

International Society of Biomechanics Newsletter

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AFFILIATE SOCIETIES OF ISB:

American Society of Biomechanics; British Association of Sports Science; Canadian Society of Biomechanics; China Sports Biomechanics Association; Czechoslovak Committee on Biomechanics; French Société de Biomécanique; Japanese Society of Biomechanics; Korean Society of Biomechanics; Polish Society of Biomechanics; Sports Commission of the Soviet Union.

XIIIth INTERNATIONAL CONGRESS ON BIOMECHANICS - Organisers' Update

Well, the "best laid plans of mice and men" went a little awry for some of you. Despite the fact that the Congress Final Announcement and Call for Papers packages, together with the last Newsletter issue, were airborne out of Perth last November I understand that some have only just received their copies in recent weeks! Small consolation that many would have received two (or more) copies of the Congress booklet (every ISB member got one copy automatically irrespective of their First Announcement return request or other society affiliations), and the March 1 abstract deadline didn't go down too well either I'm sure. Just for the record, our material was airfreighted to individual countries and personal assignees, and thereafter entrusted to the local mail service. Perhaps our cartons were viewed with unusual suspicion by customs agents or anxious airport security personnel, but the bottom line is **WE'RE SORRY!** To make amends the XIIIth Congress organising committee members have agreed to work a few extra hours each day during the months of April and May to review those abstracts that arrive a bit late so that all can still be notified by mid June of the acceptance (or otherwise) of their abstract. Please though, don't use this as an escape clause to procrastinate further. There will still be a time beyond which it will become impossible to process an abstract, and there is also the distinct possibility that we will reach saturation point as far as the program is concerned. However, abstracts received before May 1 will be given every consideration. Late submitters should, though, take very careful note of the "Instructions to Authors" in order to minimise the chance that we will have to return their abstract for amendment. Also, late submitters might consider using electronic mail to deliver their text to us; the Congress e-mail address is:

(ACSNET) ISB91@VAXA.UWA.OZ.AU.

On some previous congress occasions there has been concern expressed about the relative isolation of the trade exhibit from the scientific sessions and refreshment stations. The XIIIth Congress organisers have gone to some trouble to ensure that this won't occur in Perth and plan to erect a huge marquee on an open area immediately adjacent to the poster display area and right next door to the cafeteria. In no way though should it be construed that we think trade exhibitors can be likened to circus performers! Indeed we want this trade exhibit to be one of the highlights of the Congress, and so we would like to ask ISB members to give every encouragement to their commercial contacts for them to come and exhibit their wares in Perth. Tell them you won't buy until you see their equipment working successfully under *inverse gravity* conditions 'down under'! Sceptical? You just wait 'till you see which way the water spirals when you pull the plug on a basin full of water in Perth! And, why do you think our boomerangs always come back?



From John Paul,
immediate Past
President

At general meetings of the society the immediate past president of the society (me) has the responsibility of organising elections for the presidency and membership of Council. In previous years members have suggested a "carve up". This has not been the case before, please let it not seem so this time.

Please help me by making suggestions for the Vice President (president elect) and nominations for Council members (having first obtained the candidate's permission). You will be aware that there is a progression in respect of president's office from nomination as vice president to accession to president and thence to immediate past president. We are looking therefore for a nomination of any appropriate member except Bob Norman or Aurelio Cappozzo or myself. Generally the society looks for a succession of presidents on a basis of geographical location and of scientific discipline. Recent incumbents have come from Finland, Canada, U.S.A., Scotland and Italy, and disciplines represented have been sports science, physics with sports science, engineering (rehabilitation), ergonomics and engineering (biomechanics). It is a major advantage if the vice president has previous experience as a member of the council. Please give me some suggestions by a letter, FAX or phone. Note that my FAX number is XX 44 41 552 6098. The society needs nominations for election to council. Any member may be nominated except the retiring members Don Chaffin, Erich Schneider and myself. They should not nominate Bob Norman and Aurelio Cappozzo! Dick Nelson is resigning as treasurer and does not wish to be elected to council.

The council nominates for election those members of council who have not undertaken duties for the maximum period. These are Peter Cavanagh, Micheline Gagnon, Andrzej Komor, Minayen Kumomoto, Reints Rozendal, Richard Stein and Ronald Zernicke.

Please note that the society gives the immediate past president the duty of arranging the selection of nominees for the election to council. If there is an insufficient total number submitted. Once again it is desirable in thinking of nominees to be aware of the desirability for a balance in disciplines and in geographical base across the Council. At present we have none from the area between Japan and Poland in the northern hemisphere and none from New Zealand, the Pacific Islands or Africa in the southern hemisphere. Australia is represented by Graeme Wood who is the Newsletter Editor.

Please convey nominations to me using the form letter over the page, or by FAX or telephone and send to:

Professor John P. Paul
Bioengineering Unit
University of Strathclyde
Glasgow G4 0NW
Scotland

I hereby nominate
of

for the position: President Elect/Council Member (delete as necessary).

Nomination by:

I confirm that the nominee agrees to be nominated.

