ANNUAL REPORT 1988



LABORATORY FOR HUMAN PERFORMANCE STUDIES

THE UNIVERSITY OF CALGARY, CALGARY, ALBERTA CANADA



ANNUAL REPORT 1988

OVERVIEW

(a) General Comments

The main activities of the Human Performance Laboratory in 1988 were highlighted by three special involvements: (a) the organization of the IOC research projects during the Winter Olympics in Calgary; (b) the collaboration with some coaches in the preparation of selected Canadian athletes for the Winter and Summer Olympics; and (c) the organization of the new laboratory into an efficient and comfortable work space.

More than 70 researchers and technicians from eight countries gathered during the Winter Olympics in Calgary to take part in the IOC research projects. The Human Performance Laboratory was responsible for preparing the various projects. More than 120 rolls of film were exposed and then taken to the different research laboratories to be analysed and interpreted. Results from these studies are expected to be published in the Spring of 1989 in the International Journal of Sports Biomechanics. The researchers, assistants and technicians of the Human Performance Laboratory who were involved in this project did an outstanding job, arid their contribution was acknowledged by the President of the IOC, Mr. Samaranch, and its Vice-president, Prince de Merode.

The exercise physiology/biochemistry and sport anthropology groups of our laboratory were intensively involved in the preparation of some Canadian athletes for the Winter and Summer Olympics. The research groups headed by Drs. David Smith and Michael Hawes performed sophisticated tests to carefully monitor the training program of athletes towards the Olympics and helped to fine tune, the "peaking" of these athletes for the moment when it counted most. The two gold medals won by synchronized swimmer Carolyn Waldo at the Seoul Olympics were an honest reward for the work performed by Dr. Smith which was based on results of seven years of research in training, planning and application and was augmented with body composition analysis by Dr. Daniela Sovak.

The move into the new facilities provided us (as indicated in last year's report) with the possibility of buying numerous pieces of new equipment. A substantial amount of time was used in the last year to make these new measuring systems work. Some of these systems are now fully operational and were demonstrated to the many visitors from all over the world who came to our laboratory during the Winter Olympics and to about 250 guests during an open house for members of The University of Calgary.

The research in our laboratory is under the direction of seven faculty members. Following is a short description of the work of each of these faculty members.

(b) Biomechanics

Benno Nigg

Load on the human locomotor system is the general thrust of the research. Specific interests include the following projects. (1) Etiology of running injuries – a prospective longitudinal study. The purpose of this project is to understand the correlation between typical movement patterns of runners and the injuries they have. (2) Torsion in tennis shoes. The purpose of this study is to analyse the effect of systematically changed

torsional stiff ness of tennis shoes on the movement pattern of typical tennis movements. (3) Walking pattern as a function of age. The purpose of this study is to document the walking pattern in the lower extremities as a function of age and to study whether joint stiffness during walking does change with age. (4) Test methods for sports surface testing. The purpose of this study is to critically analyse the relevance of various test methods used for the assessment of sports surfaces and to propose a set of tests that are appropriate. (5) Development of a method to estimate internal forces in the foot. The purpose of this study Is to develop a method to estimate forces in tendon, ligament and bone-to-bone forces in an athlete's foot during sports activities using pressure data as input. (6) Adaptation of running style to changes in surface. The purpose of this project is to study the adaptation effect due to changes in surfaces by analysing lower leg kinematics and kinetics in running.

Fred Yeadon

Main areas of interest are the mechanical analysis of technique in aerial sports and the computer simulation of human movement. For the past two years elite divers in Calgary have had their twisting techniques analysed and subsequently modified. In general, twisting results from configurational changes made while airborne, rather than from initiation during take-off. Whether this is true for other sports remains to be seen. The results of Olympic research projects on freestyle aerial skiing and gymnastics high bar dismounts should prove illuminating.

In the area of computer simulation of aerial movement, the acquisition of accurate data for use as Input to the model is critical. Progress has been made in developing generalized three-dimensional filming techniques using pan and tilt cameras, methods for synchronising film data sets using the film data and methods of curve fitting for the purposes of interpolation and differentiation. A three-dimensional graphics package depicting human movement has been developed using an 18 segment block model with hidden line removal. It is planned to develop a fully fleshed rendered model to be used for video sequences of computer simulations.

Walter Herzog

My two areas of research interest are low back pain and muscle mechanics. The longterm goal in the low back pain research is to understand the etiology of mechanical low back problems and their cure using conservative treament modalities.

We have just completed a series of movement studies on low back pain patients during and following their treatment periods. These studies showed that conservative treatment modalities, such as spinal manipulative therapy, changed the external mechanics of low back pain patients during walking as measured using a force-platform and high-speed film. In a next step, the mechanics of conservative treatment modalities will be investigated by measuring the forces of the treater on the patient.

The long-term goal in the muscle mechanics research is to accurately calculate the forces exerted by individual muscles during human movement using non-invasive techniques.

We are attempting to reach this long-term goal using an holistic approach. Our most recent experiments involved:(a) direct force measurements on individual muscles of the cat hindlimb in order to determine synergistic and antagonistic load sharing during movement; (b) the experimental determination of mechanical properties of intact human skeletal muscles, such as the force-length relation; and (c) the determination of the relation between muscle structure and mechanical properties of muscles using dissection and histological techniques on fresh human cadavers. All these studies are at an initial stage and will be continued in the following years.

