# NEWSLETTER NUMBER 4

## JULY 1977

## FORCE PLATFORM GROUP

## INTERNATIONAL SOCIETY OF BIOMECHANICS


Group Chairperson — Dr. Peter R. Cavanagh
Biomechanics Laboratory,
Pennsylvania State University,
University Park,
Pa. 16802,
U.S.A.

Newsletter Edited by — A.H. Payne (Secretary)
Department of Physical Education,
University of Birmingham,
P.O. Box 363,
Birmingham B15 2TT,
England.



(The Newsletter is circulated free to members of the Force Platform Group. Membership enquiries to the Secretary).

# CONTENTS

The Force Platform Group of the ISB

The Group first formed in 1973 at the Fourth International Seminar on Biomechanics at the Pennsylvania State University, U.S.A. with an ad hoc committee of Peter Cavanagh (U.S.A.) and Don Grieve (England). Howard Payne (England) became 'catalogue editor' and produced two editions of "A catalogue of force platforms used in biomechanics research".

At the 1975 Fifth International Congress of Biomechanics at the University of Jyväskylä, Finland, the Group re-formed itself, and elected Peter Cavanagh as chairperson with Howard Payne as secretary. It was decided that six-monthly newsletters should be produced and sent to all members, who were asked to pay a US $5 subscription to cover the costs of producing and mailing the newsletter.

The biannual newsletter was initiated with the following objectives:-

(a) To provide a bibliographic service to Group members on a regular basis.

(b) To publish original articles on topics related to force measurement in human biomechanics.

(c) To provide a forum for questions and answers on related subjects.

In his 'Message' in the Newsletter No. 1 the Chairperson urged: "Firstly, please let the editor of the newsletter have any ideas that you might generate concerning material to be included in future editions. The newsletter is a far stronger means of communication than one meeting of the Group every two years, and in such a small group, we shall need input from almost every member. Secondly, if you are aware of force platform users who are not members of our group, please encourage them to get in touch with us so that we can benefit from their input".

## Editorial

With the prospect of the Third Biennial General Meeting of the Force Platform Group to be held during the VI$^{th}$ International Congress of Biomechanics in Copenhagen, July 11-14, 1977, it is an appropriate time to take stock of the Group. The 70 entries in the "register", or list of people with force platform interests, published in this Newsletter show that the F.P.G. is a successful enterprise which helps to satisfy some of the needs of its members. The interdisciplinary nature of work with force platforms and the wide-ranging interests of force platform users mean that reports and publications are spread throughout the scientific literature, which makes it imperative that users have some common meeting point, if work is not to be duplicated and if the benefits of research in one area can be readily available for workers in another area.

Many enquiries have been received from researchers about to set up force platform facilities and, with the membership list available, it has been possible to assist these people by referring them to members with similar interests near to them geographically. In this way we have also extended our membership.

The Bibliography produced by Barry Wilson (with encouragement from Jim Hay) from time to time has been of great help to all of us, who have been spared countless hours of literature searching because of it. Gustav Gautschi and Bill Munday of Kistler Instrumente A.G. have very kindly assisted through their commercial contacts. Our Chairperson, Peter Cavanagh, has been very active encouraging American membership and in his negotiations with the International Society of Biomechanics concerning the status of the F.P.G.

On behalf of the Group I would also like to express my appreciation for the assistance given to the Group by Mr. Bill Slater, Head of the Physical Education Department at the University of Birmingham.

All associations have problems when it comes to subscription fees, and the Force Platform Group is no exception. It seems that Man (and that includes Woman) suffers from some kind of amnesia when it comes to paying his dues! In 1976 we had 65 members who were exceptions to this ailment, but many of them succumbed in 1977, so that even with many new members, only 53 can boast of being paid-up at the present time. I have been very loathe to remove names from our young association and the result is that approximately 110 copies of Newsletter No. 4 are being mailed. Some of these are going to prospective new members and some are purely courtesy copies to libraries, information centres etc., but rather a lot are going to the forgetful. Are some of these no longer interested? This is a subject which will need to be discussed at the meeting in Copenhagen.

After four years of editing Catalogues and Newsletters your secretary is retiring. It would be helpful if nominations for the post could be sent to me or to Peter Cavanagh as soon as possible.

# FORCE PLATFORM RESONANCES

By

Ian A.F. Stokes
Oxford Orthopaedic Engineering Centre,
University of Oxford

"Call me what instrument you will, though you can fret me,
yet you cannot play upon me." Hamlet

Most force platform users are seen occasionally to tremble in sympathy with their instruments at the mention of the natural frequencies and resonances of their measuring equipment. This phenomenon is a result of two fears: firstly that the force platform may not be recording faithfully the forces which are imposed on its top surface, and secondly that the platform itself may be altering those forces which the researcher sets out to measure, by interfering with the imposed forces.

