. About 90% are active in their profession and most are in positions where they can influence not only the fitting tasks, but further development as well.

An improvement of the quantitative fitting is noticeable. In 1968, there existed hardly any regulated orthopaedic technological fitting systems in 30 African countries – today, 27 years later, every African country has at least a central workshop and a developing governmental delivery system. There are now workshops available that provide up to date devices.

The orthopaedic industry too is recognising that only a well educated and trained core of specialists is able to influence development and thus become a focal point for the industry. New initiatives may evolve from mutual assistance for development with and from the industry. At the same time, feedback information regarding needs is important for the future development of components.

Not only do resources and materials go into the Third World, but in return ideas come out of developing countries which can be incorporated to treatments. An example of this is a walking plaster made from plastazote for the treatment of diabetic plantar ulcers, which was successfully used in Tübingen in the past and presently used in Berlin. This was derived from a technique used for the treatment of leprosy patients.

The increasingly active participation of professionals from the Third World at international conferences and seminars is a significant sign of the development of a new generation of interested and qualified specialists.

Open questions

Until today, the question remains open as to what appropriate technology actually means. A central topic of the workshop in Jönköping in 1985 was the introduction of appropriate technology into the prosthetic and orthotic manufacturing processes but under control of the professional. Attempts were also made to classify the different levels of technology used.

For me, appropriate technology is that which is the most suitable for a specific environment but applied in a sound biomechanical fashion by the professional. To this end many different technologies can be used. Thus, at the lowest level, simple technology can be applied, whereas at the upper level there are no limits. Every specialist must question appropriate technology which does not correspond with biomechanical principles. There must be no professional relaxation of basic principles. Simple technology should be used as a first aid under certain circumstances especially in a disaster or crisis situation but should lead to the use of a normal appropriate technology where transient local resources are the main influence. Adaptation to local habits, such as squatting, sitting cross-legged or walking bare-foot has still not been incorporated sufficiently into component production.

Cooperation in development with the industry could be an investment in the future.

For instance, the development of components at socially affordable prices adapted to the conditions of the respective regions. The individual manufacturing of components for prostheses and orthoses, as still practised in many fitting centres, cannot represent a solution. An orthopaedic technologist has not been educated to produce components such as knees or feet. He has been trained to fit prosthetic and orthotic devices to patients and he should spend his time doing that.

In the field of social acceptance of a fitting delivery system, many questions still remain unanswered. Rigorous cost calculation and a greater cost consciousness are necessary for the survival of a care system.

The possibilities of using a central fitting and production system using CAD CAM production technologies are still in their infancy and need to be explored as far as:

- improvement in the quality of devices provided;
- decrease in the often considerable overhead expenses in order to reduce the costs of devices; and
- a better utilisation of the professional potential for the best fitting to the patient.

The manpower development invariably remains the focal point of all development activities. The individual recognition of a professional level of the various training centres and the introduction of independent examinations for upgrading of qualifications, has still not been fully achieved. In the future training for Category I personnel, the high level prosthetist/orthotist, for developing countries needs to be considered.

Above all, the instruction of the instructors has to be kept in mind.

The results reached so far are good and should stimulate us all in order to plan and achieve further advances in the development and the improvement of prosthetic and orthotic services throughout large parts of the world.

Everything that has been achieved to date has only been possible because of the interest and enthusiasm of individuals in all these countries and I would like to take this opportunity of thanking them for all their help and efforts in realising the activities that I have attempted to describe.

Thank you for your attention.

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British Standard (BS) 5750 – quality assurance?

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Abstract

BS5750 is the British Standard on "Quality Systems". Its equivalent in European Standards is EN29000 and in the International Standards Organisation ISO9000. This paper points out that these standards lay down formalised procedures and require documentation but do not *ipso facto* lead to quality assurance.

The author points to the Japanese post-war industrial success as being an example of Total Quality Management within the framework provided by the philosophy of Dr. W. Edwards Deming (1988 and 1993). This philosophy on the management of "systems" to provide high quality products and services is briefly outlined.

The author argues that improvement in prosthetic and orthotic services will not be reached through implementation of BS5750 but rather through radical rethinking and the adoption and application of the Deming philosophy.

Introduction

BS5750 has been promoted in the United Kingdom in parallel with its European (EN29000) and International (ISO9000) counterparts as a means of ensuring quality of products or services. The National Health Service, purchasing section has insisted that all orthotic and prosthetic companies trading in the UK must satisfy BS5750 or its equivalent, The standard has also found a place within the new European Medical Devices Directive (93/42/EEC) as forming part of the conformity procedure. This has placed a considerable bureaucratic and administrative burden on companies, many of which are small, but the actual benefit of this certification as a means of *ensuring* quality is, at the very least, questionable. This is not to say that the process gone through to attain BS5750 has not been of value to some orthotic and prosthetic companies. Many of these are small and had few formalised procedures; although this was found in larger companies as well. The process of formalising and documenting meant that the processes within the company were examined and perhaps altered which gave some semblance of improved quality by tighter control of procedures (this should have been carried out regardless of the need for BS5750, but was lacking generally in the orthotic and prosthetic industry). However, this article will detail where BS5750 fails in its objective of guaranteeing high quality services or products and will outline the preferred process whereby high quality is both *assured* and *improved*.

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The problem with BS5750

The main tenet of BS5750 is that by writing down, and adhering to, set procedures a high quality product or service will be produced. This unfortunately does *not* ensure quality, only repeatability and conformity to a standard. What is more, the standard is set by the host company or institution at a level of its choice. Rarely will anybody set a target or level that is unattainable as it would immediately invalidate their certification, so they set ones which are attainable. Having set these targets they are just required to reach them to maintain their certification which does not ensure anything other than the company or institution has met an attainable target yet again. To prove to the auditors that this level has been attained and

non-adherence has been rectified, a vast amount of documentation is produced which again does nothing to ensure a high quality product or service. It is just part of the audit trail required as part of the certification process.

There was a need within the industry for more formalised inspection of products and services which had a beneficial effect on the quality of the product or service but the dependence of a quality assurance system on mass inspection as the main process will not work. There is a commonly held belief that to have a high quality product or service requires lots of inspection. This however slows down the process, which reduces the profits and could, in the extreme, lead to cessation of trading. This is not the case if a proper Quality Assurance (QA) system is used, as improved quality will lead to a reduction in waste of materials, time spent on re-doing jobs, time spent correcting the "process" and management time. A sound QA system will lead to higher quality, lower unit costs and higher effective capacity (for all parts of the system including manufacture, ordering, sales, administration and management). In other words proper Total Quality Management (TQM). This aims to treat the whole of the company (or office or department) as one system and manage its processes with one common aim in mind; customer satisfaction. By adopting this attitude the whole system can be managed efficiently and with improving quality.

TQM, the alternative

These do sound like rather grand claims but all of these, and more, have been proved to be true if this fundamental change in the way in which the whole system (company, workshop, hospital, etc.) is viewed is adopted. To explain this, the background to a major international success story needs to be outlined as it sets the scene for the rest of this article. Just after World War II the Japanese industrial "machine" was devastated. As they needed to get back into effective production quickly a method was sought that would provide this. However, with great foresight they chose not to copy their old ways but to look for another system which would *ensure* that their output would be of such high quality that their products would be purchased in preference to those from more established companies and countries. In the 1940's and 50's they employed the services of Dr. W. Edwards Deming, a statistician by training. However, it was not mainly for his statistical prowess that they employed him but for his philosophy on the way to manage a "system" so that a high quality product or service would result. This management system is so designed that it involves everybody in the company or institution in working together towards a high quality product or service. This may sound naive but it works because people work *in* the system and with their help management works *on* the system to improve it continuously. Although some procedural systems, such as parts of BS5750, may form part of TQM, an emphasis on people rather than systems and procedures forms one of TQM's key features and distinguishes it from more restricted approaches to quality management which concentrate on a rigorous adherence to procedures.

The success of the Deming approach is there for everybody to see. Japan has made an enviable reputation for itself and one has to ask the question, "what have the Japanese got that others haven't?" Apart from a different work ethic, the answer is, of course, nothing. They found it easier to accept Deming's approach as it was in line with their attitude to work and the employer. But, by applying the Deming approach *any* company producing any product or service will benefit by a marked and continual improvement in quality, How can this be done? To answer this question some illustrations of the success and use of Deming need to be presented followed by the fourteen basic rules of management set out by Deming.

The train arriving late is now on time! and other stories

There are too many instances where numbers and statistics are manipulated to provide support for a policy or change. This occurs in Government, companies, hospitals, etc. and is so commonplace that we can be unaware of its use. Statistics should be used only to help to monitor and improve an aspect of manufacture or policy. Unfortunately, many people and organisations use statistics like a drunkard uses a lampost – for support rather than illumination. It is felt that rather than tackle the problem the statistics have revealed it is better to alter the way in which the statistics are collected or analysed to produce a false level of implied

quality. An example of this was to be seen in the Daily Mail on 16th July 1987 in which could be read "The train now arriving late is on time". This recounted the story that British Rail had considered trains which arrived within 5 minutes of their timetable schedule to be on time, but now this limit was to be extended to be within 10 minutes! This certainly made the system look better but did nothing to solve the underlying problem of late arrival of trains. In comparison, in Japan the trains are so reliable that a visitor to Japan who asked the ticket inspector to tell her when a certain station had been reached, as she could not read Japanese, was told "Don't worry, just get off the train at 10.46"!