Signature of sender

MUYBRIDGE MEDAL - Call for Nominations

The Muybridge Medal is awarded to those who have made outstanding contributions to the development of biomechanics. These contributions may be through good scientific publications and/or methodological developments and/or application. The recipient(s) of this award is selected by the ISB Honours Awards Committee and he/she is required to attend the next biennial Congress of the Society to deliver the Muybridge Lecture and to receive their medal(s).

At last year's Council meeting in San Diego it was decided that a small pool of qualified candidates would be established from which one candidate could be readily selected for honour at a particular Congress (considering factors such as impending retirement or time already in the pool); and that the pool would be updated regularly to eliminate the urgency that currently exists in finding and reviewing potential candidates. Nominations for this purpose are therefore now called for, and should be sent to:

Professor Paavo V. Komi (Honours Committee Chair)
Department of Biology of Physical Activity
University of Jyväskylä
SF-40100 Jyväskylä, Finland

PROMISING SCIENTIST GRANT - Call for Applications

This Grant is intended to be an encouragement to persons possessing inquisitive minds, a sound and fundamental grasp of basic biomechanics, and promise of future significant contributions to the body of knowledge. The Grant takes the form of US \$1500, and is awarded on the understanding that the recipient will spend a minimum of four months in a recognised biomechanics laboratory in a continent other than the one where the grantee usually works, with the intended

purpose being to carry out a research project there. Candidates must be under 30 years of age, enrolled in an accredited PhD or other training program in biomechanics, and both the candidate and his/her academic advisor must be ISB members.

Applicants should forward their request for a grant to the ISB President (address on front cover). All applications must include five (5) copies of the following:

- a) a letter of presentation from the candidate's academic advisor;
- b) at least one letter of support from a senior scientist in biomechanics working in a different Institution from the applicant who has personal knowledge of the applicant's capabilities;
- c) a curriculum vitae and list of publications;
- d) copies of a maximum of five relevant publications;
- e) a detailed research program and justification for visiting the laboratory abroad;
- f) a letter of acceptance of the host Institution indicating that they are aware of the candidate's research program and that they have the required research facilities;
- g) an estimated budget.

Applications for a 1991 grant should be in the President's hands no later than May 1 of this year. This years successful applicant will be expected to complete their project during the period September 1, 1991 and September 1, 1992.

Request for Input from Members

The Committee for Standardization and Terminology of the ISB requests proposals from any interested individuals or groups for standard descriptions of kinematic data relating to human movement. Our ultimate goal is to produce recommendations for a standardized approach to the three dimensional description of movements of all major joints of the body. While we realise this is a rather grandiose goal, we also realise that the final goal must be kept in mind as the first steps are made. We are, therefore, willing to accept input on a spectrum that extends from recommended conventions for the two-dimensional description of motion at a single joint to a three-dimensional system for all joints of the body. Input will be evaluated by both members of the committee and by an ad hoc working group of interested society members that has been assembled for this purpose. Correspondence, to be received by April 15, 1991, should be addressed to:

Peter R. Cavanagh, Center for Locomotion Studies,
Room 10 IM Building, Penn State University
University Park, PA 16802, USA
FAX No: (814) 863-4755
E-MAIL: PRC@PSUVM.PSU.EDU
or PRC@PSUVM.BITNET.

Conference news

XIIIth ISB Congress Satellite Meeting Update

The Longest International Symposium in History

The "Trans-Australian", one of the great railway journeys on earth, will be the venue for the International Symposium on Occupational Electromyography, a satellite conference to the XIIIth International Congress on Biomechanics. The Symposium will originate in Adelaide, South Australia, and conclude in Perth, Western Australia, a journey lasting approximately 37 hours and covering 2,700 kilometers. The conference facilities on board provide air conditioned comfort and up-to-date multi-media audio-visual equipment.

The aim of the Symposium is to examine current developments and directions in occupational electromyography. Topics to be discussed include techniques suitable for field application, methods of quantification of the EMG, standardization of techniques, development of normative data, quantification of muscle function in occupationally related activities and biofeedback in industry.

The Symposium will include three invited papers, several free paper sessions, a poster session and two workshops. The workshops will provide a forum for participants to demonstrate useful techniques and to exchange solutions to practical problems in occupational electromyography.

Interested individuals should contact the Symposium organisers for further details. If possible, in addition to a return address, please provide electronic-mail and facsimile contacts.

Symposium organisers:

O.M. Evans and T.M. Bach
Department of Human Biosciences
La Trobe University: Carlton Campus
625 Swanston Street
Carlton Victoria 3053
Australia

Telephone: 61-3-3420311
Facsimile: 61-3-3479939

International conference on experimental mechanics: TECHNOLOGY TRANSFER between HIGH TECH ENGINEERING and BIOMECHANICS

University of Limerick, Ireland. 4th - 5th September 1992

This British Society for Strain Measurement (BSSM) conference is being organised by the society's bioengineering measurements group. The meeting is co-sponsored by the American Society of Experimental Mechanics (SEM).

The objectives are to promote measurement technology transfer between aero/mech eng and biomechanics. For example, ingenious telemetry systems developed in biomechanics for in vivo force measurement in a hostile environment may be highly relevant to mechanical engineering problems of a similar nature. Furthermore, techniques in force measurement developed by the standards labs. are applicable to both disciplines.

