ISB

International Society of Biomechanics Newsletter

SPRING ISSUE 1985 N° 18

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Editorial

In our winter issue 1984 n° 17 p. 12 you saw a cartoon "we're working on it'...
Well, this "new" newsletter is "it"... not perfect yet, but we need a few issues to warm up.
We got used to the old one, and in the past years we learned a lot, but somehow we have the impression to start all over again.
Therefore we would greatly appreciate your comments, suggestions and critics... and off course your contributions!
One of the reasons of this newly designed newsletter is to attract more of your attention which hopefully will result in a better collaboration because we need copies more than ever (at your choise in American-English, English-English, Japanese-English of Femisch-English) as long as it is of interest to ISB members.
We keep most of the "old" items such as: Laboratory Features, Special Articles, Membership News, Executive Notes, Congress Announcements, but we introduce new items such as: Bookreviews (if we get any or if you send reviews you made), Free Publicity (for members and non-commercial features only), Thesis Abstract Corner (Lic., M.Sc. and Ph.D's), Past Conference News, W.G.B.S. - Working Group Biomechanis of Sport News; and a "You should know..." corner.
We do hope you will like it!?

Jan Cabri, Jan Pieter Clarys

Special article

BIOMECHANICS: ARE THERE SUBSTANTIVE ISSUES ?

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(Paper presented on the 3rd. Biannual Conference of the Canadian Society of Biomechanics, aug. 1984).

Studies of the biomechanics of human motion have been reported in a formal way since at least as long ago was 1889 with Braune and Fischer's treatise on the centre of gravity of the human body. Even 400 years before, DaVinci (1452-1519) recorded observations on human movements and Borelli (1609-1679), one of Galileo's students analyzed human and animal muscle function.
Notwithstanding this early beginning and the exponential increase in published biomechanics research since about 1950, it is interesting and, perhaps, an indictment of the field that in 1983 Cappozzo (2:302) was moved to write, "We have been gathering a great deal of numbers regarding various aspects of human locomotion. Now, I think, more efforts should be devoted to speculation. We should try to interpret the phenomena we have observed, we should try to identify, through generalization of single observations, the laws that govern them. In other words, we should go back to a more genuine scientific operation."
I agree. But what does Gappozzo mean by "a more genuine scientific operation?" I agree with him that mere data accumulation, description of numerous movement patterns recorded by biomechanists, has taken us about as far as it can. Cappozzo is advocating advancing biomechanics to a higher level in the scientific process. Synthesis, theory development and theory testing is now required if biomechanists are to contribute appreciably to attaining the objective of basis biomechanics research in human motion, that of enhancing the understanding of the mechanisms of human motion.

Science

It may be presumptuous of me to review what science is considered to be by philosophers of science. However, reflection on the obvious is sometimes useful and I will risk being pedantic. Science is defined in the Random House Dictionary (11), as "A branch of knowledge or study dealing with a body of facts of truths systematically arranged and showing the operation of general laws." The basic aim of science is simply the achievement of understanding. The "scientific method" has been defined, again in the same source, as "A method of research in which a problem is identified, relevant data are gathered, a hyptohesis is formulated from these data and the hypothesis is empirically tested".
An English philosopher of science, Sir Karl Popper (10) has proposed that science is performed by the process of "falsificationism", the major role of science being the falsification of incorrect hypotheses and theories. This process implies that the formation of testable theories and hypotheses is necessary for science to be performed.
However, perusal of the biomechanics literature of the past

decade reveals very few stated or implied hypotheses. Does this atheoretical approach then mean that biomechanics research is not scientific or is the science of biomechanics simply still immature and struggling to establish a data base upon which to build theories of the mechanisms of human motion? Is data acquisition pre-requisite to theory development?

The answers to these questions also depend upon one's approach to science. Popper (10.106) has stated, "The naive empiricist... thinks that we begin by collecting and arranging our experiences, and so ascend the ladder of science... A science needs a point of view, and theoretical problems." But Popper is clearly from the camp that is convinced that knowledge is generated most rapidly by "conjectures" (theories), followed by attempts, through empirical research, at "refutation". He opposes the notion that the accumulation of data has an appreciable effect on theorizing, and claims that theories can be reached only by intuition. Theories must precede research in his camp.