Jack Engsberg

Main research focus lies in the area of lower extremity structure and function and can be divided into three areas: (1) gait of below the knee amputee children; (2) ankle joint complex mechanics; and (3) chiropractic treatment associated with female distance runners. In the amputee research, our objective is to understand the etiology for longterm pain, and we are currently investigating gait kinematics and socket construction. Some present results are indicating the need to determine whether the gait of below the knee amputees should emulate gait of typical children or should have characteristics specific to their structure and function. The long-term goal for the ankle joint complex project is to describe in vivo its anatomical structure, function and variability through noninvasive techniques. Our present focus is the range of motion of the ankle joint complex in vivo. the chiropractic project is attempting to quantify the effects of treatment on the lower back and lower extremity anatomy and on the gait characteristics of female distance runners.

(c) Exercise Physiology

David Smith

The laboratory provided training and life style support to four Olympic teams, speed skating, biathlon, swimming and synchronized swimming. The program was very successful with many best-time performances. While the winter sports did not produce any medals, there were substantial improvements in world rankings and team depth. The summer sports produced two gold medals, one silver and one- bronze.

The design and monitoring of training programs for elite athletes continues with several specific areas of research. In continuation of prior work, the shifts of heart rate and blood lactate concentrations during training in speed skating and synchronized swimming are being investigated. The acquisition of several new instruments has increased the scope of biochemical research in the laboratory. A major new area of investigation includes the full range of iron parameters, including serum ferritin, and the effects of training volume. Other areas include the monitoring of serum cortisol and further investigation of acute inflammatory proteins.

Finally, Dr. Smith began his sabbatical year.

(d) Neuro-Motor Acquisition and Control

Joan Vickers

The Neuro-Motor Psychology Laboratory will be two years old this June. Two major projects are ongoing in the laboratory, one in hypermedia systems development and the other in eve movements research. In addition to this, we have been working with Human Kinetics Publishers on a new activity series which will be launched this Spring at AAHPERD in Boston, called The Steps to Success Series. The theory book for the series will be released this Summer (Instructional Design for Teaching Physical Activity: A Structures of Knowledge Approach), as well as two books in badminton. The hypermedia systems prototype is in ice hockey and is well underway with two videodiscs and two tapes nearing completion, as well as the software accompanying the series ActionMark. ActionView, ActionAdvisor. The eye movements research program has made significant strides this past year in that we have developed a method for collecting eye data in complex sport situations (ice hockey, baseball) as well as a system for coding and analyzing eye data in the Mac environment. Our long range goal in the eye movements program is to describe the skill acquisition, attentional and perceptual processes of athletes at the elite level followed by comparative studies of beginner and intermediate players. At the Olympics we demonstrated both the hypermedia and eye movements systems and found the interaction with athletes, coaches and officials from around the world very valuable. In addition to the above projects, the Neuro-Motor Psychology Laboratory also completed a three part videotape series on Women and Sport. This is a multidisciplinary project, funded by Secretary of State, involving faculty members from Women's Studies, Educational and Counselling Psychology and Computing Science.

(d) Sport Anthropology

Michael Hawes

The Winter Olympic Games are now behind us but they will colour our direction, opportunities and perspectives for many years to come. Our group had the satisfaction of successfully completing a study of Olympic athletes that included a high proportion of medallists and top eight finishers in the speed skating events. We feel that the data are important, but our most significant memory was the cooperation and interest shown by officials and athletes from countries of diverse political ideologies.

After the Olympics it took a while to catch up, re-focus and continue with our long-term objectives. Nevertheless, by early summer our program of work involving the morphology of the human foot was back on track, and Robert Heinemeyer was added to our team in the capacity of technician/programmer to develop techniques for electronic recording of the complex curves of the foot. Work in body composition through ultra sound techniques continues with the addition of Patti Anderson as a graduate student pursuing this interest. In concert with our interest in morphological prototypes in sport, Dr. Daniela Sovak continues to offer a service function to various sport groups to facilitate our interest in longitudinal growth patterns of mature and young athletes.

The year in reflection has in some sense been the year of a lifetime, but we continue to look forward to 1989 and beyond for rewarding and exciting opportunities in science.

(f) Acknowledgements

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ADIDAS Sport Shoe Company AHFMR (Alberta Heritage Foundation for Medical Research) Alberta Children's Hospital Alberta Sport Council Apple Canada Applied Sciences Laboratory, Waltham, Mass. Calgary Canoe Club Canadian Job Strategies Program Canadian Memorial Chiropractic College Chiropractic Foundation for Spinal Research Clynch Prosthetic Orthotic Laboratories Ltd. Coaching Association of Canada College of Chiropractors of Alberta Fitness Canada Foundation for Chiropractic Education and Research Institute of Computer Assisted Learning Kodak Canada Inc. Labatt's Canada Laser Publishing, Calgary Medical Materials Corporation, Los Angeles NSERC (Natural Science and Engineering Research Council of Canada) Redlake Corporation, Morgan Hill, California Secretariat of State Sport Canada Sport Canada Applied Research Program SSHRC (Social Sciences and Humanities Research Council) The City of Calgary The Faculty of Engineering The Faculty of Graduate Studies The Faculty of Medicine The Faculty of Physical Education The Free University of Amsterdam The IOC (International Olympic Committee) The University of Calgary Toronto Skydome Variety Club of Southern Alberta - Tent 61

It is our goal to contribute to the body of knowledge in human movement and we are grateful for the support we have received in this endeavor.

