ANNUAL REPORT . . . 1989



LABORATORY FOR HUMAN PERFORMANCE STUDIES

THE UNIVERSITY OF CALGARY, CALGARY, ALBERTA CANADA





General Comments

The years 1987 and 1988 were periods in which exceptional developments occurred in our laboratory, the move into the new research facilities and all the activities associated with the Olympic Winter and Summer Games. The year 1989 was not as spectacular (except that the Calgary Flames won the Stanley Cup!) and was mainly characterized by a stabilization process. The research activities in our faculty are now coordinated by an Associate Dean (Research) who coordinates three main research groups which have developed over the last few years. The Sports Medicine Centre includes currently about 35 co-workers concentrating on research and education in the field sports of medicine. The Computerized Sport Systems Group includes currently about 15 coworkers and concentrates research on and development as related to videodiscs. The Human Performance Laboratory has a complement of about 60 co-workers and concentrates on research activities which are described in detail by the individual faculty members in the following pages. Figure 1 shows the schematic illustration of the research organization in our faculty

One of the main developments during the year 1989 was the increase in research cooperation with members from other faculties. The vicinity of the Sport Medicine Centre certainly helped in this respect. Additionally, close cooperation with members from the faculties of Engineering, Computer Science and Medical Science was established which helped us to improve the quality of our research.



Fig. 1: Schematic Illustration of the research organization to the faculty of Physical Education at the University of Calgary with special emphasis on the structure of the Human Performance Laboratory

One of our faculty members, Dr. M.R. (Fred) Yeadon will leave us by the end of 1989. He has accepted a position at the University of Loughborough in his native country, the U K. Fred is an outstanding scientist. His achievements have been documented by the Borelli Award he received during his stay at the Human Performance Laboratory. Additionally, Fred was a colourful addition to our group and we will miss his outstanding scientific input as well as his dry humour. We wish him all the best in his new position.

The research in the Human Performance Laboratory is organized into eight groups, each of them under the direction of a faculty member. Following, is a short description of the work pf each of these groups as reported by their respective heads.

EXAMPLE ANICS

Benno M. Nigg

The general thrust of my research is the study of *load on the human locomotor system* and its application to footwear and sport surfaces. The various projects can be grouped into epidemiological studies, methodological developments and general research topics.

The *epidemiological* study in running has been completed. The main finding was that excessive pronation is the main predictor for running injuries. Specifically, patella femoral syndrome could be predicted by using the amount of pronation of a runner. In the *methodological* area three main advances have been made.

Firstly, a 3-D model of the foot has been developed subdividing the foot into six segments and using the pressure distribution insole together with video information as input to estimate internal forces in the human foot during dynamic movement.

Secondly, a model has been developed determining the length and length changes of ligaments and/or tendon/muscle structures around joints.





Thirdly, a procedure has been developed to determine he vertical impact forces during running using the kinematic information of each segment. Currently we are working on the 3-D joint motion description.

The main goal of our work in the area of general research topics is to understand the mechanical reasons for load and overload. Progress has been made in the understanding of the etiology of patellafemoral syndrome and the mechanical functioning of the torsion concept. We are currently working on the basic understanding of the possible internal loading effects of impact forces and the effects of aging on movement pattern and loading.

Walter Herzog

My two areas of research interest are low back mechanical injuries / rehabilitation and muscle mechanics. In both these areas we have made a significant step forward in this last year. In the low back research we have developed and tested a methodology which allows us to quantify the forces which are exerted by a doctor during spinal manipulative treatment of low back pain patients.

Furthermore, we have just finished a study effects different comparing the of conservative treatment modalities on the recovery of patients with sacroiliac joint fixations. In the muscle mechanics research we have developed and tested the technology to measure individual muscle forces of all muscles in a synergistic group of the cat hindlimb. In addition. we have reexamined the mechanisms underlying muscular force production in a mammalian skeletal muscle. Also, we have continued our efforts at determining mechanical of intact human properties skeletal muscles. Overall, it was a year of developing measurement techniques and testing these techniques in selected applied situations.

In the coming year we will be using these methodologies to define low back mechanics and the effectiveness of conservative treatments in low back pain patients, as well as trying to answer what factors influence muscular force production and synergistic load sharing in an intact biological system.

Jack Engsberg

The long term objective of my research is to understand the relationship between structure and function of the lower extremity during gait.