The opposite position, first research then theory, has also be espoused. Merton (7:103) has stated that research plays, "..at least four major functions which help shape the development of theory. It initiates, it reformulates, it deflects, and it clarifies theory". This approach to science certainly rationalizes exploratory data collection.

Which approach would lead to the most rapid acquisition of knowledge of the mechanisms of human motion is impossible to answer. Research and theory continually interact and one would be hard pressed to be convincing that theories can be conjured in a vacuum, without the influence of prior experience. But what is disconcerting about most biomechanics research is that is is not a all obvious from published work that theory building is an objective at all. Most papers in our field appear to be research projects devoted to the solution of an immediate problem. Few appear to be steps towards a more widespread theoretical understanding of human motion.

This is not to say the field of biomechanics is devoid of theories. In fact, one could argue that the research paradigm of the biomechanist is solidly based on well substantiated laws and theories of Newtonian, Hamiltonian, and Lagrangian mechanics. The social and, to a large extent, the strictly biological sciences do not have the advantage of anchoring their research on such well established laws. Furthermore, in addition to these mechanics traditions; several scientists have proposed hypotheses of basic biomechanical objective functions called on by humans at rest and in motion.

Biomechanical Theories

Nubar and Contini (9:381) formally proposed that, "A mentally normal individual will... move (or adjust his posture) in such a way as to reduce his total muscular effort to a minimum, consistent with the constraints." This was operationlized by defining muscular effort as a function of the squares of the joint moments and their duration ($c.M^2.\Delta t$). Hatze (4) studied a time-optimal task which involved a kick at a target. He noted that minimizing energy, a feasible objective function for submaximal cyclical tasks, was not relevant to his single, maximal effort movement.

Macconnail (6) hypothesized that muscular action, in particular instances, is governed by the "Principal of Minimal Total Muscular Force", whereby no more total muscular force is used, statically or dynamically, that is both necessary and sufficient for the task to be performed. Yeo (13) tested this principal and claimed that it was unlikely to be true, based on his calculations of relative moment arm lengths of elbow joint muscles which predicted that brachioradialis should turn on to saturation before other muscles were recruited. Electromyographic evidence showe that this was not the case.

Gracovetsky et al (3) have recently claimed that the control of the neuro-muscular mechanical linkage has the objective function of mechanical stress minimization of all tissues. Nelson (8), on the other hand, proposed that a number of possible mechanical objective functions could be selected according to the purpose of the task. These could include the "cost" minimization of time, force, impulse, energy and jerk.

Which, if any, of these objective functions emerges to become the cornerstone of a "biomechanical" theory of the control mechanisms of human motion remains to be seen. Asking questions about human motion in these speculative ways permits invoking Popper's (10) process of falsifying incorrect hypotheses.

But are these questions central to biomechanical study? Do Biomechanists identify with substantive issues? When we ask a Ph.D. student of biomechanics, a colleague, or ourselves what is our area of study, frequently the response is a description of a research tool, methodology or application (e.g., electromyography, gait, sport) rather than intrigue with a basic issue (e.g., efficiency of human locomotion). The distinction is important because the response reflects a conscious or unconscious outlook on what is perceived by the responder to be central to his/her research. Identification with a methodology will tend to lead to more data collection: identification with a substantive issue will tend to sharply focus not only the immediate project but also the ultimate objectives of a long term research program.

Substantive Biomechanics Issues

The following represent examples of what I believe to be substantive issues in the understanding of the human movement mechanisms, to which biomechanists can contribute. The list is not exhaustive and undoubtedly shows my own biases.

1. Efficiency of muscular contraction and of human motion:

   The question of relationships between metabolic and mechanical work rates has not been resolved adequately. Associated with this broad issue are unanswered questions of mechanisms of eccentric muscular contractions; efficiency of negative work; utilization and site of elastic energy storage; and a definitive explanation of energy exchanges within and between body segments during various forms of locomotion.