Calgary, at the end of 1987.

Benno M. Nigg

Faculty of Physical Education 2500 University Drive N.W. Calgary, Alberta, CANADA T2N 1N4

(403) 220-3435

HIGHLIGHTS

EVENT	DETAIL
Adjunct Appointments	J.R. Engsberg
	Assistant Professor to the Department of Surgery, Faculty of Medicine, The University of Calgary.
	W. Herzog
	Assistant Professor to the Department of Surgery, Faculty of Medicine, The University of Calgary.
Travelling Fellowship	M.R. Yeadon
	Received from the American Society of Biomechanics.
Ph. D. Thesis Defense	A. H. Bahlsen
	<i>"Etiology of running injuries"</i> Thesis accepted by the Faculty of Mechanical Engineering, The University: of Calgary, December,1988.
Research cooperation with U.S.S.R.	M.M. Morlock
	Invited by the Russian NOC to work at the Russian institute for Sport Sciences.

STAFF

Director			
NIGG, Benno M., Dr. sc. Nat	Professor	Biomechanics	
Associates			
ENGSBERG lack R Ph D	Asst Prof	Biomechanics	
HAWES Michael Ph D	Assoc Prof	Sport Anthropology	
HERZOG, Walter, Ph.D.	Asst. Prof.	Biomechanics	
SMITH, David, Ph.D.	Assoc. Prof.	Exercise Physiology	
SOVACK, Daniela, Dr. sc. Nat.		,	
VICKERS, Joan, D. Ed.	Assoc. Prof.	Neuro-Motor	
YEADON, M.R. (Fred), Ph.D.	Asst. Prof.	Biomechanics	
Visiting Professors			
YOSHIHUKU, Yasuo, Ph. D.	Biomechanics	Japan (to Oct.)	
SCHAMHARDT, Henk, PhD.	Biomechanics	Netherlands (from Aug.)	
Post-Doctoral Fellows:			
	Biomechanics		
BOBBERT Maarten Ph D	Biomechanics	(to Oot)	
BUZZELL Nancy D Ed	Neuro-Motor		
CANIC Michael	Neuro-Motor	(to Doo)	
	Neuro-Motor		
Secretaries			
DAVIS, Wanda		(part time)	
DELMAN, Eileen		(P C C)	
LOGAN, Annette		(from Oct.)	
ROBERTSON, Colleen		(from Sept.)	
Technicians and Research	Assistants		

General:

FISHER, Veronica, B.A. (P.E.) MCNEIL, Glenda, B.Sc. SKLERYK, Blaine, M.Sc. STANO, Andrzej Supervisor Programmer / Analyst Optical Systems Electronics

Biomechanics:

ABRAHAMSE, Shelia, B.Sc. AZAD, Audrey **BIRNIE-BROWN**, John Carvalho, Andrew, B.P.E. DUNN, Eileen, M.Sc. FLANAGAN, Colin GRIMSTON, Susan, PhD. GOODWIN, Sean, B.Sc. HASLER, Evelyn HEETVELT, Angela, B.Sc. LEE, Andrew, B.Sc. LEESMAN, Mike LEONARD, Tim, B.Sc. MILLS, Jocelyn, B.Sc. NILSEN, Kim, B.P.E. PATTERSON, Janice, B.Sc. PAQUETTE, Trevor, B.Sc. PLATT, Ron, B.Sc. SCHUH, Chris SEIFERT, Kathryn, B.Sc. WILLCOX, Brad, B.Sc. YEADON, Lili, M.L.S.

Research Assistant Student Research Asst. **Research Assistant** Student Research Asst. **Research Assistant** Student Research Asst. **Research Assistant** Computer Programmer Student Research Asst. **Research Assistant Research Assistant** Student Research Asst. **Research Assistant Research Assistant Research Assistant Research Assistant Computer Graphics Research Assistant** Student Research Asst. Computer Documentation **Research Assistant** Librarian

(to Aug.) (from May) (from Apr.) (from May) (to Apr.) (to Aug.) (from Apr.) (from Apr.) (from Sept.) (July-Oct.) (from Mar.) (from May) (from Aug.) (May-Dec.) (from Sept.)

(from May) (Feb. – Sept.) (part-time) (to Oct.) (to Dec.)