Conference themes are planned in:

- * Force measurement and telemetry
- * Combined finite element and experimental analysis
- * Optical measurements
- * Thermoelastic techniques
- * Model testing (photoelastic coatings etc.)
- * Strain measurement on plastics, composites and soft tissue
- * Residual stress

Sessions will be jointly chaired by aero/mech engs and bioengs. Keynote speakers have been invited from high tech disciplines throughout Europe and America.

Time schedule:

- | | |
|----------------------------------|-----------------|
| * 300 word abstracts required by | 15th Dec. 1991 |
| * Preliminary acceptance: | 15th Jan. 1992 |
| * Submit final paper: | 15th March 1992 |
| * Final acceptance: | 15th April 1992 |

For full details contact:

The Conference Secretariat (BSSM'92)
FAX Int+353-61-330316

The International Society of Postural and Gait Research **XIth INTERNATIONAL SYMPOSIUM OF POSTURE AND GAIT: CONTROL MECHANISMS**

May 21-May 25, 1992
Portland, Oregon, USA

(Please note the change in date from that listed on the First Announcement).

The first announcement has just gone out for the next International Symposium of Posture and Gait. If you are interested in the meeting and would like to receive a copy of the First Announcement please send correspondence to:

NSC Education N300
Good Samaritan Hospital & Medical Center
1015 N.W. 22nd Avenue
Portland, Oregon 97210-6198, USA

The meeting will be organised by the University of Oregon, Eugene and the R.S. Dow Neurological Sciences Institute of Good Samaritan Hospital, Portland.

The Scientific Advisory Committee:

B. Amblard, Marseille
A. Berthoz, Paris
W. Bles, Amsterdam
V. Gurfinkel, Moscow
M. Igarashi, Tokyo
J. Smith, Los Angeles
D. Winter, Waterloo

The Organising Committee:

F. Horak, co-chair
M. Woollacott, co-chair
J. Macpherson
C. Shupert
J. Nutt
V. Panzer
C. Pratt

Provisional List of Topics:

- * Sensorimotor integration in posture and gait
- * Neural circuitry underlying locomotion and posture
- * Biomechanical and theoretical approaches to posture and gait
- * Vestibular function in posture and gait
- * Neurological disorders of posture and gait
- * Effects of aging and development
- * Rehabilitation and motor learning

Conference language: English

Call for Abstracts (250 words):

Deadline: September 1, 1991

Notification of Acceptance: November 1, 1991

Conference Proceedings will be Published.

Meeting Announcement and Call for Papers 15th Annual Meeting of the American Society of Biomechanics (ASB)

Description:

The American Society of Biomechanics was formed in 1977 to foster interaction among various disciplines. The membership of the Society includes biologists, engineers, ergonomists, health scientists, exercise scientists and physical educators. The Society invites researchers in all areas of biomechanics to submit original scientific papers for presentation at the 1991 meeting. The selection of papers to be presented will be based on scientific quality as well as relevance of the material to an audience with diverse and broad interests.

Meeting Details:

16-18 October, 1991 at Tempe, Arizona.

Abstracts:

In order to have a paper considered for the scientific program, abstracts must be received by the Program Chair by 15 May, 1991.

Contact:

Philip E. Martin, PhD

Department of Exercise Science and Physical Education
Arizona State University, Tempe Arizona 85287-0404.
Phone: (602) 965-1023; Fax: (602) 965-8108

The Eighth Meeting of the European Society of Biomechanics in cooperation with the European Society of Biomaterials.

June 21-24, 1992, Rome, Italy

The meeting will include instructional courses, keynote addresses, oral and poster presentations of original research, and trade exhibitions.

The scientific program will cover all areas of biomechanical research. Biomechanics is, by definition, multidisciplinary and, as such, brings together scientists and professionals with different cultures and related languages. This may entail communication problems among the attendees of the Conference. For this reason authors are asked to make a special effort and write their papers and address the audience in a language comprehensible to everybody.

Awards to be given during the Meeting are the ESB Research Award, the Clinical Biomechanics Award, and the Poster Award.

The Proceedings, consisting of long abstracts, will be available in bound form at the time of the Meeting. Short abstracts will be published later in the Journal of Biomechanics.

The Meeting will be held at the Scuola dello Sport - Via del Campi Sportivi - Roma. The Meeting site is located in a large green area not far from the historical centre. There is a frequent train service five minutes' walk away from the Meeting site. The train takes 15 minutes to reach the city center. Hotels may be found close by. Inexpensive accommodation located within the Scuola Sport dello Sport is also available but limited.

Guest Studentships will be available for selected young participants. They will consist of free registration fee and full board accommodation.

Time Schedule:

June 1, '91	Call for papers
October 1, '91	Submission of manuscripts for the ESB Research Award
December 1, '91	Deadline for submission of both long and short abstracts
February 1, '91	Deadline for discounted registration
June 21, '92	Instructional courses
June 22-24, '92	Eight ESB Meeting

For further information and in order to be included in the mailing list, please contact the Conference Secretariat at:

ESB92, Istituto di Fisiologia Umana
Università 'La Sapienza', Piazzale Aldo Moro 5
00185 Rome, Italy.
Tel: 39-6-490673; Fax: 39-6-4452824.