2. Description and explanation of the function of patterns of muscles and ligament force time histories in submaximal and maximal effort human movements:

   The techonology of making these measurements in situ in normal human movements has yet to be adequately developed. The ultimate objective of developing the technology is to allow improvements in understanding issues such as the role of multijoint muscles in the context of movement efficiency and whether minimization of bone-on-bone forces, articular, ligamentous and muscular stresses are basic locomotory objectives.

3. Control mechanisms of human motion:

   The effects of growth, age and physiological conditioning on human movement patterns and the effectiveness

of practice and rehabilitation on altering movements patterns are issues which have a major biomechanical component. The reason is that movement patterns are currently primarily described as outputs of the human linked segment system.

Appropriate kinematic and kinetic descriptions of movement patterns are necessary before inference as to control and learning mechanisms can be made.

The Crystal Ball

Prediction of future directions is a risky buisiness. When Alice asked the Cheshire-Puss which way she ought to form here, the Puss replied, "That depends a good deal on where you want to get to." I propose that there are two places we in biomechanis should try to get to:

1) If we continue only to collect more and more data, no matter how sophisticated our kinematic, kinetic and electromyographic descriptions, our contributions to be understanding of the mechanisms of human movement will remain minimal. I am advocating that we stap back, look again at our problems and reformulate our research questions with the long term goal the theory development in mind.

2) The issues which I identified as being major substantive issues all have large biomechanical components. But in addition they all have extensive overlaps with other fields. Perhaps there is no exclusive biomechanics issue. "Efficiency" involves physiology and biochemistry: the study of "control mechanisms" involves neurophysiology and neuropsychology. "Minimum stress" concepts require the interaction of biomechanics, histochemistry, and neurology. I join with Zernicke (13) and Komi (5) who both have called for more joint ventures among biomechanists and other scientists. The solution of the scientifically and, perhaps, the socially significant questions of human movement will remain retarded without more effective interdisciplinary research than we are currently producing.

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Please send us material: short papers, letters to the editor, laboratory features,... etc.

Thesis Abstract Corner

THESIS ABSTRACT CORNER
We invite you to send us abstracts of Biomechanis related thesis work made in your departments.

Title of thesis:

THE INFLUENCE OF POLYPROPYLENE ANKLE-FOOT ORTHOSES ON THE GAIT OF CEREBRAL PLASIED CHILDREN

Full name: *Christopher Barry MEADOWS*
Department: *Bioengineering unit*
University: *University of Strathclyde*
Supervisor: *J. Paul*

ABSTRACT

Clinical experience in Dundee in the use of polypropylene ankle-foot orthoses (AFOs) with cerebral palsied (CP) children had indicated that the use of the AFOs could affect markedly their gait.

A research program was established to investigate the influence of polypropylene AFOs on the gait of CP children. This included the use of a TV-computer gait analysis system. A 2-dimensional analysis was conducted which included the calculation of the external moments created by the ground-to-foot force vector in the saggital plane at the hip, knee and ankle joints. A totale of eight CP children were analysed walking barefoot and with a range of prescriptions of AFOs and associated footwear adaptations. Gait analysis was conducted on six normal children to obtain data for comparative purposes. In parallel to the gait analysis the influence of AFOs on the muscle activity of the ankle-foot complex was monitored using a force transducer and electromyography.

Analysis of the data indicated that the kinetic aspects of the gait of CP children were different from normal children. The use of AFOs resulted in a modification of the nature of the ground-to-foot reaction force and the external moments generated in the sagittal plane at the joints of the leg. Alteration of the characteristics of the associated footwear resulted in similar modifications to the gait patterns. An appropriate prescription resulted principally in the reduction of excessive external knee extension moments in mid stance and in the ability of generate improved push-off forces in late stance.

The results of the research programme have confirmed the clinical impression, and attitude to management, that the AFO-footwear characteristics selected for a given child are critical. It is now apparent that further kinetic improvements, not necessarily observable clinically, may be possible by further fine-tuning of the characteristics.