Exercise Physiology:

CHAKI-FARRINGTON, L. B.P.E. NEIL, Rosemary, B.P.E. PARSONS, Colleen, B.P.E. MARALIA, Paula ROBERTS, Delia, M.Sc. Student Research Asst. Research Assistant Research Assistant Research Technician Research Technician

Part-time)

Neuro-Motor:

ABBOT, Shawn, B.Sc. ARCHIBALD, Kathy, B.G.S. BRECHT, David, B.P.E., B.Ed. GREATREX, Sandee, Appl. Arts JOHNSON, David, B.P.E. LARSON, Yasue LAYCOCK, Robin, B.P.E., B.Ed. MORRILL, Mark, B.Sc., B.Ed. SHASKIN, Diane, Appl. Arts TYMSTRA, Jerry, B.Sc. Macintosh Prog. / Analyst Videodisc Designer (to Apr.) Videodisc Designer (from Apr.) Videodisc Designer Macintosh Programmer (part-time) Videodisc Designer (from May) Instructional Designer (part-time) Macintosh Prog. / Analyst (from May) Videodisc Designer (to Apr.) Student Research Asst. (from Nov.)

Sport Anthropology

ANDERSON, Patti, B.Sc.
BOODY, Mirium
HEINEMEYER, Robert, B.SC.
PLANTE, Jeff
RAMBOUSEK, Sheila, B.P.E.

Research Assistant Research Assistant Computer Programmer Research Assistant Research Assistant

(June - Dec.) (Apr. – Aug.) (from Oct.) (from Sept.)

Graduate Students

Biomechanics:

ALLINGER, Todd BAHLSEN, Alexander MORLOCK, Michael READ, Lynda RONSKY, Janet VERMEULEN, Stephen

Neuro-Motor:

LIVINGSTON, Lori

M.Sc. Candidate Ph.D. Candidate Ph.D. Candidate M.Sc. Candidate M.Sc. Candidate Ph.D. Candidate

Ph.D. Candidate

Mechanical Engineering Mechanical Engineering Medical Sciences Medical Sciences Mechanical Engineering Mechanical Engineering

Educational Psychology

PUBLICATIONS

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 Hollander, P.A. Huijing, and G.J. van Ingen Schenau (eds.). Free University Press, Amsterdam.
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- Vickers, J. and D. Brecht. Badminton: Steps to Success. Human Kinetics, Champaign, IL.

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- *Yeadon, M.R. Techniques used in twisting somersaults, in: *Biomechanics XI,* G. de Groot, A.P. Hollander, P.A. Huijing, and G.J. van Ingen Schenau (eds.). Free University Press, Amsterdam.
- *Yeadon, M.R. The simulation of aerial movement. Part I: The determination of orientation angles from film data. *J. Biomech.*
- *Yeadon, M.R. The simulation of aerial movement. Part II: A mathematical inertia model of the human body. *J. Biomech.*
- *Yeadon, M.R. The simulation of aerial movement. Part III: The determination of the angular momentum of the human body. *J. Biomech.*
- *Yeadon, M.R. J. Atha, and F.D. Hales. The simulation of aerial movement. Part IV: A computer simulation model. *J. Biomech.*
- *Yeadon, M.R. and M. Morlock. The appropriate use of regression equations for the determination of segmental inertia parameters from anthropometric measurements. *J. Biomech.*
- Yoshihuku, Y., B.M. Nigg, and J.R. Engsberg. An effective mass model for the support phase running. *Proceedings of the American Society of Biomechanics,* Champaign, IL.

PUBLICATIONS SUBMITTED

- *Bahlsen, H.A., B.M. Nigg, and R. Strother. The etiology of running injuries: a longitudinal prospective study. *Med. Sci. Sports Exerc.*
- *Boer, R.W. de, K.L. Nilsen, and B.M. Nigg. Biomechanics of treadmill running: kinetic aspects. *Med. Sci. Sports Exerc.*
- *Boer, R.W. de and D.J. Smith. Biochemical and physiological aspects of training in speed skating (survey). *Sports Med.*
- *Boer, R.W. de and K.L. Nilsen. Work per stroke and stroke frequency in Olympic speed skaters. *Int. J. Sports Biomech.*
- *Boer, R.W. de and K.L. Nilsen. The push off technique of male and female Olympic speed skaters. *Int. J. Sports Biomech.*
- *Canic, M.J. and I.M. Franks. Perceptual and response organization of rhythmic patterns. *ACTA Psychologica*.

- *Canic, M.J. and G. Sinclair. Levels of expectancy induction in the evaluation of soccer performance. *J. Sport Psychol.*
- *Ekstrand, J. and B.M. Nigg. Surface-related injuries in soccer. J. Sports Med.²
- *Engsberg, J.R., T.L. Allinger, J.A. Harder, and G. Clynch. Standing pressure distribution for below the knee amputee children. *J. Rehab. Research Develop.*
- *Engsberg, J.R., K.G. Tedford, J.A. Harder, and J.P. Mills. Temporal gait changes for a recent below the knee amputee child. *J. Rehab. Research Develop.*
- *Herzog, W. Sensitivity of muscle force estimations of non-linear optimal designs to changes in muscle input variables. *J. Biomech.*
- Morlock, M.M., V. Zatsiorsky, M.R. Yeadon, and M. Hubbard. Factors influencing the performance in bobsledding: I. A mechanical model to estimate air and ice friction parameters of a bobsled. *Int. J. Sport Biomech.*
- Morlock, M.M; and V. Zatsiorsky. Factors influencing the performance in bobsledding: II. External and crew influences. *Int. J. Sport Biomech.*
- *Motriuk, H.U. and B.M. Nigg. A technique for normalizing centre of pressure paths. *J. Biomech.*
- *Nigg, B.M. The validity and relevance of tests used for the assessment of sports surfaces. *Med. Sci. Sports Exerc.*
- *Nigg, B.M., K.L. Nilsen, and R.W. de Boer. Biomechanics of treadmill running: kinematic aspects. *Med. Sci. Sports Exerc.*
- *Nigg, B.M., G. Skarvan, C.B. Frank, and M.R. Yeadon. Elongation and forces of ankle ligaments in a physiological range of motion. *J. Ortho. Res.*
- *Roberts, D. and D. Smith. Effects of high-intensity exercise on serum iron and alpha-1 antitrypsin on trained and untrained men. Int. *J. Sports Med.*
- *Yoshihuku, Y. and W. Herzog. Optimal design parameters of the bicycle-rider system for maximal muscle power output. *J. Biomech.*
- *Yeadon, M.R. Numerical differentiation of noisy data using cosine series. *Numerische Mathematik.*
- *Yeadon, M.R. Twisting techniques used in freestyle aerial skiing. Int. J. Sports Biomech.
- *Yeadon, M.R. A method for the three-dimensional film analysis of ski jumping using panning cameras. *Int. J. Sports Biomech.*