We are currently focusing on an atypical population, below-knee-amputee (BKA) children. The objective of this research is to enable these children to stand, walk and run similarly to normal children without adversely affecting their comfort and skeletal health. To this end three areas of research are critical: prosthetic socket fit, prosthetic alignment, and prosthetic components. We are currently investigating the first two areas. The fit of the prosthetic socket is the most important of the three areas. Presently, sockets are constructed and fitted on the basis of the craftsmanship of the prosthetist. We have developed a quantitative method for constructing and fitting sockets utilizing 3-D laser digitizing, computer aided design and numerical milling. We are currently in the stage of clinical testing.

Our second area of research is focused on the alignment of the prosthetic leg with respect to the prosthetic foot. In this regard we have collected, and are currently analyzing, mechanical data on 237 typical and 30 BKA children to quantitatively determine how both groups of children stand, walk and run. Upon completion of these projects we will evaluate how the location and orientation of the prosthetic foot relative to the prosthetic leg can affect gait.

Fred Yeadon

I spent the first half of this year on sabbatical at the Department of Sport Science at Loughborough University, U.K. During this time two projects on high bar dismounts from the Men's Olympic Gymnastics events at the 1988 Seoul Summer Games were completed for the IOC Medical Commission. One of these compared double and triple somersault dismounts while the other analyzed twisting techniques in the full twisting dismount of the compulsory exercise.

Further studies are in progress for the British Amateur Gymnastics Association and the Canadian Gymnastics Federation. A three year study on twisting techniques used by elite springboard divers was completed for Sport Canada. The results were employed in a most enjoyable practical presentation on twisting at the Canadian Diving Coaches Symposium in The research on twisting Ottawa. somersaults has also found application in the Level III Trampolining Manual. The computer graphics package for the depiction of 3-D human movement using a block model was also completed this year for use on UNIX systems.

Next year I am moving to Loughborough.





University in the U.K. to take up a position in the Department of Physical Education and Sport Science. The past four years at the University of Calgary have been busy but fulfilling. While I will certainly miss the unique company of my colleagues and the infamous Friday seminars, I look forward to continuing my association with the Human Performance Laboratory in the years to come.

= EXERCISE PHYSIOLOGY =

Brian MacIntosh

Excitation-contraction coupling and mechanical response of striated muscle are my major research interests. More specifically, my work is concerned with determining the underlying cellular mechanisms associated with the intervalforce relationships of cardiac and skeletal muscle as well as the role played by failure in excitation-contraction coupling in fatigue of skeletal muscle or during hypoxia in cardiac muscle.

The cardiac muscle studies entail the measurement of the contractile response "in vitro," with manipulation of the fluid environment of the tissue.

This permits me to study the contribution of various ions to the variation in contractile force, as the frequency of stimulation is altered or during hypoxia.

The skeletal muscle studies have been conducted on two levels: 1) "in vitro" and 2) "in situ." Various drugs, (caffeine, halothane, dantrolene) have been used in these studies to determine the role played by changes in calcium release during muscle fatigue. A recent feature of this work has been the study of the staircase response with fatigue.

As a new member of the Faculty, I am looking forward to the new research opportunities made available to me both here in the Human Performance Laboratory as well as with colleagues in Medical Physiology.

David Smith

The Exercise Physiology group continued their applied work, counselling a number of national teams and the Calgary Flames Hockey Club for training and general lifestyle. This work included closely monitoring physiological and biological parameters during the various training phases, prior to a competition.





In addition we have continued with our basic aim of transcribing the trends observed with elite athletes into discrete questions which can then be addressed by individual research projects.

The Applied Physiology group continued their work with the following national teams: swimming, speed skating, and men's volleyball. In particular a three year project was begun, investigating the effect of altitude for training at sea level performance in swimming. This is a major several levels project involving of swimmers from all across Canada. Despite the use of altitude training by many athletes, much of the physiology and biochemistry of the adaptation has never been clearly identified. This makes the altitude project especially exciting.

The physiology group travelled to Font-Romeu, France for 21 days with 35 national team swimmers. Preliminary results from this training camp are very promising.

The value of the translation of applied to research work was clearly demonstrated with the success of Delia Roberts at the Annual Sport Medicine conference of the Ontario Medical Association in Toronto. She was presented with the J.C. Kennedy Award for Excellence in Sport Medicine, for her presentation of work on serum ferritin and anemia. The award was based on quality and significance of research as well as quality of presentation.