THE FUTURE OF ORTHOPAEDIC IMPLANTS - A one day Seminar Organised by The Institution of Mechanical Engineers' Engineering in Medicine Group

November 29, 1991, London, UK

The theme of this seminar will be the advancement of new designs, materials and technologies, in the context of cost containment, regulations and standards. There will be presentations from Orthopaedic Surgeons, Researchers, Manufacturers and Representatives of Government Organisations. The aim will be to involve Speakers and Participants from European Countries.

The day will be divided into five plenary sessions: Pointers to the Future; Indications for Higher Cost Implants; Emerging Technologies; Cost Benefit Procedures and The Future of Orthopaedic Implants - a panel discussion chaired by Professor G. Bentley and Professor P. Walker, Royal National Orthopaedic Hospital.

The Seminar will be held at the Institution of Mechanical Engineers Headquarters, Westminster, London. If you would like to register your interest in the Seminar and receive full program details when available, then write to:

Nicola Peters
Institution of Mechanical Engineers
1 Birdcage Walk
Westminster, London, SW1H 9JJ
Telephone: (071) 973 1262
Facsimile: (071) 233 1654

BIOMCH-L Update

In ISB Newsletter No. 39 (Aug/Sept, 1990), an announcement was provided for Biomch-L, an electronic forum for fast exchange of information in the Biomechanics and Movement Science area. This forum has now been in existence for almost two and a half years, and the current membership is more than 250 over all continents.