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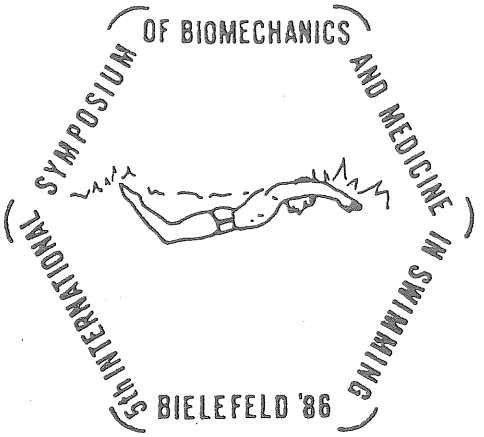

In July 1986 West – Germany will host the

5 TH INTERNATIONAL SYMPOSIUM OF BIOMECHANICS AND MEDICINE IN SWIMMING

which will take place in BIELEFELD, July, 27 – 31, 1986 at University.

The Symposium is organized after the "1986 COMMONWEALTH GAMES CONFERENCE ON SPORT" held in Glasgow, Scotland, July, 18 – 23, 1986. It is agreed, that swimming is only discussed at the Bielefeld Symposium.

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For further information and the 2 nd announcement, please contact:
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NEURAL AND MECHANICAL CONTROL OF MOVEMENT

Edited by
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Proceedings of the Post-Congress Kyoto Satellite Symposium of the VIIIth ICB
"BRIDGE THE GAP BETWEEN BASIC NEUROPHYSIOLOGY AND APPLIED BIOMECHANICS"

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In the year 1984 the CZECHOSLOVAK NATIONAL COMMITTEE OF ISB OF THE CZECHOSLOVAK ACADEMY OF SCIENCES was constituted in Czechoslovakia. This Committee has become also a collective member of ISB. The purpose of the Committee is above all to control and corroborate international contacts among scientists in the field of biomechanics and to support the development of cooperation with international scientific societies.

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For the coming period 1986-90 an extensive research program "Biomechanics of Man" has been prepared, focussed on the follwoing basis question: the structure and mechanical properties of biomaterials, the mechanical interaction man - environment, pathogenic influences on the locomotor system, substituting devices in the locomotor system and oesteosynthesis, subsidiary heart systems, subsitution of heart, stomatology. About 28 working-places take part in those assignments. The INSTITUTE OF THEORETICAL AND APPLIED MECHANICS OF CZECHOSLOVAKIA, ACADEMY OF SCIENCES, coordinates all the work (Director: Academicien Jaroslav Němec), Vyśehradská 49, 128 00 Praha 2, Czechoslovakia.

J. Valenta

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1° All material should be typewritten.

2° The title should be written in CAPITAL LETTERS.

3° Subtitles should be written *in italics* and/or underlined.

4° Different paragraphs should be seperated by double spacing.

5° Try to use the whole text-frame.
There should not be any margines inside the frame.

Thank you in advance for your cooperation.