More important than this trivial example is that of Hewlett Packard in the UK who, early in the 1980's had a component quality level (Acceptable Quality Level or AQL) of 1%. This was the worldwide industry norm and meant that, for example, in each moving message display of anything up to 15,000 light emitting diodes (LEDs) about 150 would be defective. To correct this all of the failed LEDS had to be unsoldered and replaced by hand, with the replacement LEDS being subject to the same quality level. This would usually mean a second process of replacement to make the final display work. By 1983, after applying the principles of Deming, the level of component failure had been reduced to 50 parts per million, ppm (1% AQL = 10,000 ppm). This meant that, using the example of the LEDS, the failure rate now represented one failed LED for every 200 moving message displays, with concomitant savings in replacement time and materials etc. However, there has been a reluctance to accept the principles of Deming in the western world due to the inability to readily accept that there is anything wrong. To many of us it is inevitable that some trains will run late instead of all being on time. Many of us accept that mistakes will be made that have to be corrected and we do not understand that developing systems for dealing with these mistakes, handling rework in all activities, not just manufacturing, but also administration and other services is hugely expensive. The first step is to get over the belief that what we are doing is right. The whole approach of management needs to be changed from the *Directive* or *Results Management* to what is called *Process Management.*

A definition of quality is contained in BS4778 as "the totality of features and characteristics of a product or service that bear upon its ability to satisfy stated or implied needs". Defined in this way, the assurance of quality relies upon effective management of all those affairs of an organisation which influence the satisfaction of customer need. This cannot be achieved if the customer is not part of the QA system as customer satisfaction is fundamental to the whole process. Yet how many orthotic/prosthetic companies actually involve their customers in their QA system? This does not mean that companies do not sometimes ask selected customers for their opinion but this is not the kind of total inclusion in the QA system which is envisaged by the Deming approach.

The fourteen fundamental ways (or "Obligations") in which this is brought about are listed below together with a brief outline. This is not a comprehensive list of how to employ Deming's theories but more of an introduction to his philosophy. One aspect of these which is very important is that of training which is considered as the single most important factor in actually improving quality. It is necessary to state that not all of what Deming mentions is new as some of these aspects are well accepted in existing management theory. What was, and still is to many, new is the totality of the approach.

Deming's fourteen points for management

1. Constancy of purpose
   Create constancy of purpose for continual improvement of products and service, allocating resources to provide for long-range needs rather than short term profitability, with a plan to become competitive, to stay in business and to provide jobs.
2. Implement the new philosophy
   Adopt the new philosophy. We are in a new economic age, created in Japan. We can no longer live with commonly accepted levels of delays, mistakes, defective materials and defective workmanship.
3. Cease dependence on inspection
   Eliminate the need for *mass* inspection as a way to achieve high quality by building quality into the product in the first place.

4. End lowest-tender contracts
   End the practice of awarding business solely on the basis of price tag. Instead require meaningful measures of quality along with the price; price has *no* meaning without a measure of the quality being purchased.
5. Constantly improve the system
   Improve constantly the system of planning, production and service, to avoid problems, to improve quality and productivity and thus constantly decrease cost.
6. Institute training on the job
   Institute modern methods of training, and retraining on the job for all, including management, to make better use of every employee.
7. Institute leadership
   Adopt and institute leadership aimed at helping people to do a better job. The responsibility of managers and supervisors must be changed from sheer numbers to quality. Improvement of quality will automatically improve productivity.
8. Drive out fear
   Encourage effective two-way communication and other means to drive out fear throughout the organisation so that everybody may work effectively and more productively for the company.
9. Break down barriers
   Break down barriers between departments and staff areas. People in different areas such as Research, Sales, Administration, etc. must work in teams to tackle and prevent problems that may be encountered with products or service.
10. Eliminate exhortations
    Eliminate the use of slogans, posters and exhortations for the workforce demanding zero defects and new levels of productivity, without providing methods. Such exhortations only create adversarial relationships; the bulk of the causes of low quality and low productivity belong to the *system*, and thus lie beyond the power of the workforce.
11. Eliminate arbitrary numerical targets
    Eliminate work standards that prescribe arbitrary numerical quotas for the workforce and numerical goals for people in management. Substitute aids and helpful leadership in order to achieve continual improvement of quality and productivity.
12. Permit pride of workmanship
    Remove the barriers that rob workers of their right to pride of workmanship. This implies the removal of the annual merit ranking (or performance appraisal) and of Management by Objective. The responsibility of managers, supervisors, etc. must be changed from sheer numbers to quality.
13. Encourage education
    Encourage education and self-improvement in everyone. People require, in their careers, more than just money; they need ever-broadening opportunities to add something to society, materially and otherwise.
14. Top management's commitment
    Clearly define top management's permanent commitment to ever-improving quality and productivity and their obligation to implement all of these principles.

Many of these points may read initially as idealistic and incapable of implementation. This is wrong as many companies outside Japan have now found to their great benefit. This is not a Japanese system but a system devised by an American and first implemented in a meaningful way in Japan. It can and does work and is encapsulated in Deming's "Chain Reaction" (Fig. 1).

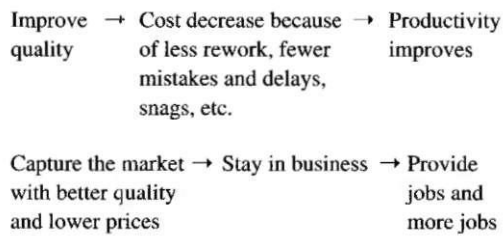


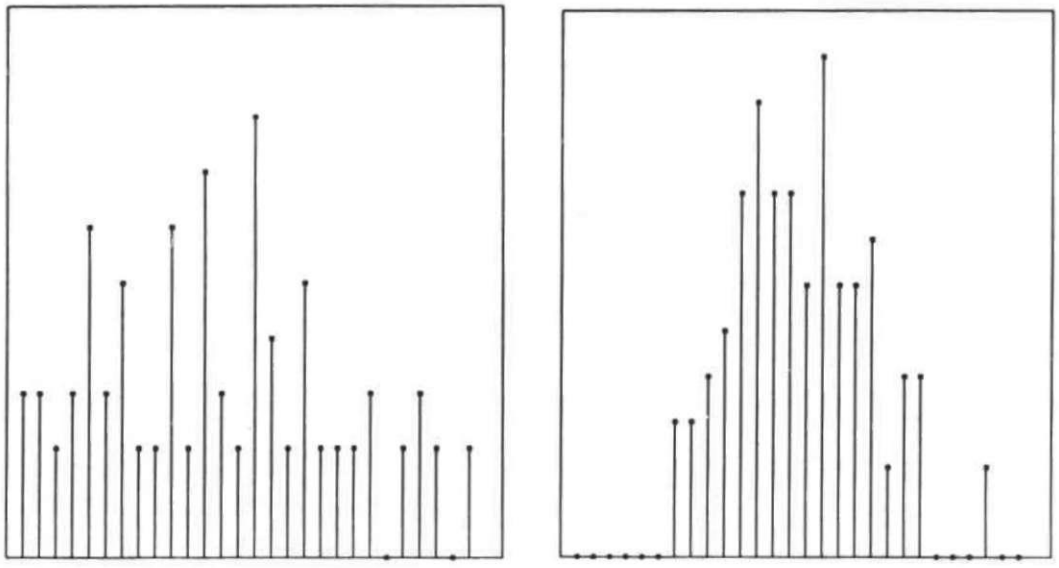
Fig. 1. Deming's "Chain Reaction"

To make the best use of the Deming points for management the use of Statistical Process Control (SPC) is vital. However, the blind use of statistics has already been shown to be useless. What is required is the targetted use of SPC to aid the Deming philosophy. Shewart (1986) was the first to recognise this and the combined value of Deming and Shewart is well

illustrated by the experience of many companies. Fundamental to the use of SPC is the understanding of variation. No two products or service elements will be exactly alike because any process contains sources of variability. The source of the variability is either common cause or special cause. The former of these is generally outside the specific control of the system but special cause variations are controllable. The monitoring of this variation and its time history with Control Charts will provide the necessary information to allow the system to be adjusted, when appropriate, to counter those effects which can be controlled and not to waste time trying to correct common cause variations. Without the proper use of Control Charts there is no way that the two causes of variation can be differentiated. The actual specifics of this are well outside the scope of this paper but are fundamental to effective TQM. However, a useful example of the waste of time, money and personnel on trying to "control" common cause variation can be illustrated by the experience of the Ford Motor Company.

The following is adapted from Scherkenbach (1986) and relates to the effort Ford put in to trying to control the turned diameter of transmission input shafts. They reasoned that if they installed an automatic compensation for the turning machine, when a shaft came out too wide the next one would be made smaller, and vice versa. This they hoped would produce more uniform shaft diameters and hence improve their quality. On the face of it this was a logical approach but it totally failed to recognise that the variation in shaft diameter was generally a common cause variation – due to aspects such as ambient temperature variations, cutting speeds, humidity, exact material properties of the stock metal, etc. There will be small variations in all of these which are essentially uncontrollable by the intervention of adjustment to the final diameters. Figure 2(a) shows the variation in shaft diameters with the automatic compensator in operation. No shaft is outside the limits but there is a random spread of diameters between these limits. Figure 2(b) shows the shaft diameters with the automatic compensator switched off – resulting in reduced variation. How could this be?

The answer is that the production process was already in statistical control. Without the compensation device the process was already exhibiting its lowest variability as only common



(a) (b)

Fig. 2. Shaft diameters
(a) Automatic compensation turned on.
(b) Automatic compensation turned off.

causes were present. Reduction of that variability could only be produced by improvements in the process itself, i.e. more stable temperatures, steadier cutting speeds, etc. The compensation device was not an improvement in the process but is an example of what Deming calls "tampering" with a stable process. The use of Control Charts and related SPC would have shown the lack of need for the compensation device.