In 1990, the use of electronic communication has been expanded to include also the Eastern countries; for example, Poland has now a number of nodes on BITNET. From the point of view of societies such as the ISB, aiming to promote Biomechanics across political boundaries, this is a very positive development, and the BIOMCH-L moderators are pleased to re-invite the ISB Newsletter readership to join. If you have access to an electronic mail computer account on, e.g., EARN/BITNET/NETNORTH, just send the following requests (one per line) to LISTSERV@HEARN:

```
SUBSCRIBE BIOMCH-L your_first_name your_last_name
REVIEW BIOMCH-L (COUNTRIES)
INDEX BIOMCH-L
GET BIOMCH-L LOG9011
INFO ?
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which will result in your name (one space is necessary) and electronic address being added to the BIOMCH-L distribution list; furthermore, you will receive a number of so-called

NETDATA files in your account: a list of all subscribers and their EARN/BITNET/NETNORTH distribution (other nets are lumped into a ?? category, and you may opt for remaining an anonymous subscriber), a list of all BIOMCH-L files that can be retrieved from the LISTSERV (some of which are for members only), the archive file of all posted items for November 1990, and general help information on LISTSERV use.

Posting to the BIOMCH-L list is done by simply sending an item directly to BIOMCH-L@HEARN, as if this were an individual's electronic mail address. At present, the list is unmoderated, so anyone, whether or not a subscriber, can directly post items onto it; however, only the subscribers will receive such list postings. Postings may include announcements, calls for help, discussions, book reviews, and anything else relevant to the target domain.

Holders of email accounts on other networks such as the Internet, the UK's JANET, and UUCP may also address the HEARN.BITNET address above. However, it is recommended that they send their subscription request to the equivalent Internet address LISTSERV@NIC.SURFNET.NL, and postings to the equivalent Internet address BIOMCH-L@NIC.SURFNET.NL. Datasets retrieved from the LISTSERV will be received as regular mail, and not as NETDATA files, which will require minor editing before a file has been restored to its original format.

From its inception, Biomch-L has been a rather informal activity, thanks to facilities voluntarily provided. At this time, we wish to acknowledge the support from both Nijmegen University (LISTSERV management) and Eindhoven University of Technology (Computer Centre networking and management staff) who have been most helpful in providing a number of facilities. Biomch-L management has been largely funded through the CAMARC project under the Advanced Informatics in Medicine action of the Commission of the European Communities (see ISB Newsletter #39, August/September 1990).

At the present time, the CAMARC project is approaching its end, and there is hope for a continuation by the end of 1991. In this context, the current moderators of the list (one planning to go on sabbatical in the summer) would be grateful for additional management support. Anyone interested in becoming involved with the management of this list may contact either of the two moderators at their respective email addresses stated below.

If you are not familiar with the possibilities of electronic communication, we suggest the following book: John S. Quarterman, *The Matrix -- Computer Networks and Conferencing Systems Worldwide*, Digital Press, Bedford, MA/USA 1990, ISBN 1-55558-033-5; alternatively, just go to the wide-area networking specialist at your local computer centre (most universities and larger research institutions employ such a functionary).

Looking forward to seeing many new subscribers to this fast, informal, and free facility.

Ton van den Bogert, Utrecht, The Netherlands
<ddiatvb@cc.ruu.nl>

Herman J. Woltring, Eindhoven, The Netherlands
<elercama@urc.tue.nl or elercama@heitue5.bitnet>

Thesis abstract corner

BIOMECHANICS OF THE FOREFOOT

by

Hilaire A.C. Jacob, Masch. Ing. HTL

A Thesis presented for the Degree of
Doctor of Philosophy, May 1990
Bioengineering Unit, University of Strathclyde
Glasgow, Scotland

The work reported in this thesis was carried out to investigate the kinematic and dynamic behaviour of the forefoot during normal locomotion activities.

An extensive literature review on the subject is presented and the need for further investigations shown.

Fresh autopsy specimens were studied to determine the course taken by tendons in relation to the joints of the forefoot, and the topography of joint surfaces mapped. The overall geometries of the first and second rays have been described too. Also, an experimental investigation has shown that without muscular activity the metatarsal bones are mainly loaded in bending.

Locomotion studies have shown that the average peak ground forces under the pad of the great toe, the head of the 1st metatarsal, the pad of the 2nd toe, the head of the 2nd metatarsal and the head of the 5th metatarsal measure about 30% body weight (BW), 15% BW, 6% BW, 30% BW and 15% BW respectively. Temporal graphs of these forces show their behaviour during the gait cycle. Furthermore, the magnitudes of these forces when wearing shoes with stiff soles, when climbing up and down stairs, as well as when walking up and down a slope of 15° are reported.