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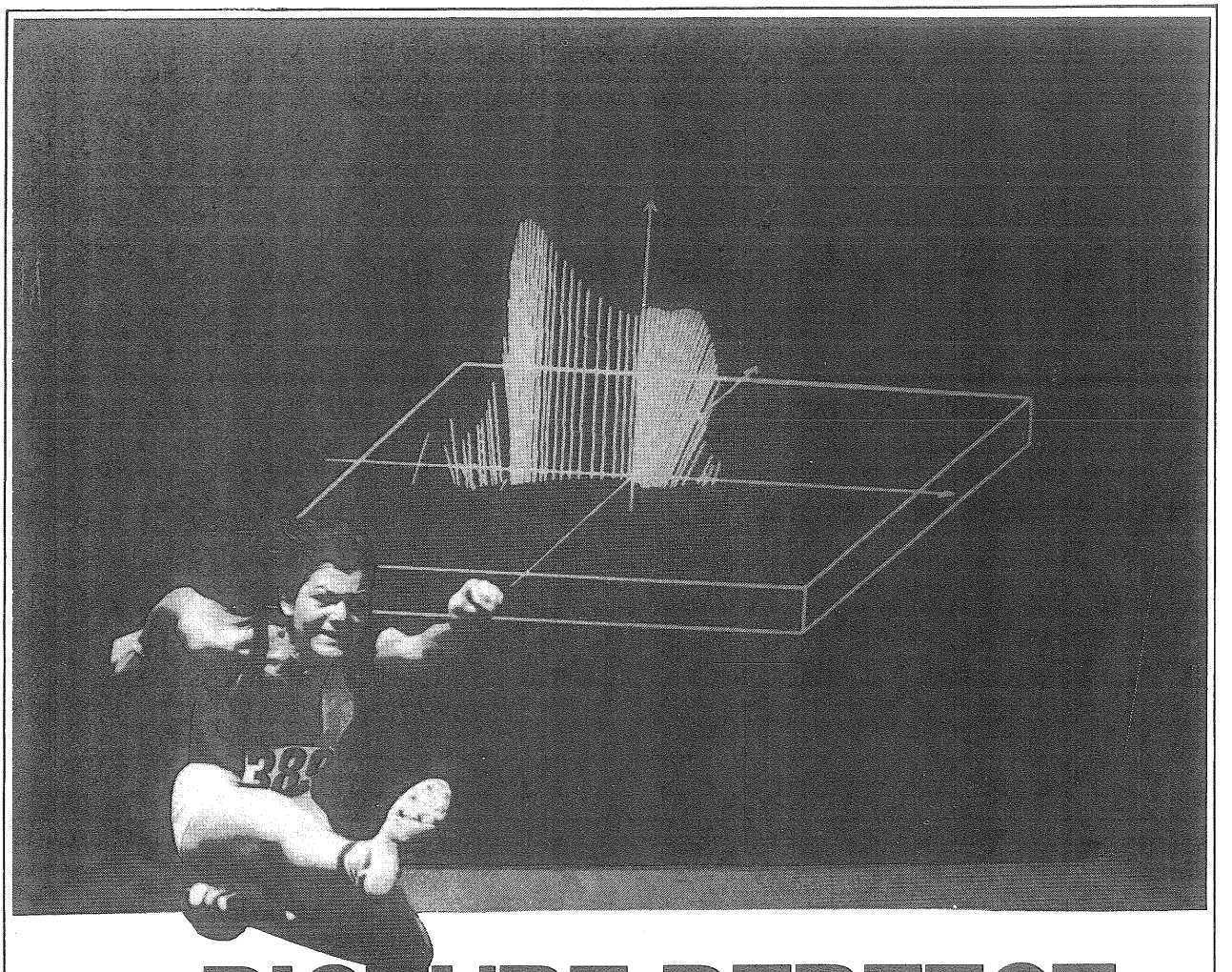

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New members should forward the $15.U.S. dues when submitting their completed applications. Upon receipt of these dues, new members will receive a validated membership card containing their ISB member number and a receipt for dues. At this time their names are placed on the computer membership list.

All members receive an acknowledgement and a newly validated membership card upon receipt of their annual dues each year.

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Symposium:
"The human spine in research and practise"

This symposium was held in Utrecht, December 7 and 8, 1984 and organized by the Dutch work-group "Prevention backaches".
The presented 28 papers including the three topics: introduction to back problems and it social relevance, biomechanics of the spine and clinical aspects, can be obtained at a price of Dfl 25,- or U.S. $ 8,-.

Orders should be addressed to:
Peter Scholten
Department of Anatomy and Biomechanics
Vrije Universiteit, Amsterdam
The Netherlands.

Calender of scientific events

June 15 - 20, 1985
Umea, Sweden, "Xth Int. Congress of Biomechanics" (c/o Congress Secretariat, X International Congress of Biomechanics, Work Physiology Division, National Board of Occupational Safety and Health, Box 6104, S-900 06 Umea, Sweden)

June 24 - 26, 1985
Göteborg, Sweden, "The Biomechanics of Impacts" 1985 International IRCOBI Conference.