The project was a direct result of trends which had been observed over several years monitoring of a number of national teams.

Dr. Smith returned from his sabbatical leave in June. He was awarded the Alberta Achievement Award for his contributions to exercise physiology.

Our research focus this year has been directed toward hormonal changes during training. This follows directly from our work in the acute inflammatory response.



Joan Vickers

Three major projects are ongoing in the laboratory.

a) Instructional design of the Steps to





Success Activity Series, published by Leisure Press, a division of Human Kinetics Publishers, Champaign, IL.

The *Steps to Success Series* was unveiled at AAHPERD in April, 1989 with 14 titles.

The instructional design of the series follows a model called the KS Model with the theory book explaining this concept: Instructional Design for Teaching Physical Activity: A Knowledge Structures Approach, Vickers (in press) being released at AAHPERD in March, 1990.

b) The development of a hypermedia system for sports teaching and coaching.

The hypermedia systems prototype in ice hockey is nearing completion. Formal testing will begin this spring at the International Ice Hockey Centre of Excellence, the Calgary Board of Education.

c) Eye movements research.

The eye movements research program has made significant strides this past year with completed preliminary studies in ice hockey, Bruininks perceptual-motor development and golf. Final studies in each area are nearing completion, as well as a dissertation on the role of colour in software design, by L. Livingston.

= SPORT ANTHROPOLOGY =

Michael Hawes

The Sport Anthropology Group experienced a fruitful and satisfying year. Our previous work on the shape and dimension of the North American foot came to fruition with the release of the Adidas Torsion shoe. Stimulated by this initial success, we have refined our techniques for foot measurement by developing a 3-D digitizing program, a new tool for recording profiles (the profilometer) expertly built in the Faculty of Engineering workshop and digital calipers that interface with а microprocessor.

Armed with the two latter pieces of equipment, we embarked on a comparative study of the oriental foot which entailed travelling to Korea and Japan for data collection. In five weeks we were able to measure over 1,000 subjects, and we are indebted to our Korean and Japanese colleagues and





their dedicated students for their overwhelming cooperation, generosity and bon vivants. A second study, conducted within the confines of our laboratory, uses the 3-D digitizer and will provide information about the proportionate growth of the human foot.

Our group continues to assess morphological changes in many of Canada's finest athletes of the present and future. Our longitudinal data is starting to provide some extremely indicators interesting of training. overtraining and performance that correlate well with the biochemical assays of our collaborator, David Smith. We have recently had the opportunity to present our methods and findings and are grateful for their warm reception.

One of the highlights of the year for us was the opportunity to present papers in the microsymposia series at SFU as part of the Kinanthropometry Americas Project.

As the 1980's draw to a close we take this opportunity to thank our colleagues around the world for their interest and input in our work. We look forward to the 1990's with enthusiasm and anticipation of exciting developments in Kinanthropometry and the sport sciences.



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A research institution like the Human Performance Laboratory depends very much on the support from government, industry and other sponsors. Our gratitude is extended to all institutions, groups and individuals that have provided equipment donations or financial support in 1989. The sponsors include:

> Adidas Sport Shoe Company Alberta Children's Hospital, Calgary Alberta Heritage Foundation for Medical Research AMTI (Advanced Mechanical Technology, Inc.) Calgary General Hospital Canadian Fitness and Lifestyle Research Institute Canadian Job Strategies Program Canadian Memorial Chiropractic College Chiropractic Foundation for Spinal Research Clynch Prosthetic & Orthotic Laboratory, Ltd. College of Chiropractors of Alberta Coordenadoria de Akerfeicoaureuto de Pessoal de Eusino Superior, Ministerio da Educação, Brazil Dairy Bureau of Canada Foundation for Chiropractic Education and Research The Kate Bishop Foundation

Motion Analysis Corporation Natural Sciences and Engineering Research Council of Canada Province of Alberta Graduate Scholarship (1988-1989) Saskatchewan Heart and Stroke Foundation Sport Canada Applied Research Program The Toronto Hospital for Sick Children Foundation The University of Calgary The Faculty of Engineering The Faculty of Engineering The Faculty of Graduate Studies The Faculty of Medicine The Faculty of Physical Education The Faculty of Science 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 1989