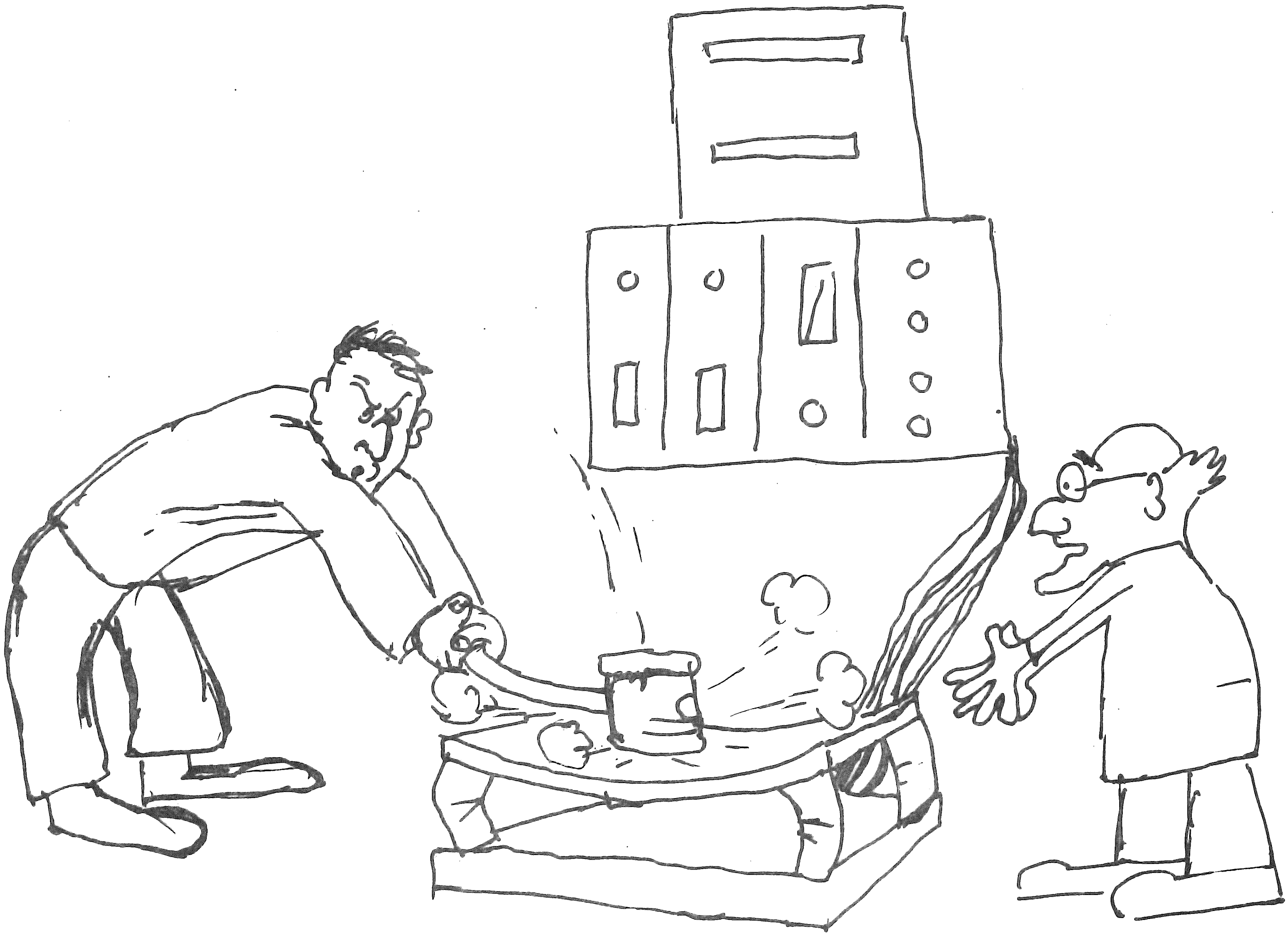
The researcher is in a position similar to that of the listener to gramophone recordings. In this case the sound coming from the loudspeakers should represent accurately the movements of the stylus as it moves along the track, without losing the high notes or suffering vibrations or buzzes in the midrange. At the same time the listener wants the stylus to follow the profile of the track without altering that profile from the shape imposed when the record was pressed. The stylus should not elastically or plastically deform the record.

This paper is intended to show to a user how the properties of the force platform can be assessed to ensure that it functions as an accurate measuring instrument. It is hoped that it also indicates how the system may be improved if inadequacies are found. Force platforms are built to resolve forces into horizontal and vertical components, and to transduce these forces and associated moments of forces linearly and repeatably. Ideally, the platform should also respond to the applied forces irrespective of how fast or slowly they are applied. It is this last requirement which is considered here. A resonance in the system is an obvious manifestation of a poor time response to applied forces.

## Unloaded Natural Frequencies

By striking the top surface of a force platform with a sharp hammer blow we hope to see on the recorded output the impulse response of the system. The "system" includes the force platform, its amplifiers and the recorder. The impulse response is useful since a true impulse contains the full spectrum of harmonic frequencies, and the hammer blow probably contains all the frequency components that the force platform will ever have to deal with. The response of the system may contain periodic components which show us the natural frequencies. These resonances may be in the recorder, the amplifiers, the force platform, or in the floor on which it is mounted. If these natural frequencies are never excited when the force platform is in use, then there is nothing to worry about. However, a frequency which appears in any routine recordings from the instrument is distorting the recordings and should be tracked down and eliminated if possible.

Simple bench tests can be performed to check the amplifiers and recorder by applying square waveforms or sinusoidal signals of various frequencies. The output should ideally follow the input at all the frequencies in terms of both amplitude and phase. A resonance interferes with both.