Based on the external forces measured, the internal forces acting along the flexor tendons and across joint surfaces of the 1st and 2nd rays during gait are estimated. The stresses that thereby develop in the shanks of the metatarsal bones indicate that the 1st metatarsal bone is subjected mainly to compression while the 2nd metatarsal bone is exposed to a high degree of bending.

The relationship between the results of this study and clinical problems is considered and especially a hypothesis has been advanced to explain how under edge-loading conditions localised necrosis of the metatarsal heads could occur, thus giving rise to Koehler-Freiberg's disease.

Editor's Note: This thesis was awarded the Komrad Biesalski prize by the German Society for Orthopaedics and Traumatology for distinguished scientific achievement in the field of technical orthopaedics and rehabilitation.



SKELETAL MUSCLE STRENGTH IN MAN with special reference to eccentric torque-velocity characteristics

by

STEPHEN H. WESTING, B.S., M.S.

Department of Physiology III, Karolinska Institute
Box 5626, S-114 86 Stockholm, Sweden.

The relationship among torque output, movement velocity and myoelectric activity during eccentric (lengthening) and concentric (shortening) muscle actions of intact human skeletal muscle has been investigated. The following are the main findings and conclusions:

- * Maximal voluntary torque output during eccentric knee extension or flexion is largely independent of movement velocity, and remains at the isometric level. Concentric torque is less than eccentric or isometric torque, and decreases with increasing velocity.
- * Movement velocity as such is the prime determinant of maximal voluntary knee extension torque output, and not whether this velocity is attained during accelerative, decelerative or constant-velocity movements.
- * Eccentric torque output of the knee extensor muscles can be increased by 25 % over voluntary levels by superimposing electrical stimulation onto voluntarily muscle actions. No corresponding difference is seen under isometric or concentric conditions.
- * Electrical stimulation applied to the relaxed muscle results in eccentric torque output exceeding voluntary levels by 10 %, and increasing with increasing velocity. This level of stimulation results in isometric and concentric torque outputs that are markedly lower (10 to 50 %) than the corresponding voluntary values. The shape of the torque-velocity curve for electrically evoked muscle actions likens the curve for isolated and maximally stimulated animal skeletal muscle more than does the voluntary curve.
- * Agonist myoelectric activity is 10 to 30 % less under maximal voluntary eccentric actions of the knee extensor muscles compared to velocity-matched concentric actions. Agonist myoelectric activity remains constant across movement velocities for eccentric actions, but decreases with decreasing velocity for concentric actions. Based on the present evidence, it does not appear possible to fully activate the muscle voluntarily under eccentric loading, despite "maximal" effort. This may at least partially explain the differences observed between intact muscle and isolated muscle force-velocity characteristics. An inhibitory mechanism is suggested to prevent the utilization of the full muscle force potential under certain high-tension loading conditions. Such a mechanism may protect the musculoskeletal system against extreme forces that could otherwise occur under truly maximal activation.

Key words: concentric, eccentric, electromyography, man, torque-velocity characteristics, inhibition, isoacceleration, isokinetic, isometric, knee extension, knee flexion, strength.

The above dissertation is based on the following publications.

- Seger, J.Y., Westing, S.H., Hanson, M., Karlson, E. & Ekblom, B. 1988. A new dynamometer measuring concentric and eccentric muscle strength in accelerated, decelerated, or isokinetic movements. *Eur J Appl Physiol* 57, 526-530.
- Westing, S.H., Seger, J.Y., Karlson, E. & Ekblom, B. 1988. Eccentric and concentric torque-velocity characteristics of the quadriceps femoris in man. *Eur J Appl Physiol* 58, 100-104.
- Westing, S.H. & Seger, J.Y. 1989. Eccentric and concentric torque-velocity characteristics, torque output comparisons, and gravity effect torque corrections for the quadriceps and hamstring muscles in females. *Int J Sports Med* 10, 175-180.
- Westing, S.H., Seger, J.Y. & Thorstensson, A. 1990. Isoacceleration: a new concept of resistive exercise. *Med Sci Sports Exerc* 00, 000-000 (in press).
- Westing, S.H., Seger, J.Y. & Thorstensson, A. 1990. Effects of electrical stimulation on eccentric and concentric torque-velocity relationships in man. *Acta Physiol Scand* 140, 000-000 (in press).
- Westing, S.H., Cresswell, A.G. & Thorstensson, A. Muscle activation during maximal voluntary eccentric and concentric knee extension. *Eur J Appl Physiol* 00, 000-000 (submitted for publication).