This is a brief paper to outline why the path to quality improvement via BS5750 is fundamentally wrong and how a more proven way is via the Deming philosophy. The attitude of most managers, company executives, etc. about this approach, is that "we do not need to change – we are doing this right already". In reply to that kind of statement the following quote from Daniel Boorstin in The Discoverers is of value–

"The greatest obstacle to discovering the shape of the Earth, the oceans and the continents was not ignorance but the illusion of knowledge."

What this is saying is that, with respect to our orthotic/prosthetic products and services in this country, we too have a flat earth mentality. We cannot let go of the things that we believe to be correct. For us, therefore, it seems inevitable that our orthotic/prosthetic workshops will produce some percentage level of scrap and rework and that some devices will not be ready on time. The first step is to get over the belief that what we do is right.

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Editor's note: In July 1994 BS5750 was formally renumbered as BS EN ISO 9000.

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A biomechanical comparison of the SACH, Seattle and Jaipur feet using ground reaction forces

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Abstract

The Jaipur prosthetic foot was developed in India in response to specific socio-cultural needs of Indian amputees. It is being used extensively in India and several other developing countries. Its claim of being a cheaper and satisfactory alternative to other prosthetic feet has not been investigated biomechanically. The present study was undertaken to compare its biomechanical properties with the SACH and Seattle feet, using ground reaction forces.

Three trans-tibial amputees participated in the experiment which measured the ground reaction force data using a Kistler force plate. Subject's normal foot was used as a reference. Six variables from the vertical and anteroposterior components of ground reaction forces were quantified. their statistical analysis showed that the normal foot generates significantly larger ground reaction forces than the prosthetic foot. The shock absorption capacity of the SACH foot was found to be better when compared with the other two feet, while the Jaipur foot allowed a more natural gait and was closer in performance to the normal foot. None of the prostheses significantly influenced the locomotor style of the amputees.

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Introduction

The last decade has seen many technological and material developments in the field of lower limb prosthetics. This includes a greater understanding of biomechanics, extensive use of CAD CAM techniques and the availability of new and composite materials. Expectations of amputees have also increased in terms of a greater desire to participate in recreational and sporting activities. these advances have led to the evolution of several new designs of ankle-foot assembly. The most exciting amongst these are the so called "energy storing prosthetic feet" (ESPF), of which the Seattle foot is the most popular example. In spite of the increasing popularity of these new designs they have hardly dented the dominance of the SACH foot which due to its unique properties, is used throughout the world.

Another significant development which has largely gone unnoticed is the evolution of the Jaipur foot from India. It is widely used there and in several other developing and under-developed countries. It has not been recognized in the developed world presumably due to a lack of awareness and the absence of its biomechanical evaluation. There is also a popular impression that it is meant for barefoot walking, although amputees do use it satisfactorily with shoes.

The Jaipur foot came into existence in response to socio-economic and cultural needs (of squatting, cross-legged sitting and barefoot walking) of Indian amputees. It consists of three

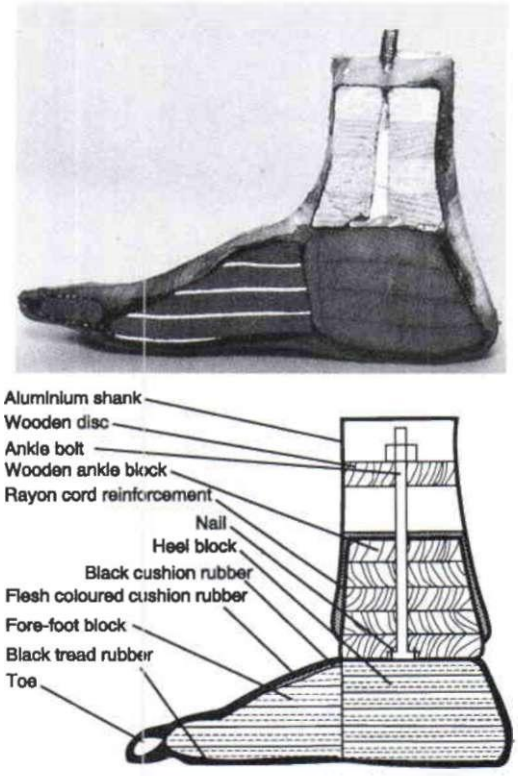

Fig. 1. A sagittal section of the Jaipur foot.

structural blocks simulating the anatomy of a normal foot (Fig. 1). The forefoot and heel blocks are made of sponge rubber while the ankle block is made of light wood. The three components are bound together, enclosed in a rubber shell and vulcanized in a die to give it the shape and cosmetic appearance of a real foot (Sethi, 1978 and 1988). It is probably one of the cheapest commercially available prosthetic feet. Although a very durable, waterproof and supple foot, it is heavier than most other prosthetic feet. Its production is labour intensive and the cosmesis and standardization still remains far from satisfactory. Currently it is being used in India and six other developing countries. In India alone more than 200,000 amputees have been fitted with it to date (Sethi, 1993).

There are numerous reports in the literature which evaluate the different prosthetic feet (Edelstein, 1984; Goh *et al.,* 1984; Wagner *et al.*, 1987; Michael, 1987; Murray, 1988; Torburn *et al.,* 1990; Mizuno *et al.,* 1992) but only one previous report in English literature (North *et al.,* 1974) has investigated some of the biomechanical properties of the Jaipur foot. They used a strain gauged pylon dynamometer to measure the axial load, torque, medio-lateral and antero-posterior moments of the lower limb joints. They were unable to reach any definite conclusions regarding differences between the Jaipur and SACH feet, and observed that more patient tests would be required to investigate any significant differences in the variables measured.

The main function of an ankle-foot prosthesis is to facilitate locomotion. The biomechanical assessment of locomotion is traditionally done by evaluating its kinematic and kinetic characteristics. The later criteria are more useful as, by using a force plate to measure ground reaction forces, characteristics of shock absorption and locomotor style can be studied (Lees and Bouracier, 1994).

The magnitude and rate of vertical ground reaction forces indicates the shock absorption capacity of the foot. Some of the other variables of ground reaction forces such as braking impulse, support impulse, propulsive impulse and force can help in assessing the gait style. These, respectively, indicate the efforts put into initial contact, support and propulsion into the next stride. Thus, a comparison of shock absorption capacity and locomotor style by measuring ground reaction forces, can be used to judge the performance of different prosthetic feet.

The present study was undertaken to assess the performance characteristics of the Jaipur foot by comparing its shock absorption capacity and influence on gait style with that of SACH and Seattle feet, using the ground reaction forces. These three feet were selected for comparison as they not only belong to the same group of non-articulated ankle-foot assemblies but also represent the most widely used designs of prosthetics feet in general.

Material and methods

Subjects

Three healthy adult males with left trans-tibial amputations were selected for the study from the Donald Tod Rehabilitation Centre, Fazakerley Hospital, Liverpool. Their age range was 43-47 years and their weight ranged from 66 to 86kg. All three were established, fairly active and gainfully employed amputees. All

the subjects normally wore an *Endolite PTB prosthesis with a soft prosthetic liner and †Quantum foot as a terminal device. Each subject gave informed consent before participating in the experiment.

Prostheses

Three experimental prostheses were used. While the SACH and Seattle feet were obtained locally, the Jaipur foot was specially procured from Jaipur (India). In order to minimize the variables which might influence the results, it was necessary to provide each amputee with an experimental limb, adaptable to accommodate each of the three prosthetic feet. This was a replica of their usual prostheses but with a provision in the lower end of the shin tube to interchange the foot by loosening and tightening a screw. An alignment device was fitted at the socket/shin tube junction and the alignment checked by a qualified prosthetist.

Procedure

The experiment was conducted using a Kistler force plate (type 5281B). The three co-ordinate force data were sampled at a rate of 200Hz. Using each prosthesis in turn, subjects walked at a self selected speed over the force platform. Fifteen trials were recorded for walking and the subject was required to repeat a similar number of trials at a jogging pace. No attempt was made to force a fixed speed. The exact speed, however, was recorded using a timing gate so as to exclude the readings with excessive speed variations (+/- 10% of SRH selected speed) and to ensure consistency of speed on repeat visits. One subject was unable to complete the trials involving jogging as he did not feel comfortable during this. The subject's normal foot was used as a control reference and all wore their usual prosthesis with a Quantum foot during control trials. A total of three test sessions were conducted for each subject on three different days.

Data processing

From the fifteen successful trials recorded for each condition, the ten best were selected for analysis by visual inspection, omitting data which appeared atypical. Six variables were quantified from the ground reaction forces. These were the impact force peak, impact loading rate, propulsion force peak, and the vertical impulse obtained from the vertical ground reaction force; and the negative (braking) and positive (propulsive) impulses from the horizontal ground reaction forces. The data were normalised to body weight before being analysed. Analysis was done using an ANOVA model, and a level of statistical significance of $p<0.01$ was used unless otherwise stated.

Result

Typical force curves for walking and jogging are shown in Figures 2 and 3 respectively. These curves show the vertical and antero-posterior force components. The curve for walking is typified by three distinct peaks. The first, referred to as the impact force peak, is small but sharp and is associated with heel strike. The second, referred to as the loading force peak, is larger and more rounded and corresponds to loading of the foot just before mid-stance. The third, referred to as the propulsion force peak, is associated with the push-off into the next stride. The area under the vertical force curve gives a measure of the support impulse, while a combination of the magnitude of the impact force peak and the time taken to reach it gives the impact load rate. The antero-posterior force is typified by an initial braking phase followed by a propulsive phase. The corresponding areas under each part yield the braking and propulsive impulses respectively.

The curve for jogging contains similar characteristics, except that the loading and propulsive force peaks are now combined to give just one discernible peak which is referred to as drive-off force peak, to indicate a more dynamic action and to distinguish it from the two separate peaks identified in the walking data.