"Ian Stokes meant a gentle hammer blow, Igor!"

Resonances in the force platform itself are often at lower frequencies, and are therefore those which are likely to limit the performance of the system. A number of resonances may be expected, due to the various modes of vibration of the top plate on its supports (including vertical, horizontal, rocking and torsional modes). The top plate itself is not rigid, so it will have its own resonances. In addition, a non-rigid floor mounting will introduce more vibrations (as described by Gautschi in Newsletter No. 1). Resonances of the force platform may be investigated in a number of ways:

(a) The sound of a hammer blow is easier to assess quickly than long lengths of "hard copy". Tapping the top plate at different points over its surface to excite the various modes of vibration is often overlooked as a method of assessing resonances.

(b) Looking at the outputs of all the vertical (and, if applicable, horizontal) force transducers separately may be useful. A multi-channel storage oscilloscope is invaluable for this. The phase relationships between the various channels can tell a great deal about the modes of vibration.

(c) Compare the results of remounting the force platform temporarily on a thickness of absorbent material, such as foam rubber. Resonances can result from the force platform vibrating on its mountings.

Having identified the source of a resonance, ingenious methods of increasing stiffnesses and decreasing masses must be used to increase the frequency to one which is not excited by the forces to be measured. It is one of the unfortunate facts of life that this may result in a loss of sensitivity of the instrument, if the stiffness of the transducers has to be increased. It is wrong to filter out the resonance mechanically or electrically. Resonances which cannot be removed should be left in order to identify those parts of a recording which are not reliable. (Filtering to reduce noise beyond the spectrum of the imposed forces is permissible, and desirable).

## Loaded Natural Frequencies and Stiffnesses

If one walks along a plank of wood which is supported only at its ends, this surface resonates up and down under the influence of bodyweight. The forces transmitted by the feet are altered from those imposed on hard surfaces. This might apply to the non-rigid surface of the force platform too. However, the force platform still records the forces between it and the body as faithfully as any other forces. The interaction between the force platform and the body only affects the forces between them, not the accuracy with which the forces are measured.

If a mass of 70Kg were placed on the force platform, the natural frequencies would be altered by the change in the mass of the top plate. However, the human body is not just a mass - it is described better as a stack of masses connected by springs and dampers with muscles too. There is, therefore, little point in considering the loaded natural frequencies unless they are just below 10Hz, since only below this frequency does the human body behave as a simple mass. It is usually more useful to ask the question "What stiffness should the top surface have?"

If we want to study the forces on the shoe when walking along a hard pavement or sidewalk, then we need a hard and stiff top surface on the force platform. If we are interested in athletic events on the running track, then that surface should be created on the top of the measuring system by placing a box of cinders on it. The result would be that the athlete would be able to experience the same forces when running over the force platform as on the rest of the running track. The box of cinders cannot "absorb" force since its momentum is the same before and after the athlete runs over it, so the force platform still records the force applied by the athlete. However, the researcher would have to inspect the recordings to see whether any of the new and lowered natural frequencies of the instrument (resulting from the extra mass) had been excited during the event he had recorded.

What is an Acceptable System?

The forces acting on a body can change instantaneously. However, the recordings from force platforms usually show forces which do not change very fast, with the notable exception of initial contact forces such as at heel strike in walking. It seems that muscles develop forces gradually and that there is enough elastic material in the body to prevent rapidly changing forces reaching a force platform except during the initial contact.

Most individuals have been observed by the author to excite a force plate resonance of 250Hz when walking barefoot on the hard top surface. This only occurred at heel strike, and rather surprisingly was not observed when the subjects wore shoes. Thereafter, a bandwidth of 25Hz would have been adequate to record the forces quite accurately. (A suitable adjustment should be made to this figure for more athletic activities). Thus, unless the impact forces at heel strike are of particular interest, a lowest natural frequency of about 100Hz is acceptable for recording most activities. It becomes expensive to have recording equipment which can handle very much higher frequencies than this.

If the force platform has loaded natural frequencies lower than about 20Hz on addition of a 70Kg mass, the platform may be unacceptable because this suggests that it does not have sufficient stiffness to simulate the normal ground surface. The best policy is to start with a hard and stiff surface and to add a layer of softer material to create the desired surface. The addition of this mass will lower the natural frequencies of the force platform, but its elasticity will often create a surface onto which rapidly changing forces are not applied.

A force platform user should therefore be able to satisfy himself about the effect of resonances in his instrument. Firstly, he should be certain that it has no resonances or natural frequencies which can interfere with the range of applied frequencies which he wants to measure. All force platforms have an "upper limit" which restricts the rate of applied load which they can follow. Secondly, the loaded natural frequencies give an indication of the stiffness of the top surface. This stiffness is the important parameter, which ideally should be matched to the stiffness of the surrounding floor. In this way the force platform does not modify the forces which the researcher sets out to measure.

"Well if John Cooper can use three platforms at once ...."

## FORCE PLATFORM REGISTER

The following is a list of people with force platform interests and is based on the replies to the questionnaires sent out with Newsletters 2 and 3, plus recent correspondence.

As a matter of professional courtesy, it should be pointed out that in many of the projects listed, whole teams of researchers will be involved, but for brevity, only the correspondents' names are given.