^{*}Refereed Publications

¹ This publication was not reported in the 1987 annual report. ² Ekstrand, J., is at the Sports Medicine Clinic, Dept, of Orthopaedics, University Hospital, Linkoping, Sweden.

PRESENTATIONS

Abrahamse, S.

Canadian Society for Biomechanics, "Force-Length Relations, Theoretical Aspects," with W. Herzog, H. ter Keurs, Ottawa, Canada, August.

Allinger, T.L.

American Society of Biomechanics, "Standing Pressure Distribution for Below the Knee Amputee Children," with J.R. Engsberg, J.A. Harder, G. Clynch, Champaign, Illinois, USA, September.

Boer, R.W. de

Invited Lecture, Biomechanics of Speed Skating and Muscle Coordination. 2nd Elite Speed Skating Coaches Conference, Toronto, Canada, April.

Invited Lecture, Speed Skating Technique of Olympic Athletes and the Implications for Training, Canadian Amateur Speed Skating Association, Calgary, Canada, July.

Canic, M.J.

Cumberland College of Health Sciences, "The Role of Advance Planning in the Control of Rhythmic Response Patterns," Sydney, Australia, May.

Annual Conference of SCAPPS, "Eye Movements of Elite Ice Hockey Players," with J.N. Vickers, S. Abbott, L. Livingston, Blue Mountain, Ontario, November.

Engsberg, J.R.

American Society of Biomechanics, "Knee Instability in Fibular Hemimelic Below the Knee Amputee Children," with J.A. Harder, T.L. Allinger, G. Clynch, Champaign, Illinois, USA, September.

American Society of Biomechanics, "An Effective Mass Model for the Support Phase of Running," with Y. Yoshihuku, B.M. Nigg, Champaign, Illinois, USA, September.

Invited Lecture, "Changes in Gait Kinematics for Recent Below the Knee Amputee Children," IEEE Engineering in Medicine & Biology Society, New Orleans, USA, November.

Invited Lecture, "The Relationship Between Biomechanics and Chiropractic," Alberta Chiropractic Association Annual Meeting, March.

Hawes, M.

Invited Lecture, Olympic Scientific Congress, "The Winter Olympic Games Anthopometry Project (WOGAP 88)," with D. Sovak, Seol, Korea, September.

Olympic Scientific Congress, "Comfort of Fit of Sport Shoes: A Kinanthropometric Link with Industry," with D. Sovak, Seoul, Korea, September.

Alberta Gymnastics Federation Conference, "Physical Growth and Motor Development of Children Ages 2-6 yrs," Calgary, Canada, October.

Herzog, W.

Canadian Memorial Chiropractic College, "Past, Present, Future in Chiropractic Research," Toronto, Canada, February.

College of Chiropractors of Alberta, "Galt Analysis for Low Back Pain Patients," Calgary, Canada, March.

Canadian Society for Biomechanics, "Synergistic Load Sharing of Muscles," with A. Hoffer, S. Abrahamse, Ottawa, Canada, August.

University of Waterloo, "Low Back Research," with A. Heetvelt, B. Willcox, Waterloo, Canada, October.

University of Toronto, "Low Back Research," with A. Heetvelt, B. Willcox, Toronto, Canada, October.

Canadian Memorial Chiropractic College, "The Relation Between Mechanical Properties and Force Production in Skeletal Muscles, "with A. Heetvelt, B. Willcox, Toronto, Canada, October.

Engineering and Medicine in Biology Society, "The Influence of Antagonistic Muscular Forces on the Calculation of Synergistic Muscular Forces," with S. Abrahamse, New Orleans, USA, November.

Morlock, M.M.

Canadian Society for Biomechanics, "A Model of a Gymnast at the Highbar," with M.R. Yeadon, Ottawa, Canada, September.

Nigg, B.M.

Invited Speaker, OEISS-Symposium, "Biomechanical Aspects of Playing Surfaces with Special Consideration of the Differences between Artificial and Natural Turf," Vienna, Austria, March.