Amongst these six variables the impact force peak and the impact load rate are considered as representing the shock absorption characteristics, while the propulsive (and drive-off) force peak and the support impulse represent a walking (or jogging) style. In addition the braking and propulsive impulses are also considered to represent gait style.

Three test sessions were conducted to

*Trade name of Blatchford modular, carbon fibre endo-skeletal construction.

†Trade name of the Vessa "energy storing foot."

Table 1. Mean (N=10) heel strike force peak (N/kg body mass) for walking (Three sessions being shown as S_1, S_2, S_3)

		PROSTHESIS			
		SACH	SEATTLE	JAIPUR	NORMAL FOOT
Subject 1	S1	1.39	1.75	2.60	5.29
	S2	1.64	2.47	2.84	4.97
	S3	1.81	1.62	2.79	5.53
Subject 2	S1	1.18	1.88	2.50	7.27
	S2	1.33	1.70	2.32	6.40
	S3	1.32	1.67	2.31	6.67
Subject 3	S1	0.91	1.04	1.67	4.22
	S2	1.25	1.28	1.63	3.84
	S3	0.94	1.16	1.56	3.46

Table 2. Mean (N=10) propulsive force peak (N/kg body mass) for walking (Three sessions being shown as S_1, S_2, S_3)

		PROSTHESIS			
		SACH	SEATTLE	JAIPUR	NORMAL FOOT
Subject 1	S1	9.80	9.63	9.85	11.18
	S2	9.78	9.47	9.70	11.19
	S3	9.96	10.02	9.89	11.09
Subject 2	S1	9.51	9.66	9.67	10.52
	S2	9.75	9.73	9.41	11.61
	S3	9.30	9.56	9.12	10.78
Subject 3	S1	9.80	9.99	9.91	11.35
	S2	10.06	10.03	9.74	11.43
	S3	9.84	9.82	9.79	11.07

overcome the possibility of a movement pattern fixation noted for athlete response testing for sport footwear (Lees and Bouracier, 1994). It has been found that subjects may produce consistent but untypical movement patterns due to the testing environment. Repeated trials mitigate against this, ensuring that data collected are a true representation of an individual's gait style. Mean data for selected variables over each test session are given in Tables 1 and 2. It can be seen from this that there are marked differences between test sessions for a particular subject/prosthesis combination, indicating that there is a session effect. There is no trend in the session effect (e.g. as a result of habituation to the testing protocols) and so for further analysis, and to reduce the effect of movement pattern fixations, the data from each session were combined.

The combined data for the two shock absorption variables and the four gait style variables are presented in Table 3 for each prosthetic foot and for the normal foot. Levels of statistical significance derived from the

Table 3. Mean data averaged over each test session and all subjects for walking. Fz refers to the vertical force while Fy refers to the horizontal force.

	PROSTHESIS				NORMAL FOOT	
	SACH	SEATTLE	JAIPUR			
Shock absorption				p		p
Fz Impact force peak	1.29	1.62	2.25	<.001	5.30	<.001
Fz Impact load rate	96.8	136.8	190.3	<.001	329.6	<.001
Gait style						
Fz Propulsive force peak	9.76	9.76	9.67	NS	11.13	<.001
Fz Support impulse	5.85	5.93	5.79	NS	6.57	<.01
Fy Braking impulse	0.288	0.283	0.317	<.001	0.388	<.001
Fy Propulsive impulse	0.273	0.278	0.274	NS	0.361	<.001

UNITS: force (N/kg); load rate (N/s.kg); impulse (N.s/kg)

Table 4. Mean (N=10) heel strike force peak N/kg body mass) for jogging (Three sessions being shown as S_1, S_2, S_3)

		PROSTHESIS			
		SACH	SEATTLE	JAIPUR	NORMAL FOOT
Subject 1	S1	4.06	4.34	3.89	13.93
	S2	3.55	3.67	3.98	14.55
	S3	2.33	3.31	3.80	14.20
Subject 2	S1	3.45	3.31	3.56	12.44
	S2	1.98	3.46	3.49	12.40
	S3	2.19	3.19	3.38	10.51

Table 5. Mean (N=10) drive off force peak (N/kg body mass) for jogging (Three sessions being shown as S_1, S_2, S_3)

		PROSTHESIS			
		SACH	SEATTLE	JAIPUR	NORMAL FOOT
Subject 1	S1	12.88	14.22	14.35	20.13
	S2	14.46	14.72	14.01	20.14
	S3	13.74	13.62	15.68	20.39
Subject 2	S1	16.85	17.51	18.39	21.03
	S2	15.71	15.94	17.11	19.68
	S3	15.69	15.77	17.04	20.24

ANOVA model are given for a comparison firstly between the three prosthetic feet and secondly, between the normal foot and all prosthetic feet. It can be seen that the normal foot yields significantly different results than the prosthetic feet in all variables. In particular, the normal foot shows a higher impact force peak and impact load rate, indicating a more severe contact with the ground. This is confirmed by a larger braking impulse. The larger support impulse for the normal foot as compared to the prosthetic foot indicates an asymmetry in gait with more weight being put on the normal foot. The asymmetry is continued into the propulsive phase with a larger propulsive force peak and a greater propulsive impulse.

Table 3 also indicates that there are significant differences amongst the prosthetic feet. These differences are mainly in the shock absorption variables. The Jaipur foot shows the greatest impact force and impact load rate while the SACH foot shows the lowest values in these variables. There is also a significant difference between the three feet in the braking impulse with the Jaipur foot again having the largest values. The differences in other variables are insignificant.

Tables 4 and 5 give data for each session for jogging. One subject was unwilling to jog, so data was available from only two subjects. It can be seen that similarly there are differences between sessions confirming the session effect noted above for walking. The data for each session were combined to form a total mean value for each prosthesis and the normal foot

Table 6. Mean data averaged over each test session and both subjects for jogging. Fz refers to the vertical force while Fy refers to the horizontal force.

	PROSTHESIS				NORMAL FOOT	
	SACH	SEATTLE	JAIPUR			
Shock absorption				p		p
Fz Impact force peak	2.93	3.55	3.69	NS	13.0	<.001
Fz Impact load rate	241	320	314	NS	335	NS
Gait style						
Fz Propulsive force peak	14.9	15.3	16.1	NS	20.2	<.01
Fz Support impulse	2.96	3.11	2.97	NS	4.03	<.001
Fy Braking impulse	0.136	0.148	0.135	NS	0.195	<.001
Fy Propulsive impulse	0.134	0.111	0.043	<.001	0.160	<.001

UNITS: force (N/kg); load rate (N/s. kg); impulse (N.s/kg)

which is presented in Table 6. Here it can be seen that, in general, there is only a small difference between each prosthesis, but a highly significant difference between the prosthetic and the normal foot.

Discussion

Several different variables such as joint angle and moments, stride time and energy consumption in walking have been used in the past to compare the performance of different prosthetic feet. Shock absorption characteristics of prosthetic feet have not been widely studied. Effective shock absorption at the ankle-foot complex is a desirable feature of any prosthetic foot as it protects the lower limb joints, by reducing the amount of forces transmitted proximally (Radin *et al.*, 1972; Volyshin and Wosk, 1982; Van Leeuwen *et al.*, 1990).

In a normal foot, there are in-built mechanisms to absorb shock and dampen the ground reaction forces (such as subtalar joint movements and heel pad compression) but in an amputee, the prosthetic foot has to substitute for those lost functions.

It is possible to evaluate the shock absorption capacities of prosthetic feet as well as their effect on gait style by analysing ground reaction forces.

Significantly lower values of all parameters in all prosthetic feet compared to normal (Table 3) suggests that significantly less ground reaction forces are generated on the amputated side, possibly because of structural and functional loss following amputation. In other words, amputees land more softly on the prosthetic foot probably because they feel less secure with an artificial limb as compared to the normal leg and therefore, load it cautiously. The increased stresses on the normal side results in an asymmetrical gait, which is consistent with previous observations that at best a normal gait in an amputee can be described as asymmetrical, having below normal acceleration and deceleration on the prosthetic side (Van Leeuwen *et al.*, 1990).

It has been recently observed that the discrepancy of weight bearing in amputees can be reduced by bio-feedback training (Quinlivan, 1994).

A notable feature in the vertical ground reaction force data is the initial peak identified here as the heel strike or impact force peak. There is surprisingly very little information in the literature about it and none about its magnitude. Murray *et al.* (1988), found it only

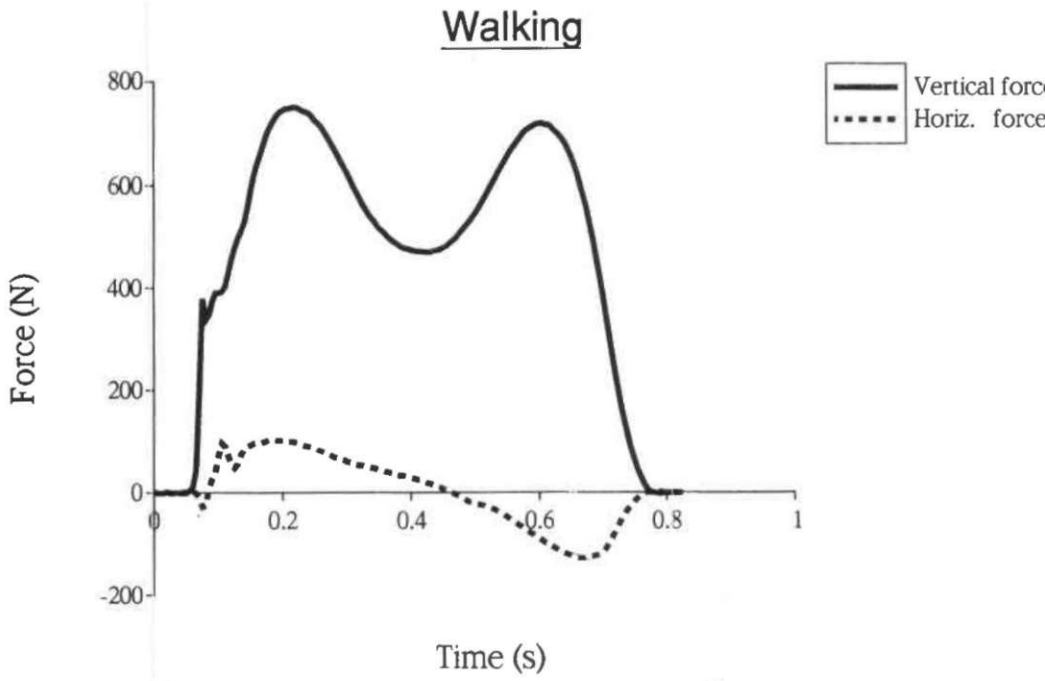

Fig. 2. A typical ground reaction force curve for walking.

on the prosthetic side. The authors found this peak consistently in both prosthetic and normal feet during walking and jogging (Figs. 2 and 3).