Mr. G. Adamson,
Physical Education Department,
University of Leeds,
Leeds,
LS2 9JT,
England

Kistler 9261 A
UV, Southern Inst.

Sports techniques,
Rheumatism research,
animal locomotion,
gait analysis.

---

Dr. Marlene Adrian,
Department of P.E. for Women,
Washington State University,
Pullman,
Washington 99163, U.S.A.

Platform designed by Prof. John Cooper,
Indiana University.

Sports techniques

---

Professor Dr. Thomas P. Andriacchi,
Department of Orthopaedic Surgery,
Rush-Presbyterian-St. Luke's Medical Centre,
1753 W. Congress Pkwy.,
Chicago,
Illinois 60612, U.S.A.

40x60 cm. Kristal 9261 A (piezoelectric)
Beckman Chart Recorder
PDP 11/40 Computer
Foot switches, EMG, Selspot.

Gait analysis, biomechanics.

---

Dr. Gideon Ariel
Computerized Biomechanical Analysis Inc.,
316 College St.,
Amherst,
Mass. 01002, U.S.A.

3 Kistlers
Microprocessors built by own engineers

Design of shoes, tennis racquets, tennis balls, knee brace and exercise equipment. Cat locomotion. locomotion models.

---

Dr. John Atha,
Department of Human Sciences,
University of Loughborough,
Leicestershire,
England.

40x60 cm. Kistler 9261 A (piezoelectric)
S.E.L. Recorder, 7 Channel taperecorder
PDP 11 Computer on-line
EMG, 16 mm cameras, Polarised light goniometers.

Gait analysis, postural studies.

---

Dr. J. Barany,
Industrial Engineering School,
Purdue University,
Lafayette,
Indiana 47907, U.S.A.

25"x22" platform of own design
Transducers : LVDTs
Heimplegic gait.

---

Dr. Barry T. Bates,
Department of Physical Education,
University of Oregon,
Eugene,
Oregon 97405, U.S.A.

No platform at present.

Analysis of running, foot function and injuries.

---

Dr. Jürg Baumann,
Neuro Orth, Abt.,
Orthopädische Universitätsklinik,
Kinderspital,
CH-4005 Basel, Switzerland.

2 glass-topped Kistlers.

Planning of orthopaedic operations, design of braces

---

Mr. Carmelo Bosco,
Kinesiology Laboratory,
Department of Biology of Physical Activity,
University of Jyväskylä,
Jyväskylä 10,
Finland.

600x660 mm platform made in University of Jyväskylä
Transducers : Kyowa LCP 500 KA and Kyowa LCP 200 KA
Transient recorder Model 512 A (Physical Data, Inc.)
Recorder Seryogor (Goerz Electro Ges. m.b.H)

EMG, cameras, display oscilloscope, electrogoniometer.

Basic movement, muscle elasticity.

---

Professor Dr. Friedrich Brussatis,
Orthopädische Univ. - Klinik,
Langenbeckstrasse 1,
6500 Mainz, W. Germany.

Intend installing platform in 1978.

EMG, cameras, computer

Gait analysis, halt-weakness

---

Dr. Peter R. Cavanagh,
Biomechanics Laboratory,
Penn State University,
University Park,
Pa. 16802, U.S.A.

(a) Kistler

(b) Laboratory built 20"x24" aluminum plate
Transducers: strain gauged rings.

Both platforms use UV recorder and on-line computer.

Cinematography, EMG, displacement transducers.

Locomotion, weight lifting, other sports studies.

---

Dr. Arthur E. Chapman,
Department of Kinesiology,
Simon Fraser University,
Burnaby,
British Columbia,
Canada V5A 1S6.

Kistler

EMG, PDP 8e mini computer.

Fundamental aspects of muscular contraction.

---

Dr. P.L. Chin,
Geriatric Department,
Cumberland Infirmary,
Carlisle CA 27 HY,
England.

No platform at present

Electrogoniometers and cinephotography

Kinematics of gait in stroke patients and the elderly
Parkinson's Disease

---

Professor Dr. R. Claeys,
State University of Ghent,
Watersportlaan 2,
B 9000 Ghent,
Belgium.

(a) Kistler

(b) 40x40 cm. strain gauged platform designed by
Professor Somerling.

Devices M.4 Pen recorder (heat sensitive paper)

EMG, cameras, TV, accelerometers (Kistler)

Gait analysis, sports, gymnastics.

---

Professor Alain Connan,
Department de la Recherche de l'ENSEPS,
11 Avenue du Tremblay,
75012 Paris,
France.

Intends constructing own platform

EMG, cine cameras

Forces in karate

---

Professor Dr. John M. Cooper,
School of Health, Physical Education and Recreation,
Indiana University,
Bloomington,
Indiana 47401, U.S.A.

(a) 4ftx4ft laboratory made platform

(b) 2ftx3ft laboratory made platform

(c) Two 6"x12" laboratory made plates, for Z and Y forces only.

Oscillograph

Three high speed cameras, Laser beam system for velocity measurement, photo elect./dig. clock system Strobotac synchronisation of force and film data, etc.

Sports techniques.

---

Dr. Kenneth E. DeHaven,
University of Rochester Medical Centre,
601 Elmwood Ave., Box 665,
Rochester,
New York 14642, U.S.A.