Invited Speaker, International Symposium on Sports Medicine, "Forces in the Ligaments around the Ankle and Subtalar Joints," St. Christoph, Austria, March.

Keynote Speaker, Seoul Olympic Scientific Congress, "Biomechanical Aspects of Sports Surfaces," Cheonan, South Korea, September.

Invited Speaker, ASTM Symposium, "The Characteristics and Safety of -Playing Surfaces for Field Sports," Phoenix, USA, December.

Invited Speaker, ASTM Symposium, "Injury Frequency on Artificial Turf and Natural Grass for American Football and Soccer," Phoenix, USA, December.

Invited Speaker, ASTM Symposium, "Some Problematic Aspects of Material Tests used for the Assessment of Sports Surfaces," Phoenix, USA, December.

Athletic Business Conference, "Indoor Sport Surfaces - Performance and Biomechanical Considerations," with Bob Johnston, New Orleans, USA, December.

Read, L.J.

Canadian Society for Biomechanics, "Force-Length Relation of In-Vivo Human Gastrocnemius Muscle," with W. Herzog, Ottawa. Canada, August.

Canadian Society for Biomechanics, "Force-Length Relations, Experimental Aspects," with W. Herzog, Ottawa, Canada, August.

Roberts, D.

Alberta Track and Field Training Camp, "Nutrition in Sport," Calgary, Canada, June

Smith, D.J.

CASSA Coaching Conference, "Physiology of Speedskating," Toronto, Canada, April.

Alberta Coaches Association Conference, "Training Program Design for Coaches," Edmonton, Canada, October.

CASS, "Heart Rate and Blood Lactate Response to an In-Water Test by Synchronized Swimmers," Sudbury, Canada, October

Canadian Association of Swimming Coaches, "Planning, Monitoring, Testing and Analysis of Swimming," Whistler, Canada, October.

Vickers, J.

Invited Lecture, Computing Science and Knowledge Science Institute Open House, "The Design of a Hypermedia System for Sports Teaching and Coaching," with S. Abbott and M. Morrill, The University of Calgary, Canada, December. Invited Lecture, Canadian Society for Psychomotor Learning and Sport Psychology Conference, "Eye Movements of Elite Ice Hockey Players," with M. Canic, S. Abbott, L. Livingston, Collingwood, Canada, November.

Invited Lecture, Growth and Development Academy, American Association of Health, Physical Education, Recreation and Dance, Annual Convention, "Eye Movements of Expert-Novice Gymnasts," Kansas City, USA, April.

Yoshihuku, Y.

Canadian Society for Biomechanics, "Optimal Power Output in Sprint Bicycling," with W. Herzog, Ottawa, Canada, August.

INTERNAL / TECHNICAL REPORTS

- Hawes, M. and D. Sovak. Anthropometric status of national synchronized swimming team. Report #5 and #6 for National Synchronized Swimming Team, 1988.
- Hawes, M, and D. Sovak. Anthropometric status of national speed skating team. Report for National Speed Skating Team (Male and female), 1988.
- Hawes, M. and D. Sovak. Anthropometric status of U of C Swimming Club. Report #4, #5, #6, #7, #8 and #9 for U of C Swimming Club, 1988.
- Hawes, M. and D. Sovak. Anthropometric status of national tumbling team. Report #2 for National Tumbling Team, 1988.
- Hawes, M. and D. Sovak. Anthropometric status of junior national level divers. Report #2 and #3 for Calgary Diving Club, 1988.
- Hawes, M. and D. Sovak. Anthropometric status of junior and senior national caliber synchronized swimmers. Report #1 for Aquabelle Club, 1988.
- Hawes, M., D. Sovak, and S. Rambousek. The Winter Olympic Games Anthropometric Project (WOGAP 88). Final technical report - Speed Skating. Reports to participating National Teams of Austria, Australia, Canada, G.D.R., Great Britain, Netherlands, Poland, Sweden, U.S.A. and U.S.S.R. and summary report to the IOC and International Speed Skating Federation, 1988.
- Nigg B.M., C. Flanagan, and M.M. Morlock. The effect of orthotics on pressure distribution and force variables in walking. Research Report for Medical Materials, Los Angeles, USA, 1988.
- Nigg, B.M. Biomechanical construction criteria for tennis shoes. Short report for ADIDAS Germany, April, 1988.
- Nigg, B.M. Construction of tennis shoes: results, ideas and suggestions. Report for ADIDAS Germany, June, 1988.

- Smith, D.J. Physiological and biochemical status of the national speed skating team. Report for the National Speed Skating Team, 1988.
- Smith, D.J. Physiological status of the national men's volleyball team. Report for the National Men's Volleyball Team, 1988.
- Smith, D.J. Physiological and biochemical status of the national synchronized swim team. Report for the National Synchronized Swim Team, 1988.
- Smith, D.J. Monitoring of training for the Seoul Olympic swimming team, 1988.