The impact peak and its slope represents the magnitude and rate of generation of vertical ground reaction forces. A small impact force peak and lower impact load rate would imply that more ground reaction forces are being absorbed at foot level, hence the better shock absorption capacity of the prosthesis, assuming that all the feet are being loaded equally. In the study, the SACH foot produced the smallest forces, apparently indicating its better shock absorption capacity compared to the Seattle and Jaipur feet. Findings were consistent in all subjects irrespective of walking pattern or velocity. Previous reports are not unanimous on this issue. Murray *et al.* (1988) found the shock absorption quality of the Seattle foot better than the SACH foot, while Torburn (1990) did not find any significant difference between the SACH and the Seattle feet. It should be noted that these authors used the force peak referred to in this study as the loading force peak. This is distinct from the impact force peak used here to determine the characteristics of shock absorption.

The antero-posterior braking impulse represents the force of loading. In the Jaipur foot it was significantly larger and nearer to the value obtained from the normal foot. This implies that amputees loaded it more, probably because they felt more secure and confident with the Jaipur foot. This would seem to suggest that the performance of the Jaipur foot is more natural and nearer to normal than the other two feet. This is entirely possible because it has been primarily designed for barefoot walking. A further study involving data collection from the normal foot with each of the three prosthetic feet on the amputated side would be more informative.

The propulsive force peak represents the push-off force of the foot as it drives off into the next stride. The greater push-off capacity of the energy storing prosthetic feet has often been claimed because of a larger propulsive force peak (Murray *et al.*, 1988). However, opinions vary on this issue. According to Perry (1974), this peak is actually a result of leverage of body alignment or the locomotor style rather than representing the magnitude of propulsive forces. Wagner *et al.* (1987) also supports the idea that it is primarily a product of alignment. They, as well as Torburn *et al.* (1990) and Amann (1990) have all shown that there is no significant

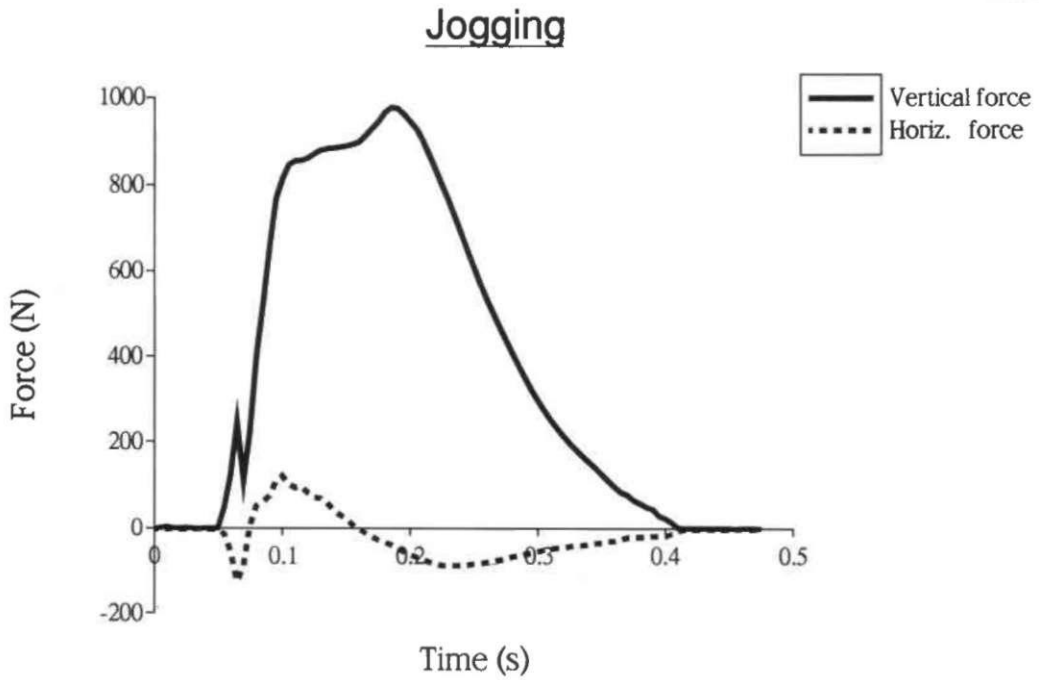

Fig. 3. A typical ground reaction force curve for jogging.

difference in the magnitude of late ground reaction force between different prosthetic feet. The results of this study support this theory. No significant difference was found in the magnitude of the propulsive force peak of different feet.

The other variables compared in this study (support impulse and push-off impulse) are not significantly different between the three prosthetic feet, which substantiates the views of Seliktar *et al.* (1986) that they represent the style of locomotion and are mainly influenced by the walking pattern rather than the actual prosthesis.

One subject was unhappy taking part in the jogging exercise. This in itself is an indication of the dissatisfaction and insecurity produced by the prosthesis. The data collected from the other two subjects confirmed previous findings. Firstly, there was a large difference between the normal foot and all prosthetic feet for all variables except the impact load rate. This confirmed the asymmetry noted for walking, and also suggested that the subjects were controlling the use of their prosthesis. It is noted for example, that the load rate is similar to that produced during walking and it is expected that this would increase with speed of locomotion. But this did not clearly happen, suggesting that subjects carefully controlled their foot placement during jogging. Secondly, there were few differences between the prostheses, and this again may be due to the conscious control of the foot as noted above. The only significant difference found was in the propulsive impulse, which was much lower in the Jaipur foot. The trend previously observed in walking, i.e. the SACH foot producing the lowest and the Jaipur foot the highest forces, was seen here also.

The small number of subjects used in this study has not limited the interpretation of the data or its generalization.

The differences between the normal and prosthetic feet are large and highly significant even with a group of subjects of this size. The differences amongst the prosthetic feet where it is substantial such as in shock absorption characteristics, is also highly significant. Where there are no significant differences, the differences are small, and it is unlikely that a larger number of subjects would lead to substantially different conclusions. Further, there is a consistency between those parameters where significant differences exist (i.e. shock absorption capacity) and those where it does not (i.e. locomotor style).

Conclusions

In conclusion it can be stated that:

1. The ground reaction force data has been successfully used to quantify shock absorption characteristics of prostheses and their effect on locomotor style.
2. The SACH foot has a better shock absorption capacity than the Seattle and Jaipur feet.
3. The performance of the Jaipur foot is more natural and nearer to the normal foot as compared to the SACH and Seattle feet.
4. There are no other significant differences in gait style produced by the SACH, Seattle or Jaipur feet.

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The effect of prosthetic rehabilitation in lower limb amputees

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Abstract

The objectives of this project were to ascertain whether, to date, the views concerning the determination of prosthetic candidacy have been optimal and whether the training methods applied have been effective and have resulted in constant use of the prosthesis after conclusion of the training programme. Secondly it was intended to set up guidelines for future budgeting as well as providing a reference framework for the process of rehabilitation.

An inquiry based on questionnaires was the first phase in a quality assurance project carried out among 29 amputees trained in 1990 and 1991.

The result of the inquiry was that rehabilitation using PTB prostheses for 19 trans-tibial amputations in 18 cases (one patient was a bilateral trans-tibial amputee) led to constant use of the prosthesis and that advanced age was no hindrance to constant use in this group. For 10 trans-femoral amputees the inquiry revealed that advanced age combined with problems of donning the prosthesis was a hindrance to constant use in two cases.

It is concluded that there is a need for testing/developing new types of femoral prostheses. The patients' evaluation of the rehabilitation process and their prostheses stresses the need for communication between the team of professionals and the patients in the decision process concerning the provision of a prosthesis as well as the provision of complete information on the patients' future functional possibilities. Qualitative measurements must include the kind and number of medical complications and the social conditions of the amputee as well as tests of physical and mental resources.

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Introduction

In Denmark economic restrictions have been experienced within all areas of health services. As regards prostheses for amputees the funding is held by the local authorities and not by the hospitals though prosthetic fitting is part of the treatment of the amputee.

This study was made to provide information on prosthetic fitting and its outcome. The hypothesis of the study rests on the assumption that estimates of outcome regarding especially trans-femoral amputees of a relatively old age have been too optimistic and that provision of a prosthesis in these cases has not led to constant use of the prosthesis after rehabilitation. Use in this sense is defined as daily use; a minimum requirement in the study was the use of the prosthesis for transfer.

There was, furthermore, a general wish in the department to know more about the patients after discharge from hospital.

Few recent follow-up studies are available, and making comparisons is difficult, as the selection methods used regarding prosthetic fitting vary and thus so does the subsequent success rate (Pohjolainen *et al.*, 1991; Kullman, 1987).