Kistler

Sports techniques.

---

Mr. M. Dhanendran and Mr. W.C. Hutton
Department of Engineering,
The Polytechnic of Central London,
115 New Cavendish St.,
London, W1M 8JS.

25 cm x 12.5 cm platform of own design and construction
Transducers: 128 Resistance strain gauged load cells in a close packed 16x8 matrix (each load cell has a 15 mm x 15 mm load bearing surface.

On-line PDP 11/40 mini computer.

System to measure the temporal/distance factors of gait.

Pathological conditions of the foot, and gait analysis.

---

Dr. Patricia Downie,
54 Prospect,
Northampton,
MA 01060, U.S.A.

No platform at present.

---

Dr. Joseph Ellis,
California Podiatry College,
1770 Eddy St.,
San Francisco,
California 92037, U.S.A.

Kristal

XY and 6 channel Galvanic

Triplane Motion Analyzer, EMG, cameras

Gait analysis, runners.

Professor Dr. Kazimierz Fidelus,
Academy of Physical Education,
01-813 Warsaw,
ul. Marymoncka 34, Poland.

120x80 cm. strain gauged prototype.

Galvanometer oscillograph

EMG, camera, goniometers.

Sports techniques, neuro-muscular coordination

---

Mr. Peter Francis,
N.P.E.B.,
Iowa State University,
Ames,
Iowa 50010, U.S.A.

No platform at present

L.E.D. driver technology

Sports techniques

---

Dr. Louis E. Freund,
Department of Industrial Engineering,
106 Electrical Engineering Building,
Columbia,
Missouri 65201, U.S.A.

Platform built by Western Electric
of Kansas City, Missouri,
based on Konz design

Transducers: LVDTs

---

Mr. Gustav H. Gautschi,
Kistler Instrumente AG,
Postfach 304,
CH-8408 Winterhur,
Switzerland.

Kistler

Designs new force plates and consults on their uses,
especially the measuring techniques.

---

John Hagy,
Shriners Hospital,
1701 19th Ave.,
San Francisco,
Ca. 94122, U.S.A.

24"x24" plexiglass-topped
platform of own design.
Transducers: Kistler model 912.

18-BIT Computer.

EMG, cameras, accelerometers.

Orthopaedics research,
gait analysis.

---

Dr. Charles E. Henning,
Orthopedic Surgery and Fractures,
320 North Hillside,
Wichita,
Kansas 67214, U.S.A.

Planning to install force plate.

EMG, cameras, foot switch synchroniser.

Gait analysis.

---

Professor Bernard Isaacs,
Department of Geriatric Medicine,
Queen Elizabeth Hospital,
University of Birmingham,
Birmingham B15 2TH, England.

Installing two Kistlers in new laboratory at
Selly Oak Hospital.

EMG, videotape recording, goniometry.

Balance and movement in the elderly.

---

Dr. F. Johnson,
Area Medical Physics,
University Hospital,
Nottingham, England.

Modified Liverpool platform built by J.T.M. Wright.
Schoenitz transducers.

Polarised light goniometer, PDP 11.

Gait analysis.

---

Mr. Gordon Judge,
Biomechanical R. & D. Unit, (BRADU)
Roehampton Lane,
London, SW15 5PR, England.

0.61 m x 0.38 m BRADU/Kistler combination
Transducers: 4 Kistler load cells type 9251 A

U/V, oscilloscope, F/m tape recorder

On-line digitisation and analysis by digital computer

Cine, foot contact event recording, polarised light goniometers.

Gait analysis, loading patterns in leg prostheses.

---

Dr. David L. Kelley,
Biomechanics Laboratory,
Department of Physical Education,
University of Maryland,
College Park,
Maryland, U.S.A.

Kistler on order

EMG, cine, strobe.

Basic biomechanics and kinesiology.

---

Professor Dr. Donald B. Kettelhamp,
Department of Orthopedic Surgery,
Indiana University,
School of Medicine,
1100 W. Michigan St.,
Indianapolis,
Indiana.

Contemplating installation of platform (has worked with platforms at University of Iowa and Purdue University)

Electrogoniometers, foot switches, cameras.

Gait analysis.

---

Professor Dr. Stephan Konz,
Department of Industrial Engineering,
Kansas State University,
Manhattan,
Kansas 66506, U.S.A.

Hexagon-shaped (640 mm across flats) platform of own design and manufacture.

Texas Instruments Oscillowriter (heat pen on paper)

Accelerometers, subject questionnaires.

Lifting research (industrial orientation)

---

Dr. Ellen F. Kreighbaum,
HPER Department,
Montana State University,
Bozeman,
Montana 59715, U.S.A.

Intending to construct own platform in near future.

Tektronics Graphic Tablet System, Beauliou 16 mm camera, electrogoniometers.

Sports techniques, biomechanics of leg syndromes (sports medicine)

---

Professor Howard Lamb,
Department of Physical Education,
St. Francis Xavier University,
Antigonish,
Nova Scotia, Canada.

Previously worked with platform at University of Waterloo, Ontario.

---

Mr. Thomas M. McLaughlin,
Biomechanics Laboratory,
University of Illinois,
81 Freer,
Urbana,
Illinois 61801, U.S.A.