ANTHROPOLOGICAL, PHYSIOLOGICAL AND BIOCHEMICAL ASSESSMENTS

Hawes, M.	National Speed Skating Teams (Men & Women)
Sovak, D.	National Synchronized Swimming Team
	Alberta Provincial Diving Team
	University of Calgary Swim Team
	University of Calgary Gymnastics Team
	Aquabelles Synchronized Swimming Team
	Individual Members of Canadian National Cycling, Luge and Swim Teams
Smith, D.	National Volleyball Team.
Chaki-Farrington, L.	National Speed Skating Team
Maralia, P.	National Synchronized Swim Team
Neil, R.	National Ski Jumping Team
Parsons, C.	National Alpine Ski Team
Roberts, D.	National Olympic Hockey Team
	Alberta Provincial Diving Team
	Alberta Speed Skating Team
	Alberta Figure Skating Team
	Flames Hockey Club
	University of Calgary Swim Club.
	Dino Hockey Club

OFFICIAL FUNCTIONS

Boer, R.W. de

Research Liaison OCO'88 Speed Skating Organizing Committee.

Hawes, M.

Publications Committee, International Society for Advancement of Kinanthropometry.

Alberta Sport Council Summer Games Committee, Editorial Reviewer, W.C. Brown Co.

Herzog, W.

Journal of the Canadian Chiropractic Association, Editorial Board Member.

Young Investigators Award of the Canadian Society for Biomechanics, Review Committee Member.

Nigg, B.M.

Associate Dean (Research), Faculty of Physical Education, The University of Calgary.

Member of the "Commission on Biomechanics and Sports Physiology" of the IOC Medical Commission.

Journal of Biomechanics, Editorial Board Member.

International Journal of Sports Biomechanics, Editorial Board Member.

French Journal of Biomechanics, Editorial Board Member.

Smith, D.J.

High Performance Committee, Canadian Association of Sport Sciences, Chairperson 1987-88.

Sport Science Association of Alberta, President 1987-88.

Sports Medicine Council of Alberta, Board Member.

Yeadon, M.R.

Sport Science Resource Committee, Canadian Gymnastics Federation.

Trampolining Certification Committee, Canadian Gymnastics Federation.

ACADEMIC GUESTS

Anderie, W.	ADIDAS, Germany	Nigg, B.M.
Andrich, B.	West Germany	Nigg, B.M.
Bochdansky, T.	Vienna	Nigg, B.M.
Denoth, J.	ETH Zurich, Switzerland	Nigg, B.M.
Ellis, F.	Ellis & Associates, Verginia, USA	Nigg, B.M.
Fialka-Moser, V.	Vienna	Nigg, B.M.
Forsyth, K.	ABC Sports, USA	Nigg, B.M.
Groot, G. de	Free University of Amsterdam	Boer, R.W. de
	The Netherlands	
Gross, R.	Research Inst. of-Physical Kulture, East	Nigg, B.M.
	Germany	00
Hartfel, M.	University of Minnesota,	Boer, R.W. de
Hoffmever. J.	Alberta Technology, Research and	Vickers, J.
	Telecommunications	, -
Imesch. F.	Director, Assoc, Suisse du Sport	Niga, B.M.
Ingen Schenau, G.J. van	Free University of Amsterdam	Boer. R.W.
	The Netherlands	de
Jerie J	Technical University of Prague	Sovak D
Koning J.I. de	Free University of Amsterdam	Boer RW
Koning, 0.0. 40	The Netherlands	de
Knuttaen H.G	Boston	Niga B M
Koloskov V	Bussian Sports Council Director	Vickore I
Kostka V	Czechoslovakia	Vickers, U.
Longmuir P	Variety Village Sports Centre Toronto	Niga B M
Mortin A	Director Sport Sciences Descareb	Hawas M
Marun, A.	Inst	
Ocwald D	IIIsi. Swice Timing, Switzerland	Niga R M
Deltanon E	Swiss Timing, Switzenand	Nigy, D.Ivi.
Pallonen, E.	National Callage of	Vickers, J.
Раракупакой, м.		NIGG, B.IVI.
Dense in D	Chiropractice, Illinois, USA	11
Popovic, D.	University of Alberta/Yugoslavia	Herzog, w.
Porta, J.	Institut Nacional d'éducacio	Hawes, M.
	física de catalunya,	
	Barcelona	
Prause, K.D.	Research Institute of Physical	Nigg, B.M.
	Kulture, East Germany	
Ramm, K.	Research Institute of Physical	Nigg, B.M.
	Kulture, East Germany	
Rose, E. de	General Secretary FIMS	Hawes, M
Ross, W.D.	Simon Fraser University	Hawes, M.
Sabetzki, G.	International Ice Hockey Federation	Vickers, J.
	Executive and Directorate	
Sabre, B.	Continental Sports Surfaces,	Nigg, B.M.
	Vancouver	
Sacheli, A.	Canadian Society of Petroleum	Nigg, B.M.
	Engineers	

Sandlin, T. Sato, T. Sung-Cheol, L. Tikinov, V. Ville, A. Vukac, L. Wanner, O. Watanabe, K.' Widmann, H. Wright, T. Swedish National Team, Sweden Sendai University, Japan Yonse University, South Korea Russian National Hockey Team French National Hockey Team Austrian National Hockey Team Federal Republic of Germany University of Hiroshima, Japan ADIDAS, Germany President, ADIDAS, Canada Vickers, J. Nigg, B.M. Yeadon, M.R. Vickers, J. Vickers, J. Vickers, J. Vickers, J. Nigg, B.M. Nigg, B.M. Nigg, B.M.