Developments within vascular and orthopaedic surgery are also assumed to have influenced the number of amputations as well as the features of the group of patients as regards age and pathological picture.

Design

The study was designed as a quality assurance project. The project was divided into two main phases:

Phase 1: Interviews of patients based on questionnaires (see Appendix). A physiotherapist carried out the interview according to the questionnaire either in the home of the patient or at the hospital as preferred by the patient. The questions were grouped into three main categories. (A) Family and housing conditions. (B) Use of the prosthesis. (C) The opinion of the patient him/herself.

Training was to have been concluded at least three months before the interview was made.

Phase 2. Adjustment of objective and construction of reference programmes.

This paper describes the first phase of the project.

Material

In the period from January 1, 1990 to December 31, 1991, patients were studied who were lower limb amputees at the trans-tibial and trans-femoral level and who had subsequently been provided with a prosthesis.

Of the 105 amputees in this period, no attempt at prosthetic provision was made in 62 cases comprising patients with a median age of 73.5 (32 to 92) years since rehabilitation was thought to be unfeasible. Some 43 patients (41%) were provided with a prosthesis of which 14 had died at the time of study. The remaining 29 patients (22 male and 7 female) were included in the study carried out over a median period of 10.5 months (3 to 22 months) after conclusion of training.

The patients with prostheses comprise 18 unilateral trans-tibial amputees, 1 bilateral trans-tibial amputee and 10 trans-femoral amputees.

The median age of the unilateral trans-tibial amputees was 64.5 (25 to 90) years and for the trans-femoral amputees the median age was 63 (17 to 94) years.

The disease or reason for amputation was arteriosclerotic occlusive disease in 22 cases – in 15 cases with associated diabetes mellitus – in 4 cases trauma and in 3 cases malignant diseases.

All trans-tibial amputees were provided with a PTB (pattellar-tendon-bearing) prosthesis Eight of the trans-femoral amputees had a total contact socket prosthesis with free knee motion, 1 patient was provided with a suction socket prosthesis with knee lock, and 1 with a suspension socket prosthesis with knee lock.

All amputees were referred to physiotherapeutic training immediately after operation. The objective of training after provision of a prosthesis was to regain their ability to walk as well as their functional abilities.

The method used was bandaging and pain treatment, a training programme comprising contraction prevention, strengthening, standing and balance training and walking training. Furthermore, the programme involved training in various other functions as well as evaluation of the need for supplementary aids/remedial measures normally in connection with a visit to the patient's home and carried out by occupational therapists and physiotherapists in cooperation.

The total training period for trans-tibial amputees (unilateral amputees) was a median period of 187 (86 to 314) days (6 months). For trans-femoral amputees the training period lasted for a median period of 217 (115 to 291) days (7 months).

The median time for the provision of the raw prosthesis for the group as a whole was 68.5 days (72.5 days for trans-tibial amputees and 63 days for trans-femoral amputees).

Home visits were made in 21 instances by occupational therapists and physiotherapists from the hospital.

Results

Family and housing conditions

At the time of the study 28 patients resided in their own home (1 in an apartment with special accommodation for physically handicapped). One trans-femoral amputee had followed his wife to a nursing home.

Prosthetic use

To the main question of use/non-use of the prosthesis the study showed that 17 of the

Table 1. Definition of bad, fair and good result

Bad	Fair	Good
– does not use prosthesis	– indoor walking	– does not use wheelchair
– uses prosthesis for cosmetic purpose	– mainly indoor walking, but also slight outdoor walking	– goes for walks
– uses prosthesis for transfer	– walking on stairs	– leads an active, outgoing life

unilateral trans-tibial amputees and 1 bilateral trans-tibial amputee used their prostheses every day. One unilateral trans-tibial amputee (5.3%) had given up using the prosthesis after having had a fall. As regards the trans-femoral amputees 7 patients used their prostheses every day. The reason for not using the prostheses was advanced age (94 and 91 years) (20%) apart from experiencing problems in donning the prostheses. The prostheses in these two cases were suspension socket and suction socket prostheses respectively both with knee lock. One patient did not use his prosthesis (total contact socket prosthesis) temporarily stating that he managed equally well without the prosthesis.

Putting on the prosthesis

Fifteen unilateral trans-tibial amputees were able to put on their prostheses by themselves. Three amputees (1 bilateral trans-tibial included) had to have assistance from others (visiting nurse/domestic help).

As for the trans-femoral amputees (7 patients used their prostheses), 5 managed to put on their prostheses without any assistance, while 2 required the assistance of others (visiting nurse/domestic help).

Prosthetic skill

For determination of the outcome in relation to the objective for amputees supplied with a prosthesis various definitions were established: **bad result, fair result** and **good result** as outlined in Table 1.

The result of the evaluation of the functional level of the 18 unilateral trans-tibial amputees and the 10 trans-femoral amputees is stated in Table 2.

The bilateral trans-tibial amputee, who was 82 years old, used his prostheses every day for transfer.

It should be mentioned that all trans-tibial as well as trans-femoral amputees categorized as bad or fair used wheelchairs (indoors or outdoors or both).

Aids for prosthetic walking

Of the 17 unilateral trans-tibial amputees who used their prostheses, 2 patients used a walker exclusively whereas the rest of the patients used 1 or 2 canes. Seven of the amputees were able to walk from time to time without any aids.

Of the 7 trans-femoral amputees who used their prostheses 2 patients used a walker exclusively and the other patients used 1 or 2 canes possibly supplemented by a walker. Two patients were able to walk from time to time without aids.

Patients' evaluation

The most remarkable result in section C of the questionnaire was that only 12 patients thought that their expectations as to the use of the prosthesis had been met (Table 3).

Patients' evaluation of the training

Seventeen patients thought that the training period was adequate. Nine patients felt that the period was too short (including 6 trans-tibial amputees), whereas 3 patients found that it was too long. As to the quality of the training, 24 patients thought that it was good. Five patients found that it was acceptable (Table 4).

Discussion

The question of quality of life is the decisive factor when determining whether lower-limb amputees are to have a prosthesis or not. The quality of life is not precisely definable but for this group of patients it is often synonymous

Table 2. Functional level – result

Level of amputation	Result		
	Good	Fair	Bad
Trans-tibial	6	11	1
Trans-femoral	4	3	3

Table 3. Patients' evaluation

	Yes	No	No answer
Did the patient expressly want to have a prosthesis	29	0	0
Did the patient think that he/she had any influence on the decision	23	6	0
Is the patient pleased to have a prosthesis	25	3	1
Is it important to wear the prosthesis in public	17	11	1
Is the patient able to use the prosthesis to the extent he/she wishes	12	16	1

with the provision of a prosthesis and the ability to walk – a definition of life quality shared by patients as well as family and professionals.

Among professionals (surgeons, physiotherapists, prosthetists) the general opinion is that the question of whether an amputee should be provided with a prosthesis should be answered as soon as possible.

In this department the evaluations are made within 6 weeks after the amputation. The requirement as to efficiency of treatment as measured by the number of hospitalization days, ambulatory treatment days etc. affects the length of this period.

The condition of the patients is such that they are often operated on the basis of a lethal situation. The provision of a prosthesis and the successive training for a period of 6 to 7 months requires that the patient has extensive physical and mental resources. A successful life after training at the hospital depends, furthermore, on the support of the family and/or public assistance via the local authorities.

This study identifies the use/non-use of a prosthesis as well as the degree to which the prosthesis was used and the level of prosthetic skill of 29 amputees who did in fact undergo prosthetic rehabilitation. It should, however, be noted that the patients were a fairly non-homogeneous group regarding age, reason for amputation and conclusion of training in relation to the time of the study. The project group has not sought to evaluate the professional reasons for not providing some patients with a prosthesis. Nor was it possible to evaluate the 14 patients fitted with a prosthesis who died before the time of the study.

Table 4. Patients' evaluation of the training

Length of the training period

Too short	9
Adequate	17
Too long	3

Quality of the training

Poor	0
Acceptable	5
Good	24

The study has shown that rehabilitation of trans-tibial amputees with a prosthesis has in 18 cases out of 19 (unilateral as well as bilateral) led to constant daily use of the prosthesis. The group included 3 patients over 80 (80, 82 and 90 years old) who used their prostheses.

Misjudgement concerning 1 patient out of 19 is thought to be acceptable. The achieved level of prosthetic skill is also deemed to be acceptable since 11 patients had achieved a level considered as fair and 6 patients had reached a level considered to be good.

Of the 10 trans-femoral amputees 7 used their prosthesis daily. The misjudgement concerning 3 patients out of 10 comprised 2 patients of advanced age (91 and 94 years old) and 1 patient (temporary non-use) who stated that he was able to manage equally well without his prosthesis.

The achieved level of prosthetic skill of the 7 users of trans-femoral prostheses must be considered to be good since 3 patients had reached a fair level and 4 patients were at a good level.

Along with other studies (Jensen and Mandrup-Poulsen, 1983; Peter Helm *et al.*, 1986) the present study stresses the fact that the level of amputation and the subsequent prosthetic technology used are of the utmost

importance for the rehabilitation result. The evaluations concerning the provision of a PTB prosthesis for trans-tibial amputees have proved that even in cases where the disease resulting in amputation has been serious and the patient of advanced age the subsequent training has led to constant use of the prosthesis. The technology of the trans-femoral prostheses applied regarding fitting and fastening make heavy demands on the users and especially those of advanced age. Evaluation of suitability for this group of trans-femoral amputees must thus be regarded as having been too optimistic in at least 2 cases (advanced age) since training did not lead to constant use of the prostheses. This tendency is in accordance with previous findings (Peter Helm *et al.*, 1986; Pohjolainen *et al.*, 1991), who found unfavourable association between increasing age and prosthetic use.