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HIGHLIGHTS

EVENT	DETAIL
Award	M. Morlock Young Investigator Award, International Society of Biomechanics. "A generalized three-dimensional model of the ankle and the foot."
Award	D. Roberts J.C. Kennedy Memorial Award, Ontario Medical Association "Serum ferritin values in elite speed and synchronized swimmers and speedskaters."
Award	D.J. Smith Government of Alberta Achievement Award for contributions to exercise physiology
Award	M.R. Yeadon American Society of Biomechanics Travelling Fellowship Award
Wartenweiler. Memorial Lecture	B.M. Nigg International Society of Biomechanics, "On the potential of various approaches in load analysis to reduce the frequency of sport injuries."
Book Series	J. Vickers Instructional Designer of "Steps to Success Activity Series," 14 titles released. Human Kinetics, (Eds.)
Ph.D. Thesis	S. Vermeulen "Three-dimensional computer model for the biomechanical analysis of surface shapes." Thesis accepted by the Faculty of Engineering, The University of Calgary.
Ph.D. Thesis	M. Morlock "A generalized three-dimensional model of the ankle and the foot." Thesis accepted by the Faculty of Medicine, The University of Calgary.
Master's Thesis	L. Read "2-dimensional knee joint model to investigate anterior cruciate ligament injury in alpine skiers." Thesis accepted by the Faculty of Medicine, The University of Calgary.
Joint Appointment	B. R. MacIntosh Associate Professor, Exercise Physiology, Adjunct Associate Professor, Medical Physiology, The University of Calgary.

STAFF

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Vickers, Joan, D. Ed.	Associate Prof.	Neuro-Motor
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Grimston, Susan, PhD.		Biology/Biomechanics
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Bradstock, Carie-Lee Plant, Jeff Symonds, Kate

PUBLICATIONS (*Publications in refereed journals)

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- *MacIntosh, B.R. Postrest potentiation of rat atrial muscle with caffeine and ryanodine. *Canadian Journal of Physiology and Pharmacology.*
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- *Posner, P., Baker, S.P., Epstein, M.L, MacIntosh, B.R. and Bass, D.D. Effects of chronic hypoxia during maturation on the negative chronotropic effect of [H+] on the rabbit sino-atrial node. *Pediatric Research*.

PRESENTATIONS (*Presentations at conferences)

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- *Bobbert, M.F. and Schamhardt, H.C. Correction of point of application readings of piezo-electric force plates. In: *Proceedings, XII International Congress of Biomechanics,* Los Angeles, U.S.A., Abstract #196.
- *Bobbert, M.F. and Schamhardt, H.C. Explanation of the impact force peak in *running. In:* Proceedings, First IOC World Congress on Sports Sciences, *Colorado Springs, U.S.A.: 318.*
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- *Engsberg, J.R., Harder, J.A. and Tedford, K.G. Biomechanical analyses of children with a below the knee amputation - longitudinal approach. *Association of Children's Prosthetic-Orthotic Clinics Annual Meeting, Chicago, U.S.A.*

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- Engsberg, J.R., Harder, J. A., Clynch, G., Lee, A.G. and Allen, J. A quantitative method for construction of below-knee prosthetic sockets. *Invited Lecture, 17th Annual Paediatric Orthopaedic Seminar and Townsend Lecture, Alberta Children's Hospital,* Calgary, Canada.
- *Grimston, S.K. Present and prior calcium intake as a factor for osteopenia in female long distance runners. In: *Proceedings, First IOC World Congress on Sport Sciences,* Colorado Springs, U.S.A.: 179-180.
- *Grimston, S.K., Huffer, W.E., Miller, P.D. and Sanborn, C.F. High bone *formation and resorption: a pathogenic mechanism for osteopenia in female long distance runners (Abstract).* Journal of Bone and Mineral Research, 4 (supplement): S170. First Joint Meeting: International Conferences on Calcium Regulating Hormones/American Society for Bone and Mineral Research, Montreal Canada.
- *Grimston, S.K., Sanborn, C.F. Huffer, W.W. and Miller, P.D. Bone biopsy analysis detects metabolic bone disease in female distance runners (Abstract). *Medicine and Science in Sports and Exercise, 21(2). American College of Sports Medicine, Annual Convention,* Baltimore, U.S.A.
- *Grimston, S.K., Shaw, L. and Engsberg, J.R. Muscular rehabilitation and chiropractic therapy for the treatment of sacroiliac subluxation in female runners. *International Conference on Spinal Manipulation, Foundation for Chiropractic Education and Research,* Washington, U.S.A.
- Grimston, S.K. On the value of muscular rehabilitation in chiropractic medicine. *Invited Lecture, Alberta Chiropractic Association,* Edmonton, Canada.
- Hawes, M.R. and Sovak, D. Kinanthropometric assessment of morphological status in young athletes. *Invited Lecture, Korean National College of Physical Education,* Seoul, Korea.
- Hawes, M.R. and Sovak, Monitoring morphological changes in high performance athletes. *Invited Lecture, Japanese College of Physical Education,* Tokyo, Japan.
- Hawes, M.R. and Sovak, D. Human variance in foot shape and dimension., *Nippon College of Physical Education for Women,* Tokyo, Japan.
- Hawes, M.R. and Sovak, D. Monitoring morphological changes in high performance athletes. *Incited Lecture, University of Tokyo,* Tokyo, Japan.
- *Hawes, M.R. and Sovak, D. Anthropometry of the human foot. *Invited Lecture,* Kinanthropometry Americas Project, Simon. Fraser University, Burnaby, *Canada.*
- Hawes, M.R. Measuring status and change in body Composition of young athletes. *Alberta Gymnastics Federation,* Calgary, Canada.