EQUIPMENT

Biomechanics

- 1 EMED foot pressure distribution system
- 5 Kistler 9287 force measuring platforms
- 1 Kistler 9067 (glass) force measuring platform
- 3 Kistler 9861A 8-channel amplifiers
- 1 Kistler 9807 8-channel amplifier
- 1 Kistler 5 channel junction box, type Z 13793
- 2 Vanguard film motion analyzer
- 1 Bolex 16mm cameras and accesories
- 3 Locam 16mm high speed cameras and accessories
- 3 Locam camera carrying cases
- 1 Millisecond timing light system (synchronization for Locams)
- 3 Heavy duty camera tripods with dollies
- 4 Miller tripod carrying cases
- 2 Contax 35mm cameras and accessories
- 4 Kodak 35mm slide projectors with cases
- 6 2 kW flood lights and accessories
- 3 Heavy duty telescopic light standards with dollies
- 8 1 kW flood lights and accessories
- 1 Motion Analysis VP310 3-D video system
- 1 NAC 200 Hz video recorder
- 1 Panasonic 6300 video recorder
- 4 NAC 200 Hz B&W video cameras
- 1 NEC 60 Hz B&W video camera
- 24 Infared photo cells
- 2 3-D film reference frame
- 1 3-D mechanical digitizer
- 3 Oscilloscopes
- 2 Goniometers triaxial (Medex)
- 5 Accelerometers (Endevco)
- 4 Strain gauge amplifiers (Inter Technology)
- *1 Three dimensional laser digitizer (Cyberware 4020/PS Digitizer)

Computer

- 1 1PDP 11/44 with Unix operating system and 577 Mb disk storage
- 2 RX-02 floppy disk drives
- 1 LPA-11 -KK data acquisition system
- 1 1600 bpi tape drive
- 1 HP 9845B
- 1 Sun 3/280S with 1.2 Gbyte disk storage, 6250/1600 bpi tape drive, 24 Mbytes of memory
- 1 Sun3/160M with 171 Mbyte disk storage
- *2 Sun 3/50M monochrome workstations
- 4 Compaq portable III
- 1 Compaq 386
- 1 Compaq 286
- 2 Mac II personal computers, 5 Mb
- 1 Mac SE computer
- 2 Mac plus micro computers
- *2 Zenith laptop personal computers
- 1 letter quality printer
- 24 text terminals
- 54 develnet data sets
- 1 HP 7220C 8-pen plotter
- 1 HP 7475 6-pen plotter
- 1 Selanar graphics terminal
- 6 1200 baud modems
- 1 2400 baud modem
- 1 HP 9874 digitizer
- 1 QMS 800+ laser printer
- 2 Epson FX-86E printers
- 2 Epson LQ-850 printers
- 1 C Itoh 600+ line printer
- 1 Mac hard disk and tape backup unit
- 1 20 Mb Mac hard disc
- *1 Apple laser writer plus
- *1 E-Machines 17" monitor (Mac)
- *1 FWB 80 Mb hard disc (Mac)
- 3 Transduction high speed data acquisition boards for the Compags

Exercise Physiology

- 1 Sensormedics Horizon Metabolic Measurement System
- 1 Beckman Metabolic Measurement Cart
- 2 Beckman medical gas analyzers (LB2, OM11)
- 1 Quinton 24-72 treadmill
- 2 Quinton Q65 treadmills
- 1 Cybex II

- 1 EMG System
- 1 Medilog ambulatory monitoring system
- 1 Beckman M-42 spectrophotometer
- 1 Sorvall RT6000 refrigerated centrifuge
- 5 Narco physiographs
- 7 Monark ergometers
- 1 Combi Power Max bike ergometer
- 2 Narco biotelemetry transmitters and receivers
- 1 Collins Eagle I clinical spirometer
- 1 Collins 120L chain compensated gasometer
- 1 Validyne 1-10 channel case with 3 carrier demodulators and integrator
- 18 Sport Tester computerized heart rate monitors
- *1 Hamilton Pipetor/Dilutor
- *1 YSI Model 27 Sugar Analyzer
- ^2 Refrigerators
- *1 Beckman DU-62 Spectrophotometer
- *1 Abbott TDX Analyzer
- *1 Abbott Quantum II
- *1 Abbott rotating shaker

Neuro-Motor

- 1 Applied Sciences Eye View Monitor H3000
- 1 Pioneer V6000 A Videodisc player
- 1 Dekan performance analyzer
- 1 Lafayette basin anticipation timer
- 1 Lafayette reaction time apparatus
- 1 Lafayette knee reflex reaction timer
- 1 Lafayette stabilometer
- 1 Honeywell visicorder with amplifiers

Sport Anthropology

- 3 Siber- Hegner GMP Anthropometers
- 3 Harpenden fat calipers
- 2 volume displacement tanks for upper & lower extremities
- 1 Densiotometry/volumetric tank
- Somototyping equipment
- 1 Zeiss microscope with photomicroscopic equipment
- 1 Somatotyping turntable
- 1 Contax 35mm camera with motor drive

^{*} Equipment acquired in 1988.