June 24 - 27, 1985
Copenhagen, Denmark, "Vith World Congress in Sport Psychology"
(VI ISSP World Congress c/o DIS CONGRESS SERVICE Copenhagen, Linde Allé 48, DK-2720 Vanlose, Copenhagen, Denmark)

June 25 - 29, 1985
Montréal, Canada, "IVth Int. Congress of Auxology" (c/o General Secretary Ms. M. Brault Dubuc, Int. Congress of Auxology, Univ. de Montréal, C.P. 6128, Succursale A., Montréal, Québec, Canada H3C 3J7)

July 01 - 05, 1985
Glasgow, Scotland, "XIth HISPA Int. Congress"
(c/o Dr. J.A. Mangan, Academic Organiser, HISPA XI Int. Congress, Jordanhill College of Education, Southbrae Drive, Glasgow G13 1PP, Scotland)

July 01 - 05, 1985
Glasgow, Scotland, "XIth HISPA Int. Congress"
(c/o Dr. J.A. Mangan, Academic Organiser, HISPA XI Int. Congress, Jordanhill College of Education, Southbrae Drive, Glasgow G13 1PP, Scotland)

July 08 - 12, 1985
New York, USA, "Physical Activity, Aging and Sports" (c/o Sara Harris, Executive Director, The Center for the Study of Aging, 706 Madison Avenue, Albany NY 12208, USA)

July 09 - 11, 1985
Budapest, Hungary, "Int. Symp. of the European Union for School and University Health and Medicine"
(c/o Congress Bureau MOTESZ, P.O. Box 32, H-1361, Budapest, Hungary)

July 14 - 20, 1985
Brussels, Belgium, "Int. Seminar on Physical Education" (c/o Prof. Clairette Brack, Vrije Universiteit Brussel, HILOK, Pleinlaan 2, 1050 Brussel, Belgium)

July 20 - 27, 1985
Warwick, England, "Xth Int. Congress of IAPESGW" (c/o Pat Bowen-West, Bedford College, 37 Lansdowne Road, Bedford MK 40 2BZ)

July 29 - August 2, 1985
London, England, "28th ICHPER World Congress", Theme: "Education For Living: the contribution of Health, Physical Education and Recreation"

August 08 - 10, 1985
Toronto, Canada, "Int. Sports Medicine Symposium on the occasion of the world's 1st Masters Games"
(c/o Dr. R.M. Brock, Co-chair Masters Games Sports Medicine Symposium, P.O. Box 1985, Station "P", Toronta, Ontario, M5S 2Y7 Canada)

August 19 - 23, 1985
Garden City, Long Island, New York, USA, "Int. AIESEP Conference on Research in Physical Education and Sport" (c/o Dr. R.S. Feingold, Dept. of Physical Education Recreation and Human Performance Science, Adelphi University, Garden City, NY 11530, USA)

August 26 - 30, 1985
Dunedin, New Zealand, VIth World FINA Medical Congress
(c/o Congress Secretariat of the VIth World FINA Medical Congress, P.O. Box 6171, Dunedin, New Zealand)

August 26 - 28, 1985
Kobe, Japan, "FISU/CESU Int. Conference" in conjunction with the Universiade 1985 Kobe;
Conference Theme: University Sport in a Changing Society
(c/o Organizing Committee for CESU Conference Kobe, 1985 International Friendship Building, 6-9-1 Minatojima-nakamachi Chuo-ku, Kobe City, (code 650) Japan)

September 19 - 23, 1985
Vienna, Austria, Int. "Sport and Leisure" Seminar on "Sport and Age"
(c/o ASKO - General sekretariat, A-1040 Wien, Margaretenstr. 13-15, Austria)

October 14 - 19, 1985
Dresden, GDR, "8th Int. IASI Congress on Sports information"
(c/o Dr. H. Bachmann, Zentrum f. Wissenschaftsinformation, Körperkultur u. Sport, Friedrich-Ludwig-Jahn-Allee 59, 7010 Leipzig, GDR)

November 09 - 12, 1985
Cologne, FRG, 9th Int. IAKS-Congress on "Sports, Swimming Pool and Leisure Facilities",
(c/o IAKS, Neusserstrasse 26, 5000 Köln 1, FRG)

November 19 - 20, 1985
London, E1 4NS United Kingdom. "Composites in Biomedical Engineering" First International Conference.
Dr. P.J. Hogg, Department of Materials, Queen Mary College, Mile End Road.

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System will be shown at:
ISB Congress, Umea, Sweden, June 1985

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