- *Herzog, W., Binding, P. and Platt, R. Predictions of antagonistic muscular activity using non-linear optimal designs. *American Society of Biomechanics,* Burlington, U.S.A.
- *Herzog, W. and Abrahamse, S. Relationship between muscular structure and force production. In: *Proceedings, XII International Congress of Biomechanics,* Los Angeles, U.S.A., Abstract #191.
- *Herzog, W. and Yoshihuku, Y. Optimization of power output in bicycling. In: *Proceedings, XII International Congress of Biomechanics*, Los Angeles, U.S.A., Abstract #3.
- Herzog, W., Abrahamse, S.K. and Hasler, E.M. Strength curves for human knee extension. *Canadian Federation of Biological Societies,* Calgary, Canada.
- Herzog, W. and Willcox, B. The forces exerted during spinal manipulative therapy. Invited Presentation, College of Chiropractors Annual Meeting, Edmonton, Canada.
- *Herzog, W., Willcox, B. and Heetvelt, A. Effects of different treatment modalities on the gait symmetry of low back pain patients. *International Conference of Spinal Manipulations,* Washington, U.S.A.
- Herzog, W. Muscle mechanics. Invited Seminar, University of Iowa, Iowa City, U.S.A.
- *Lee, A.G., Engsberg, J.R. and Harder, J.A. Force platform analysis of gait of children with below the knee amputations – vertical components. *American Society of Mechanical Engineers Convention,* Buffington, U.S.A.
- *Livingston, L.A. and Vickers, J. The cognitive cost of color. Invited Lecture, Twelfth Annual Conference of the Canadian Society for Psychomotor Learning and Sport, Psychology Conference, Victoria, Canada.
- *MacIntosh, B.R. Steady level and postrest contractions of rat atrium in the presence of caffeine rely on calcium release from sarcoplasmice reticulum. *Canadian Physiological Society*, Whistler, Canada.
- *MacIntosh, B.R. Hypoxia, caffeine and postrest contractions of rat atrium. *American Physiological Society, (FASEB), New Orleans, U.S.A.*
- •MacIntosh, B.R. Simulation of fatigue of skeletal muscle by dantrolene sodium. *American College of Sports Medicine,* Baltimore, U.S.A.
- *MacIntosh, B.R. Changes in relaxation during skeletal muscle staircase: role of calcium release. *Canadian Association of Sport Sciences,* Montreal, Canada.
- *Morlock, M. A generalized three-dimensional six segment model of the ankle and the foot. In: *Proceedings, XII International Congress of Biomechanics,* Los Angeles, U.S.A., Abstract #192.
- *Nigg, B.M. (a) Some problematic aspects of material tests used for the assessment of sport surfaces, and (b) Biomechanical aspects of sport shoes. *Keynote Lecturer, International Symposium on Sports Medicine,* Jerusalem, Israel.