ISBN 91-628-0077-9

ON THE ADAPTATION TO SPEED AND MODE OF PROGRESSION IN HUMAN LOCOMOTION

by

Johnny E. Nilsson

Department of Physiology III, Karolinska Institute and
University College of Physical Education, Box 5626,
Lidingövägen 1, S-114 86, Stockholm, Sweden.

The main objective of the present study was to explore functional aspects of the neural control of speed adaptation in human locomotion, including the transition from walking to running. In all, 36 healthy male subjects were studied during walking and running over a wide range of velocities on a motor-driven treadmill and overground. Movements of the lower extremities and trunk, myoelectric activity of the leg and trunk muscles and reaction forces from the ground were recorded and analysed via a computerized system.

In brief, the results showed that the transition from walking to running resulted in constant as well as gradually and abruptly changing locomotor patterns. Constancy was seen in the occurrence of motor events coupled with certain phases of the stride cycle, such as the yield in the knee joint during support and the activation of the knee extensor vastus lateralis. At the transition from walking to running at low speeds, the switch from single to double support was made

gradually, indicating that a typical motor pattern of walking can be integrated in the running gait. Abrupt changes were seen, for example, in the increase in vertical reaction force and vertical displacement of the body. Furthermore, the function of the erector spinae muscle changed from a braking action on the trunk movements in the frontal plane in walking to a braking action in the sagittal plane in running. Conspicuous differences were also seen in the control of the ankle joint with a heel strike in walking and a forefoot strike in running. The myoelectric activity pattern changed from a reciprocal activation of the tibialis anterior and the gastrocnemius in walking to a co-activation in running. A rearfoot strike in running showed an intermediate myoelectric pattern.

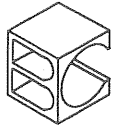
An increase in speed was accomplished by an increase in both stride frequency and stride length in walking and running. At the lowest speed stride frequency could be changed about six times in both walking and running. At high speeds this range was reduced. An earlier relative activation of several muscles occurred at higher speeds. This may act to increase muscle stiffness and thereby minimize electromechanical delay and prepare for a faster rise in muscle tension. The limitations on stride length and stride frequency at high walking speeds are related to the anatomical spread between the feet and kinematic restrictions due to the double support phase, respectively. In running, the corresponding limitations are coupled more with force production during a short support phase and the ability to move the legs quickly through the air during the swing phase. Similarities in temporal and spatial stride parameters and electromyographic patterns between quadrupeds and humans suggest that certain motor mechanisms demonstrated in animals also apply to humans.

This thesis was based upon the following papers:

- Thorstensson, A., Carlson, H., Zomlefer, M.R. & Nilsson, J. 1982. Lumbar back muscle activity in relation to trunk movements during locomotion in man. *Acta Physiol Scand* 116:13-20.
- Thorstensson, A., Nilsson, J., Carlson, H. & Zomlefer, M.R. 1984. Trunk movements in human locomotion. *Acta Physiol Scand* 121: 9-22.
- Carlson, H., Thorstensson, A. & Nilsson, J. 1988. Lumbar back muscle activity during locomotion: effects of voluntary modifications of normal trunk movements. *Acta Physiol Scand* 133: 343-353.
- Nilsson, J., Thorstensson, A. & Halbertsma, J. 1985. Changes in leg movements and muscle activity with speed of locomotion and mode of progression in humans. *Acta Physiol Scand* 123: 457-475.
- Nilsson, J. & Thorstensson, A. 1987. Adaptability in frequency and amplitude of leg movements during human locomotion at different speeds. *Acta Physiol Scand* 129:107-114.
- Nilsson, J. & Thorstensson, A. 1989. Ground reaction forces at different speeds of human walking and running. *Acta Physiol Scand* 136: 217-227.
- Key words:* human locomotion, motor control, speed, adaptations, trunk movements, leg movements, temporal stride parameters, foot-strike types, reaction forces, kinematics, electromyography.

Stockholm 1990

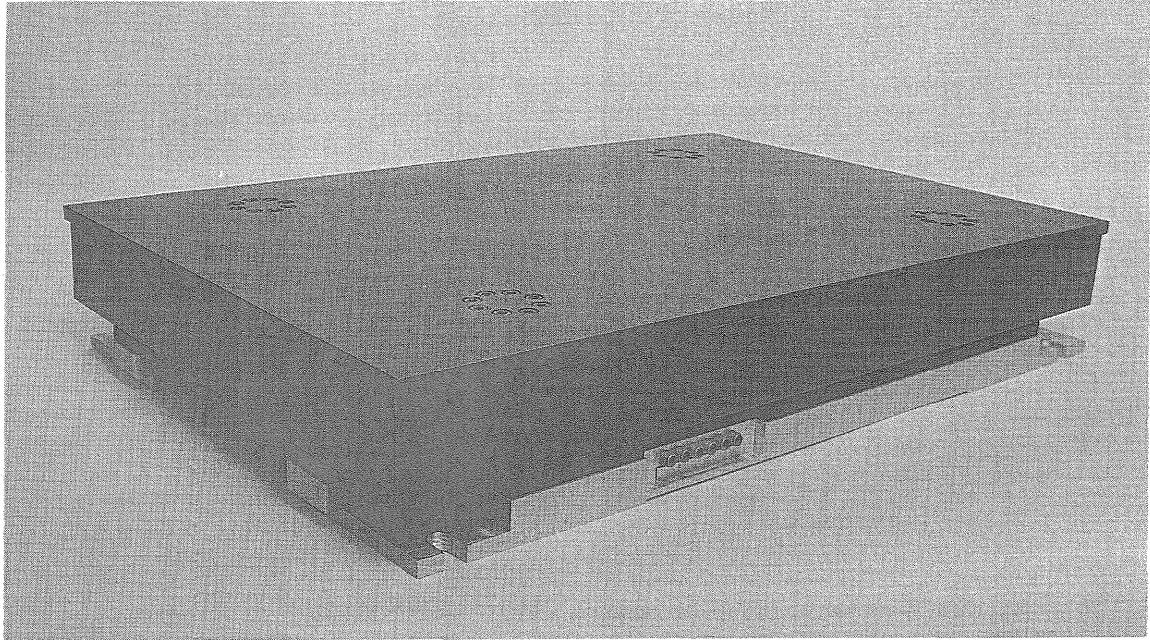
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Calendar of scientific events

May 22-25, 1991

Second World Congress of Science and Football, Eindhoven, The Netherlands. Conference Agency Limburg, c/o Mrs M.C.J.S. Frank-Roovers, University Hospital Maastricht, P.O. Box 1918, 6201 BX Maastricht, The Netherlands. Tel: 31-(0)43-862101 or 862354; Fax: 31-(0)43-477645.

April 18-19, 1991

Biomechanics Seminar, Centre for Biomechanics, Göteborg, Sweden, Contact: Gunilla Ekman, Centre for Biomechanics, Chalmers University of Technology, S-412 96 Göteborg, Sweden. Tel: +46-31-721515; Fax: +46-31-721192.