Presently designing new type of platform with anticipated completion in 1977.

EMG, cameras.

Sports techniques, injury research.

---

Dr. E. Michaut,
CEREVAL,
2 rue du Parc,
94460-Valenton,
France.

1) 0.8 m x 0.3 m )
2) 0.7 m x 1.6 m ) own design

Transducers: strain gauged cantilevers.

A/D Converter, Data General computer (NOVA 1200)
Plotter (BENSON 110)

Gait analysis

---

Dr. Doris I. Miller,
Hutchinson Hall DX-10
University of Washington,
Seattle, WA 98195, U.S.A.

Kistler 9261 A

Tektronic storage oscilloscopes

EMG, LOCAM camera

Sports techniques

---

Dr. Morris Milner,
Department of Electrical Engineering,
Chedoke - McMaster Centre,
Sanatorium Road,
P.O. Box 590,
Hamilton,
Ontario,
Canada L8N 3L6.

Has just read paper at N.I.H. meeting in San Diego - "Overview of gait laboratories in existence".

---

Mr. W. Munday,
Kistler Instruments Ltd.,
Whiteoaks,
The Grove,
Hartley Wintney,
Hants,
England.

Sales of Kistler force platforms.

---

Mr. Peter J. Nelson,
Committee on Prosthetics Research and Development
Division of Medical Sciences,
National Research Council,
2101 Constitution Avenue,
Washington D.C., 20418, U.S.A.

Collation and distribution of Register of Gait Laboratories started by Dr. E.E. Harris.

---

Dr. Klaus Nicol,
Institut für Sport und Sportwissenschaften,
Universität Frankfurt,
Ginnheimer Landstr. 39,
6000 Frankfurt, G.F.R.

Kistler 9261 and Kistler 9261 A (also several types of capacitor - mat platforms)
UV/Computer

2 Locam cameras, velocity meters based on Doppler Effect, photoelectric cells.

Sports techniques, gait analysis.

---

Dr. Benno M. Nigg,
Laboratorium für Biomechanik
ETH Zürich,
Weinbergstr, 98/100
8006 Zürich, Switzerland.

Kistler 9261 A

Charge amplifier SN 15383, PCM Tape

ECG, cameras

Sports research.

---

Dr. Roland Örtengren,
Department of Orthopaedic Surgery I,
Sahlgren Hospital,
S-41345 Göteborg,
Sweden.

40x40 cm. L'Electronique Appliquee Statokinesimetre
Transducers: Differential transformers.

Racal Thermionic Store 4, PDP 15 computer

Postural sway in Scoliosis

---

Professor John P. Paul,
Bioengineering Unit,
University of Strathclyde,
Wolfson Centre,
106 Rottenrow,
Glasgow G4 ONW, Scotland.

Two Kistlers

U.V. Recorder, PDP 12 digital/analogue computer

EMG, cameras, etc.

Gait analysis - normal, arthritic, prosthetic and brace.
Function of affected and contralateral limbs.

---

Mr. A. Howard Payne,
Physical Education Department,
University of Birmingham,
Birmingham, B15 2TT, England.

Two 0.76 m. square platforms of own construction based on Cunningham and Brown design.
Transducers: strain gauged posts.

UV recorder, S.E. Laboratories 2100

Hulcher 35 mm. Sequence Camera, 16 mm. cine cameras, photoelectric timers, synchronising clock.

Sports techniques.

---

Mr. P.J. Perkins,
Shoe and Allied Trades Research Association,
SATRA House,
Rockingham Road,
Kettering,
Northants, England.

Kistler 9261 A

UV Oscillograph, S.E. Labs. 3006

Stroboscopic photography

Gait analysis for footwear research and friction.

---

Mr. Allan Philpot,
St. Pauls College,
Swindon Road,
Cheltenham,
Glos., England.

Own construction 1 m x 1 m.
Transducers: strain gauges

Devices recorder
EMG, VTR, 16 mm. camera

Sports techniques, biomechanics

---

Elizabeth M. and Thomas W. Roberts,
Department of P.E. and Dance,
Lathrop Hall,
University of Wisconsin,
1050 University Avenue,
Madison,
Wisconsin 53706, U.S.A.

Just purchased Kristal platform

---

Professor Benoit Roy,
Laboratoire des Sciences de l'Activite Physique,
Faculte des Sciences de L'Education,
Universite Laval,
Quebec P.Q.
Canada G1K 7P4.

2ft x 2ft. platform of own design and construction.

Transducers: strain gauges

H-P Recorder

Camera

Sports Techniques, hockey starts on an artificial surface.

---

Mr. Walter Schröder,
Inst. f. Leibesübungen,
Rothenbaumchausee 80,
D 2000 Hamburg 13, W. Germany.

Intends to work with force platform in the future.

---

Dr. Eric J. Sprigings,
College of Physical Education,
University of Saskatchewan,
Saskatoon,
Sask. S7NOWO, Canada.

30" Force plate being constructed at present.

Transducers: LVDT

Honeywell UV recorder

Camera

Sports techniques

---

Dr. J. Stallard,
Orthotic Research and Locomotor Assessment Unit,
The Robert Jones and Agnes Hunt Orthopaedic Hospital,
Oswestry,
Shropshire, SY10 7AG, England.