- *Nigg, B.M. (a) Sport specific forces at the knee joint, (b) Biomechanical considerations concerning the ACL and the PCL and (c) Patella-femoral syndrome biomechanical considerations. *Invited Speaker, International Symposium on Sports Medicine,* St. Christoph, Austria.
- Nigg, B.M. Forces in the anatomical structures of the foot and running shoes. *Invited Speaker, Karolinska institute,* Stockholm, Sweden.
- *Nigg, B.M. On the potential of various approaches in load analysis to reduce the frequency of sport injuries. *Wartenweiler Memorial Lecture, XII international Congress of Biomechanics,* Los Angeles, U.S.A.
- Nigg, B.M. Quantitative assessment in physical medicine and rehabilitation. Invited Speaker, The Royal College of Physicians and Surgeons of Canada, Annual Meeting, (CAPMR), Edmonton, Canada.
- *Patterson, J.L., Engsberg, J.R. and Harder, J.A. Force platform analysis of gait of children with below the knee amputations - horizontal components. *American Society of Biomechanics Convention,* Burlington, U.S.A.
- *Read, L. and Herzog, W. A model of anterior cruciate ligament injury in alpine skiing. In: *Proceedings, XII International Congress of Biomechanics,* Los Angeles, U.S.A., Abstract #188.
- Roberts, D. and Smith, D. Serum ferritin values in elite speed and synchronized swimmers and speedskaters. *Ontario Medical Association, Annual Conference,* Toronto, Canada.
- *Ronsky, J.L. and Herzog, W. A geometric model of muscular contraction. *American Society of Biomechanics,* Burlington, U.S.A.
- Smith, D.J. Preparation and peaking of high-performance *athletes. University of New Brunswick,* Fredericton, Canada
- Smith, D.J. Altitude training in swimming. Swim Alberta and B.C., Banff, Canada.
- Smith, D.J. Specificity of testing and training. *Alberta Coaches Association Conference, Edmonton,* Canada.
- Smith, D.J., Roberts, D., Neil, R. Maralia, P., Walters, J, and Barron, A. Prediction of performance from laboratory and on-ice tests in Olympic speed skaters. In: Proceedings, IOC World Congress on Sport Science, Colorado Springs, U.S.A.: 113-114.
- Sovak, D. Kinanthropometry and its application in the sport science. *Invited Lecture, Alberta Sport Council,* Calgary, Canada.
- Sovak, D. Anthropological assessment of the active tissue development. *Invited Lecture, The University of Lethbridge,* Calgary, Canada.
- *Sovak, D. and Hawes, M.R. Monitoring of high performance athletes. *Invited* Lecture, *Kinanthropometry Americas Project, Simon Fraser University*, Burnaby, Canada.

- Sovak, D. and Hawes, M.R. Contribution of kinanthropometry in selection and training of swimmers, *North York Swimming Club,* Toronto, Canada.
- Sovak, D. Anthropological testing programs for elite athletes. *Invited Lecture,* Alberta Sport Council, Calgary, Canada.
- *Sovak, D. and Hawes, M.R. Changes in active tissue development of ten elite male swimmers during fourteen months of training prior to Olympic trials. In: *Proceedings, First IOC World Congress on Sport Sciences* Colorado Springs, U.S.A.: 55.
- Vickers, J. A comparison of fixed and helmet mounted method of eye movements research. *Invited Lecture, Sport Science Symposia, The University of North Carolina,* Greensboro, U.S.A.
- Vickers, J. and Abbott, S. Hypermedia system design for sports teaching and coaching. Invited Lecture, *First Pacific Universities Consortium Conference, Wollongong University*, Australia.
- Vickers, J, Abbott, S. and Morrill, M. ActionMark: A knowledge based software package for skill acquisition. *National Research Council's Sixth Symposium on Instructional Technology*, Halifax, Canada.
- Vickers, J. and Patterson-Wright, J. Design of the steps to success activity series. The Curriculum and Instruction Academy, American Association of Health, Physical Education and Recreation Annual Conference, Boston, U.S.A.
- Yeadon, M.R. A control model of aerial movement. In: *Proceedings, Second* International Symposium on Computer Simulation in Biomechanics, Davis, U.S.A.
- Yeadon, M.R. Numerical differentiation of noisy data. In: *Proceedings, XII International Congress of Biomechanics*, Los Angeles, U.S. A. Abstract #125.
- *Yeadon, M.R. Controlling aerial rotations. *Paper presented at Engineering Foundation Conference*, Potosi, U.S.A.
- *Yeadon, M.R. Techniques used in high bar dismounts. ASB Travelling Fellowship Report, 13th Annual Meeting of the American Society of Biomechanics, Burlington, U.S.A.
- Yeadon, M.R. Techniques used in twisting dives. In: Proceedings, Canadian Amateur Diving Association Coaching Symposium, Ottawa, Canada.
- Yeadon, M.R. Twisting techniques used in springboard diving. In: *Proceedings*, *First IOC Congress on Sport Sciences*, Colorado Springs, U.S.A.: 307-308.
- Yeadon, M.R, Three-dimensional film analysis using pan and lift cameras. In: Proceedings, British Association of Sport Sciences Conference, Leeds,, U.K

