

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 In addition it was realised that the romanticised transfer of the long outdated European stages of development in orthopaedic technology was not useful in the creation of patient care systems in Africa.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 indiscriminating 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 handicrafts 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

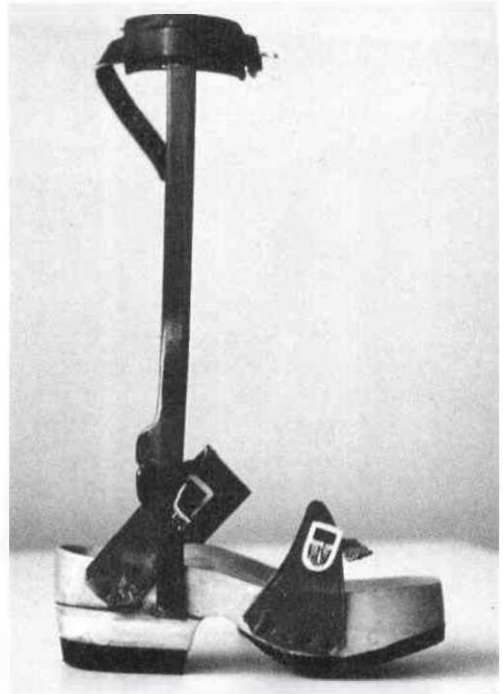


Fig 4. Corrective orthosis on wooden shoe.

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 3. P/O clinics in rural areas.



Fig 5. Direct lamination technique.

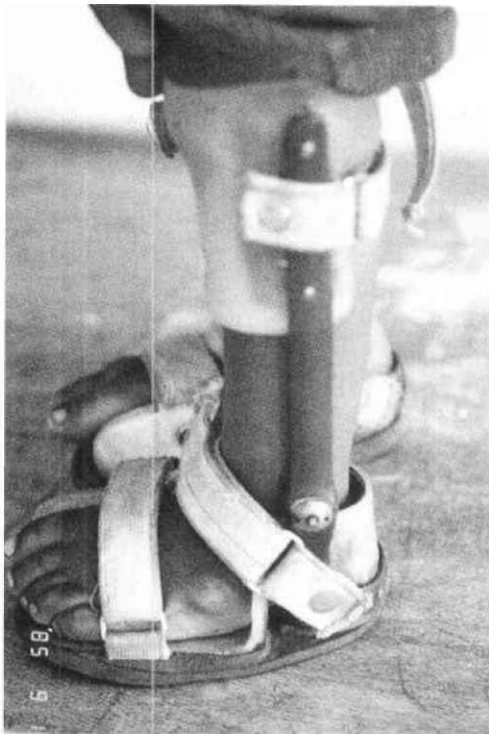


Fig 6. Appropriate clubfoot treatment.

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 defensible 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:

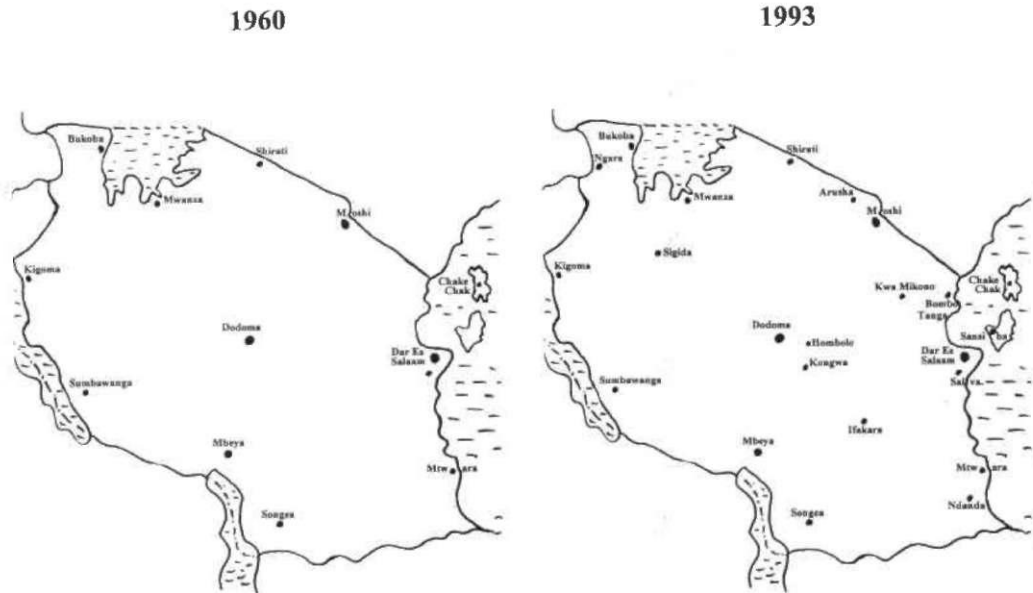


Fig 7. Prosthetic and orthotic workshops in Tanzania in 1960 and in 1993.

- 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 Jönköping, 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.

REFERENCES

- International Society for Prosthetics and Orthotics (1985). Prosthetics and orthotics in the developing world with respect to training and education and clinical services: report of a workshop, Moshi, Tanzania, 6-12 May 1984. /edited by NA Jacobs, G. Murdoch. - Denmark: ISPO.
- International Society for Prosthetics and Orthotics (1987). Training and education in prosthetics and orthotics for developing countries: report of a workshop, Jönköping, Sweden, 12-16 August 1985. /edited by J. Hughes. - Denmark: ISPO.
- United Nations (1969). Report of the United Nations International Seminar on standards for the training of prosthetists, Holte, Denmark, 1-19 July 1968. - New York: UN.
- University Rehabilitation Institute, Ljubljana (1989). Report of regional workshop on prosthetics and orthotics for African countries, Moshi, Tanzania, 10-23 July 1988. /edited by N A Jacobs, ČMarinček. - Slovenia: University Rehabilitation Institute, Ljubljana.
- University Rehabilitation Institute, Ljubljana (1989). Rapport due seminaire sur les aides techniques pour personnes handicapées, Conakry, Guinea, 20-28 November 1988. - Slovenia: University Rehabilitation Institute, Ljubljana.
- University Rehabilitation Institute, Ljubljana (1993). Rapport de seminaire de perfectionnement sur les aides techniques pour les personnes handicapées, Lomé, Togo, 31 August-5 September 1992. - Slovenia, University Rehabilitation Institute, Ljubljana and GTZ.
- University Rehabilitation Institute, Ljubljana (1993). Report of the workshop for key medical and technical personnel in prosthetics and orthotics for Western Asia and East Mediterranean Region, Amman, Jordan, 8-15 October 1993. /edited by N A Jacobs, ČMarinček. - Slovenia, University Rehabilitation Institute, Ljubljana and ISPO.
- World Health Organization (1990). Guidelines for training personnel in developing countries for prosthetic and orthotic services. WHO/RHS/90.1 - Geneva: WHO.