July 3-5, 1991

Advances in Hydrotherapy 2: Movement and Immersion in Water, University of Nijmegen, The Netherlands. Contact: Mrs J. Koot, University of Nijmegen, P.O. Box 9111, 6500 HN Nijmegen, The Netherlands. Fax: +31-80-567-956.

July 28-31, 1991

International Symposium on 3-D Analysis of Human Movement, Hotel des Gouverneurs, Montréal, Québec, Canada. Secretariat: Laboratoire d'étude du mouvement, Centre de recherche pédiatrique, Hôpital Sainte-Justine, 3175 Côte Ste-Catherine, Montréal, PQ, H3T 1C5, Canada.

July 28-August 2, 1991

11th International Congress of the World Confederation for Physical Therapy, Barbican Centre, London. Congress Secretariat: Conference Association WCPT, 27 A Medway Street, London SW1P 2BD, England. Tel: 01-222-9493.

October 13-16, 1991

7th International Conference on Mechanics in Medicine and Biology, Ljubljana, Yugoslavia. Enquiries to: Dr Uros Stanic, Joseph Stefan Institute, Jamova 39, YU-61000 Ljubljana, Yugoslavia. Tel: +38-61-214-299; Fax: +38-61-219-385.

October 16-18, 1991

15th Annual Meeting of the American Society of Biomechanics, Tempe, Arizona, USA. Enquiries to: Philip E. Martin, PhD, Department of Exercise Science and Physical Education, Arizona State University, Tempe, Arizona 85287-0404. Tel: (602) 965-1023; Fax: (602) 965-8108

December 5-6, 1991

Symposium on Human Propulsion - An integration of Man and Machine, Cumberland College of Health Sciences, Sydney, Australia, c/o Rehabilitation Centre, PO Box 170, Lidcome, NSW 2141, Australia. Tel: 61-2-646 6403; Fax: 61-2-646 4853.

December 4-5, 1991

International Symposium on Occupational Electromyography, aboard the "Trans Australian" railway between Adelaide and Perth, Department of Human Biosciences, LaTrobe University, Carlton Campus, 625 Swanston Street, Carlton, Victoria 3053, Australia. Tel: 61-3-342 0311; FAX: 61-3-347 9939.

December 5-6, 1991

Third International Symposium on Computer Simulation in Biomechanics, Perth, Western Australia. Congress Secretariat: Ms Rosemary Ingham, Department of Human Movement Studies, The University of Western Australia, Nedlands, WA 6009, Australia.

December 9-13, 1991

XIIIth ISB Congress on Biomechanics, Perth, Western Australia. Congress Secretariat: Ms Rosemary Ingham, Department of Human Movement Studies, The University of Western Australia, Nedlands, WA 6009, Australia. Tel: 61-9-380 2360; Fax: 61-9-380 1039.

December 16-17, 1991

The Teaching of Biomechanics, University of Wollongong, NSW, Australia. Contact: Dr Peter D. Milburn, Department of Human Movement Studies, The University of Wollongong, P.O. Box 1144 (Northfields Avenue), Wollongong, NSW 2500, Australia. Tel: 61-42-27 0881; Fax: 61-42-27 0486.

February 2-7, 1992

International Scientific Congress associated with the 1992 Winter Olympic Games and devoted to sport sciences related to mountain sports. Enquiries to: CERNA, B.P. 35, 73202 Albertville Cedex, France.

May 12-14, 1992

International Scientific Conference on Prevention of Work-Related Musculoskeletal Disorders, Stockholm, Sweden. Conference Secretariat: Ms Gun Carlsson, National Institute of Occupational Health, S-17184 Solna, Sweden. Tel: +46-8-730-9100; Fax: +46-8-730-1967.

June 21-24, 1992

Eighth Meeting of the European Society of Biomechanics, in association with the European Society of Biomaterials. Conference Secretariat: ESB92, Istituto di Fisiologia Umana, Università 'La Sapienza', Piazzale Aldo Moro 5, 00185 Rome, Italy. Tel: 39-6-490673; Fax: 39-6-4452824.

August 3-8, 1992

Eighth International Congress of Biorheology, Yokohama, Japan. Executive Secretary: Dr. Takuo Yokose, 3rd Dept. of Internal Medicine, Jikei University School of Medicine, 3-25-8 Nishi-Shinbashi, Minato-ku, Tokyo 105, Japan. Fax: +81-3-3578-9753.

August 24-28, 1992

Second North American Congress on Biomechanics, combining the 16th Annual Meeting of the American Society of Biomechanics (ASB) and the 7th Biennial Conference of the Canadian Society for Biomechanics/Société Canadienne de Biomécanique (CSB/SCB), at the McCormick Center Hotel, Chicago, USA. Conference Co-Chairman: Dr Louis Draganich, Dept. of Surgery, University of Chicago, 5841 South Maryland Avenue, Box 421, Chicago, IL 60637, U.S.A. Tel: +1-312-702-6839.

September 4-5, 1992

International Conference on Experimental Mechanics: Technology Transfer Between High Tech. Engineering & Biomechanics, University of Limerick, Ireland. Organised by the Bioengineering Measurements Group of the British Society for Strain Measurement (BSSM) and co-sponsored by the USA Society of Experimental Mechanics (SEM). Conference Secretariat: BSSM'92; Fax: 353-61-330316 (Ireland, Eire) or e-mail at LittleT@ul.ie

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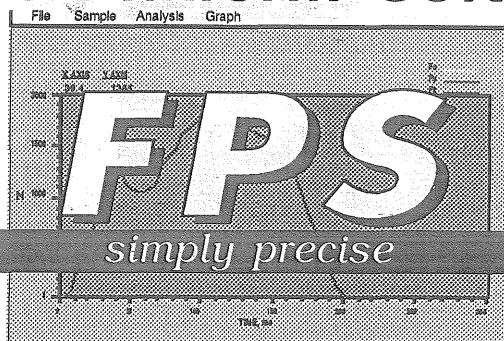
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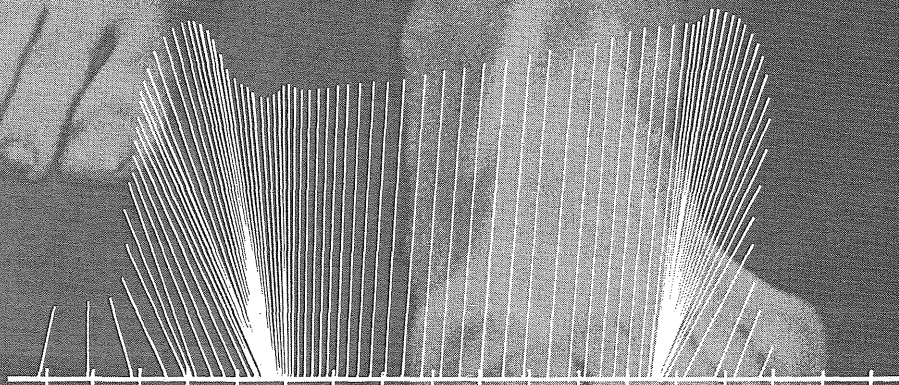
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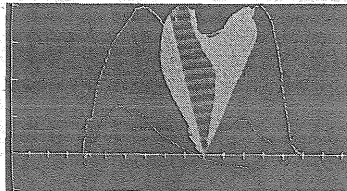
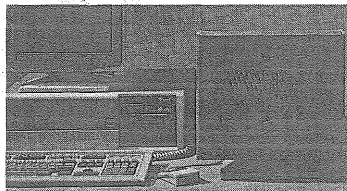
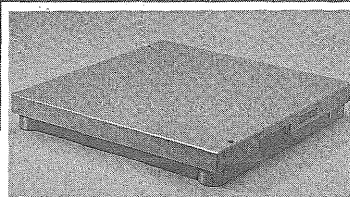
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