INTERNAL/TECHNICAL REPORTS

- *Engsberg, J.R., G. Clynch, Lee, A.G. Lee. CAD of prosthetic sockets.* Presented to the National Research Council of Canada, Division of Electrical Engineering.
- Engsberg, J.R., G. Clynch, Lee, A.G. Laser scanning in quantitative construction of prosthetic sockets. Presented to Servo-Robot, Boucherville, Ontario.
- Hawes, M.R. and Sovak, D. Anthropological status of Alberta Provincial Gymnasts. *Report #2.*
- Nigg, B.M., Fisher, V. and Stano, A. Shock absorption, sole hardness and loss of energy. Research report for Omnisport International.
- Nigg, B.M., Fisher, V. and Stano, A. Resurfacing, University of Saskatchewan running track. Research report for Jones-Konihowski Ent.
- Nigg, B.M., Fisher, V. and Stano, A. On the effect of the placement of the torsion bar on torsion and rearfoot movement in tennis. Research report for Adidas Research Center.
- Nigg, B.M. and Cole, G. The trampoline effect as applied to lateral stability in sport shoes. Research report for Adidas Research Center.
- Ronsky, J. and Nigg, B.M. Development of a 3-D method to determine pronation and internal rotation of the tibia. Research report for Adidas Research Center.
- Smith, D.J. Report for the National Speed Skating Team.
- Smith, D.J. Report for the National Volleyball Team.
- Smith, D.J. Report for Swim Canada.
- Smith, D.J. and Stengler, S. Energy cost of 3 types of running shoes. Report for Adidas Research Centre.
- Sovak, D. and Hawes, M.R. Anthropological status of junior national level divers. Report #4 and #5 for Calgary Diving Club.
- Sovak, D. and Hawes, M.R. Anthropological status of junior and senior national calibre synchronized swimmers. Report #3 and #4 for Aquabelles Club.
- Sovak, D. and Hawes, M.R. Anthropological status of The University of Calgary Swimming Club members. Report #10, #11, #12 and #13 for The University of Calgary Swimming Club.
- Sovak, D. Anthropological status of Ontario provincial team members Swimming.
- Sovak, D. Anthropological status of Alberta provincial speed skaters (Males and Females)
- Yeadon, M.R. Application of computer simulation for the modification of twisting techniques of high performance divers. Report for Sport Canada Applied Research Program.

ANTHROPOLOGICAL, PHYSIOLOGICAL AND BIOCHEMICAL ASSESSMENTS

Sovak,D. and Hawes, M.R.	 National Speed Skating Team (Female) National Synchronized Swimming Team Aquabelles Club – Synchronized Swimming University of Calgary Swimming Team (Male and Female) Alberta/Speed Skating Provincial Team University of Calgary Gymnastics Team (Female) Alberta Provincial Tumbling Team (Male arid Female) Alberta Provincial Junior gymnastics Team (Male) Alberta Provincial Diving Team (Male and Female) Calgary Swim Club Members Members of Canadian National Rowing Team Canadian National Swimming team (Male and Female) North York Swimming Club Members Members of the National Cycling Team Luge Competitors University of Calgary Faculty of Physical Education Students
Smith, D.J.	National Volleyball Team National Speed Skating Team National Swim Team University of Calgary Swim Club Calgary Flames Hockey Club Alberta Figure Skating Team Alberta Speed Skating Team Alberta Alpine Ski Team

OFFICIAL FUNCTIONS

Hawes, M.R.	Acting Associate Dean (Research) & Director of Human Performance Laboratory (Jan June)
	Publications Committee, ISAK
	Alberta Sport Council Summer Games Committee
	Stakeholders Committee, Alberta Sport Council
	Reviewer, Journal of Sport Sciences
Herzog, W.	Editorial Reviewer, W.C. Brown Publishers
	Editorial Board, Journal of the Canadian Chiropractic Association