Kistler 9261 A

Study of leg bracing and swivel walking.

---

Dr. Anthony Staros,
Veterans Administration Prosthetics Centre,
252 Seventh Ave.,
New York,
N.Y. 10001, U.S.A.

2 force platforms of Cunningham and Brown design

Foot switch, Elgons, accelerometers, cameras, EMG

Gait analysis.

---

Dr. I.A.F. Stokes,
Oxford Orthopaedic Engineering Centre,
University of Oxford,
Headington,
Oxford OX3 7LD, England.

Force platform, but no details available.

---

Dr. Peter Stothart,
Thames Hall,
University of Western Ontario,
London,
Ontario, NGA 3K7, Canada.

Has platform, no details available

---

Dr. David Stubbs,
Biological Science Department,
University of Surrey,
Guildford,
Surrey, GU2 5XH, England.

Rebuilt Williams' platform from Department of Production Engineering at University of Birmingham.

Handling materials.

---

Dr. Petr Susanka,
Laboratory of Biomechanics,
Fakulta telesne vychovy a sportu,
Universita Karlova,
Praha,
Czechoslovakia.

Kistler 9261 A

UV, oscilloscope, tape recorder

Eclair 16 camera computer

Videosystem, photoelectric cells

Techniques of top-class sportsmen.

---

Dr. David H. Sutherland,
Children's Hospital and Health Center,
8001 Frost St.,
San Diego,
California 92123, U.S.A.

24" x 24"
Transducers: piezoelectric (Kistler)

Computer disk via A/D convertor

4 cameras, EMG.

Clinical gait analysis.

---

Dr. Per Tveit,
Norges Idrettshøgskole,
Sognsv, 220,
Oslo 8, Norway.

(a) Kistler (b) Transducers based on semiconductor beems (the Aker beems) mounted in skates, skiis and rowing swivels, etc.

Tape recorders etc.,

Telemetry

Sports techniques

---

Mr. G. Veres,
National College of Prosthetics,
Sophies Minde Orthopaedic Hospital,
Trondheimsveien 132,
Oslo 5, Norway.

Kistler 9261 A

Tektronix storage oscilloscope, Beckman Dynograph RS and Houston XY Recorder.

EMG

Gait analysis

---

Mr. Jim Walton,
Division of Applied Mechanics,
Department of Mechanical Engineering,
Stanford University,
Stanford,
California 94305, U.S.A.

No platform at present.

Cameras

Sports techniques

---

Professor C. Gerald Warren,
Department of Rehabilitation Medicine, RJ-30, BB-805,
University Hospital, University of Washington,
Seattle,
Washington 98195, U.S.A.

Two platforms 1' by 2' and one platform 1' by 1½' of own design
Transducers: octagonal proof rings with strain gauges
(4 per platform)

Video, 35 mm cine cameras, EMG, electrogoniometers,
gas analysis.

Gait analysis, P and O analysis.

---

Dr. R.J. Whitney,
M.R.C. Biomechanics Research Team,
RAF Institute of Aviation Medicine,
Farnborough,
Hants, GU 14 6SZ, England.

Own design, 1230 mm. square
Transducers: wire strain gauges on cantilevers.

Technical and Research Processes Galvanometer
T. & R.P. carrier amplifiers.

Cine photography, record analysis and data logging
Benson-Lehner.

Postural sway.

---

Professor Eustache Willems,
Instituut voor Lichamelijke Opleiding
Katholieke Universiteit Leuven,
Tervuurse Vest 101,
B 3030 Heverlee,
Belgium.

1) 1 m. square platform built in University

2) Kistler

Posture

---

Mr. Barry D. Wilson,
Physical Education Department,
University of Iowa,
Iowa City,
Iowa 52242, U.S.A.

24"x24" platform designed and constructed at the University of Iowa.

Transducers: strain gauges.

Sanborn 150 heat writing.

3D cine cameras (Locam)

Fundamental movement analysis, joint forces and torques.

---

Dr. Graeme A. Wood,
c/o Department of P.E. and Recreation,
University of Western Australia,
Nedlands,
Western Australia 6009.

60cm x 60cm. platform of own construction.
Transducers: bonded strain gauges.
(intending to obtain Kistler).

Devices Instruments Inc., Magnetic tape, c.r.o.
PDP 8/E computer.

EMG, cinematography, accelerometry.

Sports techniques, basic movement analysis.

---

Dr. J.T.M. Wright,
Bio-engineering and Medical Physics Unit,
University of Liverpool,
P.O. Box 147,
Mount Pleasant,
Liverpool, L69 3BX, England.

12" by 12" wire suspended platform designed in Unit, presently in use by Dr. F. Johnson at University Hospital, Nottingham.
Transducers: LVDTs

On-line mini computer.

Gait analysis.

---

Dr. Haralds Yansons,
Riga Scientific Research Institute of Traumatology
and Orthopaedics 226005,
Latvian S.S.R., U.S.S.R.,
Riga, 12/22 Duntes Str.

Two 40x25 cm. platforms designed by Moscow Central Institute of Prosthetics.
Transducers: strain gauges.

Soviet: H-700 (14 channels)

EMG, Electroichnograph - 3.

Gait analysis in rehabilitation, guidance, control and self-control.