Screening methods with regard to prosthetic fitting of lower-limb amputees have been suggested by several authors. Thus, Moore *et al.*, (1989) suggested various tests with special attention to coronary artery disease. Kullmann (1987) describes the use of the Bathel Index and Russek's Classification as tools to anticipate the rehabilitation outcome. Beekham *et al.* (1987) tried to identify predictors (hip contracture, gait factors) from discharge to follow-up, but found no correlation.

In the second phase of the project a screening model has been set up concerning determination of prosthetic candidacy. The screening is multifactorial and the components categorized as follows:

1. age and medical complications, functional abilities and social dependence before the amputation;
2. qualitative estimate of mental resources such as motivation, cooperation and memory;
3. qualitative estimate of physical resources on the basis of functional tests of transfer, balance, ability to hop on one leg, ability to walk with a test prosthesis.

The question of age as a guideline in the evaluation of the prosthetic suitability of trans-femoral amputees is subject to careful consideration of the individual person and his/her autonomy.

Both trans-tibial and trans-femoral amputees need to have thorough information on the reason for the amputation, the level of amputation as well as functional possibilities after the amputation. This information should be given to the patient prior to the operation and should be extended after the operation *pari passu* with a constant evaluation of the physical, mental and social resources of the patient. It is suggested that the dialogue between the patient and the team of professionals – the surgeon, the prosthetist and the physiotherapist – should be made on the basis of written information.

Since the patients experience problems with fitting and fastening of the prostheses in all types of trans-femoral prostheses used, it is suggested by the project group to test/develop prostheses which tend to eliminate or reduce such problems.

Acknowledgements

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Likewise the group wishes to thank the SAHVA Foundation, The Society and Home for Disabled, and the Danske Fysioterapeuter, The Danish Association of Physiotherapists, for their financial support.

Appendix

Questionnaire

Name:
cpr.nr. (Central Person Register Number)

Diagnosis:

Medical complications occurring since the operation:

The following questions to be answered yes/no

A. Family and housing conditions

1A. Housing conditions.

Do you live in:
your family home?
specially accommodated apartment for physically handicapped?
apartment for elderly people?

nursing home?
other?

2A. Family conditions.
Do you live:
alone?
together with your wife/nuclear family?
Do you have:
frequent/good contact with your family?
with friends?

3A. Employment.
are you employed? (kind of education/job)
Do you receive:
old-age pension?
disability pension?
other?

4A. Remedial measures.
domestic help? (personal care/housekeeping) hours per week
visiting nurse? hours per week
help from family/friends? hours per week
public food service?
centre of activities?
training?

B. Use of the prosthesis
1B. Do you use your prosthesis?
If not for the time being – date of suspension?

2B. if no: why not?
phantom limb pain?
pain in the stump?
pain in the contralateral leg?
pain elsewhere?
wound in the stump?
the prosthesis does not fit? reason?
unable to put on the prosthesis?
manage equally well without?
other?

3B. if yes: do you use the prostheses?
for cosmetic purposes?
now and then?
daily? (hours per day)

4B. Are you able to put on the prosthesis?
completely alone?
alone but with some difficulty?
need some help?
help from ... (domestic/family)

5B. Walking distance (with/without prosthesis)
transfer?
indoor walking?
indoor walking and some outdoor walking? (garden, to and from car etc.)
go for walks? (distance metres ...)
stairs? (number ...)

6B. Walking aid? (with/without prosthesis)
none?
1 cane?
2 canes?
walker?
other?

7B. Do you use
wheelchair indoor?
wheelchair outdoor?
electrical wheelchair?
car? (driver/passenger)
other?

C. The patient's evaluation of rehabilitation and prosthesis.
1C. Was it your wish to be fitted with a prosthesis?
2C. Did you feel involved in the decision regarding prosthesis fitting?
3C. Are you pleased to have a prosthesis?
4C. Is it important for you to wear the prosthesis in public?
5C. Are you able to wear your prosthesis to the extent that you expected?
6C. Was the training period
too short?
sufficient?
too long?
7C. Was the quality of the training
bad?
satisfactory?
good?

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Technical note

New concept of spinal orthosis for weakened back muscles

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Abstract

An anterior bending posture of the trunk during walking is often seen among the elderly commonly due to weakened thoraco-lumbar and gluteal muscles. For the management of this debilitating condition, the authors have developed a modified design of thoraco-lumbo-sacral orthosis (TLSO). Incorporated in this device are pockets for the accommodation of lead weights, which are located posteriorly at the level of the lumbar region and an elasticated anterior abdominal band. The results and level of patient acceptance achieved with the use of this brace have both been excellent.

Introduction

An anterior bending posture of the trunk during walking often seen among the elderly most commonly arises due to weakened thoraco-lumbar and gluteal muscles (Takemitsu *et al.,* 1988). In order to relieve this awkward posture, and the consequent low back pain which frequently accompanies it, sufferers often place their hands on their thighs to support the trunk (Fig. 1A) or alternatively adopt a posterior elevation of both arms during walking (Fig. 1B). They will as a consequence have difficulty in carrying out normal domestic activities, e.g. the carrying of objects in front of the body or activities of daily living in general. When examining such patients it will commonly be found that they have neither a rigid kyphosis nor indeed any fixed spinal deformity and can often, at least for short periods, or with assistance, manage to stand erect with pelvis tilted posteriorly and knees slightly flexed (Fig. 1C).

In an attempt to address this debilitating condition the authors have developed a TLSO which incorporates pockets for the accommodation of lead counterweights located posteriorly at lumbar level (Fig. 1D).

Structure of the orthosis

This is similar to that of a conventional thoraco-lumbo-sacral orthosis with the addition of the pockets in the lumbar region and the elasticated abdominal band (Figs. 2 and 3). The weights used vary from between 200-400 grams each, with typically a total of 4 to 6 being used per orthosis. The function of the weights is to shift the centre of gravity of the trunk posteriorally and create an extension moment at the hips and on the spine thus serving to assist

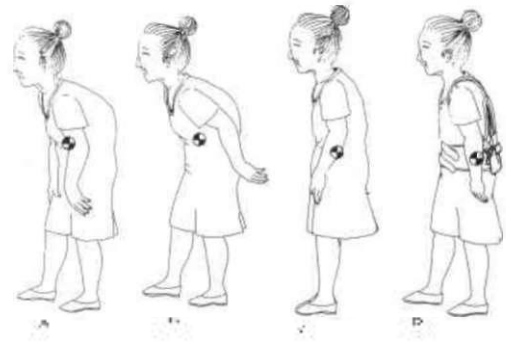

Fig. 1. Characteristic postures arising from weakened back muscles (A,B,C) and improved walking posture achieved with rucksack type orthosis (D). ⊕ = possible location of the body centre of gravity.

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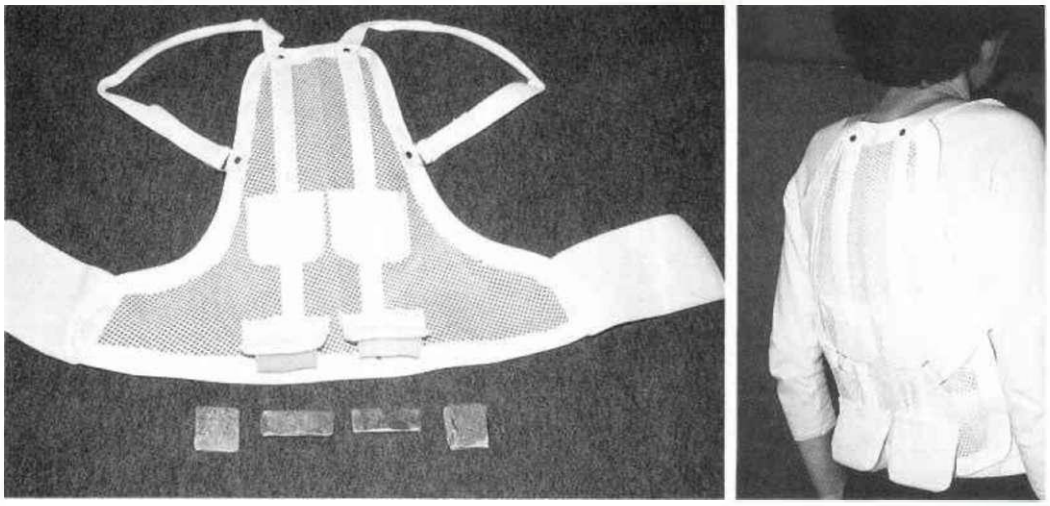

Fig. 2. The thoraco-lumbo-sacral orthosis with 'rucksack type' lead weighted pockets.

the weakened spinal muscles and thereby hold the trunk more erect during standing and walking. In addition to securing the paraspinal steels against the trunk and effecting distal anchorage of the brace, the anterior elastic abdominal band, by its construction, serves to increase the intracavital pressure which, in turn, tends to decrease the loading on the spinal vertebrae and discs.

Orthosis function

The concept of the 'rucksack type' orthosis is as follows:

1. The effect of the addition of the lead weights

Fig. 3. Further version of 'rucksack type' orthosis.

is to shift the centre of body weight posteriorly and create an extension moment acting upon hips and spine. This is imparted to the trunk, via paraspinal steels and the anterior shoulder straps thus assisting the maintenance of an erect posture during walking.

2. The anterior elastic abdominal band of the orthosis serves to increase the intracavital pressure which in turn enhances the support of the lumbar spine.

Results of bracing

The authors have to date prescribed and evaluated this device, the so-called 'rucksack' type orthosis, on a total of 42 patients assessing its effect on posture, pain relief and patient activities. Improvement in spinal posture was assessed by measuring the degree of flexion of the thoraco-lumbar spine during walking using video photographs. The average improvement was 31°. (Table 1).