Nigg, B.M.	Associate Dean (Research), Faculty of Physical Education, The University of Calgary
	Member, IOC Medical Commission, Subcommittee, "Biomechanics and Sport Physiology"
	Editorial board, Journal of Biomechanics
	Steering Committee, "First World Congress on Biomechanics", San Diego, U.S.A., 1990
	Organizing Committee "First IOC World Congress on Sport Sciences", Colorado Springs, U.S.A., 1989
Smith, D.J.	Delegate, Sport Canada Symposium on High Performance Sport
	Reviewer, Canadian Association of Sport Sciences
	Board Member, Sports Medicine Council of Alberta
	Treasurer, Sport Science Association of Alberta
Yeadon, M.R.	Member, Sport Science Resource Committee, Canadian Gymnastics Federation
	Member, Trampolining Certification Committee, Canadian Gymnastics Federation

GUESTS AND VISITORS

Ackland, T.R.	University of Western Australia	Engsberg, J.R.
Anderie, W.	Adidas, Luzern, Switzerland	Nigg, B.M.
Bailey, D.	University of Saskatchewan	Hawes, M.
Cassidy, D.	Unversity Hospital, Saskatoon, Saskatchewan	Nigg, B.M. Herzog, W.
Dainty, D.	Canadian Memorial Chiropractic College, Toronto, Ontario	Nigg, B.M. Herzog, W.
Day, J.	University of Lethbridge	Hawes, M.
Dippe, H.	Aachen, West Germany	Nigg, B.M.
Fairbanks, B.	University of Lethbridge	Hawes, M.

Folachier, M.	Centre Technique Cuir, (C.T.C.) Lyon, France	Nigg, B.M.
Greaves, J.	Motion Analysis Santa Rosa, California	Nigg, B.M.
Hubbard, M.	U.C.L.A. Davis, California	Nigg, B.M.
Huiskes, R.	University of Nijmegen The Netherlands	Nigg, B.M.
Jones, N.	McMaster University	Hawes, M.
Luethi, S.	Adidas, Luzern, Switzerland	Nigg, B.M.
Oakes, B.	Monash University Melbourne, Australia	Nigg, B.M.
Pfau, G.	Adidas Herzogenaurach, West Germany	Nigg, B.M.
Schultz, A.	University of Michigan Ann Arbor, Michigan	Nigg, B.M.
Soutas-Little, R.W.	Michigan State University	Engsberg, J.R.
Tiffany, T.	Swim Canada, Vancouver	Vickers, J.N.
Whittaker, T.	Motion Analysis Santa Rosa, California	Nigg, B.M. Engsberg, J.R.

EQUIPMENT (*Equipment acquired in 1989)

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
2	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)
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- 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)
- *1 Queue Systems (Model 710) -75°C Cryostar, 364 litre Chest Freezer
- *1 Six D.O.F. ankle joint complex Rommeter

Computer

1	PDP 11/44 with Unix operating system and 577 Mb disc 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

- 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 LaserWriter plus
- 1 Apple LaserWriter II NTX
- 1 E-Machines 17" monitor (Mac)
- 1 FWB 80 Mb hard disc (Mac)
- 3 Transduction high speed data acquisition boards for the Compage
- *1 Sun SparcStation 1 colour workstation, 200 Mb disc storage
- *1 QMS LaserJet 800+ laser printer
- *1 Macintosh IIcx computer

Exercise Physiology

1

1 Sensormedics Horizon Metabolic Measurement System 1 Beckman Metabolic Measurement Cart 2 Beckman medical gas analyzers (LB2, OM11) 1 Quinton 24-72 treadmill Quinton Q65 treadmills 2 1 Cvbex II 1 EMG System 1 Medilog ambulatory monitoring system Beckman M-42 spectrophotometer 1 1 Sorvall RT6000 refrigerated centrifuge 4 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 1 integrator 18 Sport Tester computerized heart rate monitors LKB Ustraspec K 1 1 Hamilton Pipetor/Dilutor YSI Model 27 Sugar Analyzer 1 2 Refrigerators 1 Beckman DU-62 Spectrophotometer 1 Abbott TDX Analyzer 1 Abbott Quantum II 1 Abbott rotating shaker *1 Analytical Balance

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
- *2 Modified Mitutoyo digital caliper
- *1 Digimatic processor
- *2 Profilometer developed by U of C Engineering Services