During the evaluation it was noted that all patients walked with improved posture and were able to perform various activities of daily living much more easily when wearing the orthosis. The one exception was a patient suffering from Parkinson's disease who did not demonstrate any perceptible improvement.

Table 1. Degree of correction using orthosis

Improvement	Number of patients
Worsened or unchanged	0
5° – 10°	0
11° – 20°	4
21° – 30°	13
31° – 40°	21
41° – 50°	4
51° upwards	0

The optimal total weight of the lead used was found to be from 800 grams to 1600 grams (average 1200 grams). The majority of patients did not complain of feeling the orthosis to be either uncomfortably or unduly heavy. The potential burden of the weights being well dissipated by the combined effects of the well fitted posterior steels, the elasticated abdominal band and axillary shoulder straps.

Discussion

Having noted that patients with anterior bending posture could perform various activities of daily living more easily when wearing a weighted rucksack, the authors, on the basis of this observation, developed the orthosis as described. The combined effect of the orthosis is to support the spinal column antero-posteriorly, the weights serving to shift the centre of gravity of the trunk posteriorly and create an extension moment at hips and spine. With one exception, all patients fitted found the orthosis to be beneficial and were able to walk with an improved posture and also perform various activities of daily living much more easily. The patients did not find the weights to be a burden.

REFERENCE

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Book Review

Prescribing lower limb prostheses.
R.G. Redhead, H.J.B. Day, L.J. Marks, S.L. Lachmann.
Disablement Services Authority, 1991.
ISBN 0-9517249-0-8.
55pp. GBP 5.00

Prescribing upper limb prostheses.
H.J.B. Day, J.R. Kulkarni, D. Datta.
Amputee Medical Rehabilitation Society, 1993.
56pp. GBP 5.00

These two publications, 'Prescribing Lower Limb Prostheses' and 'Prescribing Upper Limb Prostheses' can be regarded as companion volumes although they have been commissioned by different bodies and have been designed and produced by different printers. To quote from the first of the two books - "this book only attempts to be a guide to prescription in relation to the limb systems currently available in the United Kingdom and does not deal with the wider aspects" of rehabilitation of the amputee. A similar statement is made in the second book. Any critique of these volumes must be seen in the light of these disclaimers.

The first volume published by the Disablement Services Authority and concerning lower limb prescribing is comprehensive bearing in mind its limited remit and contained within 55 pages. Many will find the format uncomfortable with numbering of paragraphs to three digits and the use of a heavy bold typeface producing a very compressed text. The International Standards Organisation nomenclature for amputation level is employed but presented without the use of a hyphen. Unfortunately occasionally in the text and especially in the illustration captions the older conventional terms and abbreviations are used e.g. A/K, B/K etc. The volume is profusely illustrated with high quality colour photographs, all relevant to the adjacent text.

The information provided is standard and widely accepted albeit presented in an idiosyncratic way. It is questionable if the summaries of prosthetic 'hardware' enhance the text.

Matching stump and socket volume is essential to satisfactory prosthetic fitting and this aspect might have received more attention in the book with emphasis on the need for speedy delivery of the finished prosthesis and the necessary administrative measures required. A detailed discussion on the control of stump volume would have greatly improved the value of the publication with information on stump casting, bandaging, elastic stump shrinkers, and the various air compression devices.

The glossary provided is welcome and could usefully have been extended.

I am satisfied this handbook will be a useful companion for the doctors, prosthetists and therapists in training in England and where similar structures of service operate.

The second of these 'hand books' - a notion I shall return to in due course - is curiously, an attempt to follow the pattern and style of the first. It should be recognized that the printers are as well known as those of the first publication. The publishers, The Amputee Medical Rehabilitation Society, are in effect the past employees of the publishers of the first hand book.

The problems of care for those persons who have or acquire the disablement of the loss of an arm or arms are well expressed. The prostheses, their construction and the available components are comprehensively described as is their application at the different levels of amputation. The book is awkward to read for a number of reasons. The typeface and spacing with its crushed effect when combined with the prolific use of **bold** letters makes for difficult reading: in one 12 line paragraph 30 words are in **bold**

typeface. The presentation of ISO terms is confusing; the ISO terms as published employ hyphenated words such as trans-humeral and while it may be deemed historically allowable to drop the hyphen it is certainly not permitted to use the prefix 'trans' on its own. In some cases different forms of descriptor for the same level are used. Further discomfort is caused by overuse of upper case.

The inclusion of a glossary of terms would solve some of the other problems like jargon such as 'prosupination', and spell out in full the anatomical contractions.

The illustrations comprise black and white photographs, most of poor quality.

In conclusion it is a great pity that the laudable objective of producing 'hand books' for ready reference particularly for trainees has been spoiled by flawed production. The concept of hand or pocket books is a good one and it is to be hoped that the publishers will consider republication with, I suggest, different printers and tighter editing.

George Murdoch
Professor Emeritus of Orthopaedic Surgery
University of Dundee

Calendar of Events

7-9 April, 1995
32nd Annual Rocky Mountain Bioengineering Symposium, Colorado, USA.
Information: Dr. M. F. Nichols, Nicholos Technologies Inc., 3208 LeMone Industrial Blvd., Columbia, MO 65201, USA.

9-11 April, 1995
68th Annual Meeting of the Japanese Orthopaedic Association, Yokohama City, Japan.
Information: Dr T. Kurokawa, President, Dept. of Orthopaedic Surgery, Faculty of Medicine, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, 113, Japan.

26-28 April, 1995
1st Arab and Jordanian Conference on Physical Medicine and Rehabilitation, Amman, Jordan.
Information: Dr. Khalil Abadi, 1st Arab and Jordanian Conference, Jordan Medical Association, PO Box 915, Amman, Jordan.

30 April-2 May, 1995
9th Instructional Course of the International Society for the Study of the Lumbar Spine, Riyadh, Saudi Arabia.
Information: International Society for the Study of the Lumbar Spine, Sunnybrook Medical Centre, 2075 Bayview Ave., Room A 309, Toronto M4N 3M5, Canada.

4-6 May, 1995
1st Congress of the European Federation of National Associations of Orthopaedic Sports Traumatology, Munich, Germany
Information: Intercongress GmbH, EFOST 1995, Krautartenstrasse 30, D-65205 Weisbaden, Germany.

10-12 May, 1995
2nd International Symposium on the Diabetic Foot, The Netherlands.
Information: Conference Service Vrije Universiteit, De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands.

12-16 May, 1995
1st Mediterranean Congress on Physical Medicine and Rehabilitation, Israel.
Information: Ortra Ltd., PO Box 50432, Tel Aviv 61500, Israel.

27-31 May, 1995
1st International Congress on Rehabilitation Medicine, Istanbul, Turkey.
Information: Dr. O. Kayhan, Congress Secretariat, PO Box, Kosuyolo 81121, Istanbul, Turkey.

28 May-1 June, 1995
5th European Congress on Research in Rehabilitation, Helsinki, Finland.
Information: Prof. Simon Millar, Division of Clinical Neuroscience, The Medical School, The University, Newcastle upon Tyne, NE2 4HH, England.

9-14 June, 1995
RESNA International Conference, Vancouver, Canada.
Information: RESNA, Suite 1540, 1700 North Moore St., Arlington, VA 22209-1903, USA.

18-22 June, 1995
22nd Annual Meeting of the International Society for the Study of the Lumbar Spine, Helsinki, Finland.
Information: Dr. B. Rydevik, International Society for the Study of the Lumbar Spine, Sunnybrook Medical Centre, 2075 Bayview Ave., Room A 309, Toronto M4N 3M5, Canada.

22-25 June, 1995
Annual Meeting of the American Congress of Rehabilitation Medicine, Arlington, USA.
Information: American Congress of Rehabilitation, 5700 Old Orchard Rd., 1st Floor, Skokie, IL 60077-1057, USA.

28 June-2 July, 1995
Summer Bioengineering Conference, Beaver Creek, USA.
Information: Kathy Vickers, Dept. Mechanical Engineering and Materials Science, Box 90300, Duke University, Durham, NC 27708-0300, USA.

2-3 July, 1995
5th International Conference of the European Orthopaedic Research Society, Munich, Germany.
Information: Dr. H. P. Scharf, Orthopadische Klinik/RKU, Oberer Eselsberg 45, D-89081 Ulm, Germany.

2-6 July, 1995
15th Congress of the International Society of Biomechanics, Jyvaskyla, Finland.
Information: Prof. P. V. Komi, Congress Chairman, 15th ISB Congress, University of Jyvasklya, PO Box 35, FIN-40351 Jyvasklya, Finland.

4-7 July, 1995
2nd Congress of the European Federation of National Associations of Orthopaedics and Traumatology, Munich, Germany.
Information: Prof. W. Puhi, Efort 1995, Orthopad, Universitats-Klinik/RKU., Oberer Eselsberg 45, D-89081. Ulm/Donau, Germany.

16-19 July, 1995
7th International Conference on Mobility and Transport for Elderly and Disabled People, Reading, England.
Information: 7th Int. Conf. Secretariat, Disability Unit, Dept. of Transport, Room S10/21, 2 Marsham Street, London SW1P 3EB, England.

5-8 September, 1995
2nd Leeds European Rehabilitation Conference: Neurological Rehabilitation, Leeds, England.
Information: Dr. A. Cutts, Rheumatology and Rehabilitation Research Unit, The University of Leeds, 36 Clarendon Road, Leeds, LS2 9NZ, England.

8-10 September, 1995
4th Scientific Meeting of the Scandinavian Medical Society of Paraplegia, Oslo, Norway.
Information: Congress Secretariat, 4th Scientific Meeting of SMSOP, c/o Sunnaas Hospital, N-1450 Nesoddtangen, Norway.