---

Dr. Ir. J. Zander,
Department of Agricultural Engineering,
Agricultural University,
Sparrenbos 17,
Wageningen,
The Netherlands.

Kistler

PDP 11, Philips (PRO 12) and Honeywell (2206)
Servogor.

Camera, heart rate recorder.

Quantifying (working) posture.

---

Dr. Ronald F. Zernicke,
Biomechanics Laboratory,
Department of Kinesiology,
University of California,
Los Angeles,
California 90024, U.S.A.

Kistler

EMG, cameras

Locomotion (animal, human - normal and handicapped children) and sports techniques (including weight lifting and swimming starts).

---

## ADDITIONS TO FORCE PLATFORM BIBLIOGRAPHY

The following references were returned with the recent questionnaire (Senders' addresses are in Register).

Dr. T.P. Andriacchi

Andriacchi, T.P., Ogle, J.A., Galante, J.O., Kaushal, S.: Time-Distance measurement as a basis for normal and clinical gait studies. Transactions of the American Society of Mechanical Engineering. Houston, Texas, November, 1975 (Abstract).

Andriacchi, T.P., Ogle, J.A., Galante, J.O., Kaushal, S.: Clinical gait studies. Transactions of the 22nd Annual Meeting of the Orthopedic Research Society, New Orleans, Louisiana, January, 1976 (Abstract).

Ogle, J.A., Andriacchi, T.P., Carlson, L., Galante, J.O., Kaushal, S.: The velocity dependence of some characterists of normal human gait. Proceedings of the 29th Annual Conference on Engineering in Medicine and Biology, New Orleans Louisiana, September, 1975.

Andriacchi, T.P., Ogle, J.A., Galante, J.O.: Walking speed as a basis for normal and abnormal gait measurements. Submitted to Journal of Biomechanics.

Beck, R.J., Kuo, K., Andriacchi, T.P., Ogle, J.A., Galante, J.O.: Gait analysis of normal young children. Presented to 23rd Annual Meeting of Orthopedic Research Society, Boston, September, 1976.

Dr. J. Atha

Begbie, G.H., 1966, The effects of alcohol and varying amounts of visual information on a balancing test, Ergonomics, 9, 325-333.

Begbie, G.H., 1967, Some problems of postural sway, Myotatic, Kinesthetic and Vestibular Mechanisms (editors A.V.S. de Reuck and J. Knight), Churchill, London, p. 82-90.

Begbie, G.H., 1969, The assessment of imbalance, Physiotherapy, 55, 411-414.

Contini, R. and Drillis, R., 1966, Kinematic and kinetic techniques in biomechanics, in Advances in Bioengineering and Instrumentation, Vol. 1, 3-67.

Contini, R., Drillis, R. and Bluestein, M., 1967, Determination of body segment parameters, Human Factors, 5, 493-504.

Eklund, G. and Lofstedt, L., 1970, Biomechanical analysis of balance, Biomedical Engineering, 5, 333-337.

Greene, J.H. and Morris, W.H.M., 1958, Evaluation of the force platform Proceedings of the Purdue Farm Cardiac Seminar, Sept. 10-11, p. 28-30.

Gurfinkel, E.V., 1973, Physical foundations of stabilography, Agressologie, 14C, 9-14.

Gurfinkel, E.V., 1974, Mechanical analysis of the stabilographic method, Byulleten Eksperimental 'noi Biologii i Meditsiny, 77, 122-124.

Hellebrandt, F.A. and Kelso, L.E.A., 1938, The graphic registration of shifts on the centre of weight during standing, American Journal of Physiology, 123, 96-97.

Hellebrandt, F.A. and Fries, E.C., 1942, The eccentricity of the mean vertical projection of the centre of gravity during standing, Physiotherapy Review, 22, 186-192.

Hellebrandt, F.A. and Kelso, L.E.A., 1942, Synchronising biplane photography with centre of gravity observations, Physiotherapy Review, 22, 83-87.

Hellebrandt, F.A., Kelso, L.E.A. and Fries, E.C., 1942, Devices useful to the physiological study of posture, Physiotherapy Review, 22, 10-16.

Hirasawa, Y., 1973, Study on human standing ability, Agressologie, 14C, 37-44.

Kapteyn, T.S., 1972, Data processing of posturographic curves, Agressologie, 13B, 29-33.

Kapteyn, T.S., 1972, The stabilogram: measurement techniques, Agressologie, 13C, 75-78.

Kelso, L.E.A., and Hellebrandt, F.A., 1937, Devices for the study of two plane shifts in the centre of gravity of a swaying body, Science, 86, 451-452.

Morgan, P.G. and Watkins, R., 1967, Centre of gravity movements in the standing human body, Nature, 215, 324-325.

Scott, D.E. and Dzendolet, E., 1972, Quantification of sway in standing humans, Agressologie, 13B, 35-40.

Shipley, R.E. and Harley, R.J., 1970, A device for estimating stability of stance in human subjects, Psychophysiology, 7, 287-292.

Smith, K.O., and Arndt, R., 1970, Self generated control mechanisms in posture, American Journal of Physical Medicine, 49.

Soames, R.W., Atha, J. and Harding, R.H., 1976, Temporal changes in the pattern of postural sway as reflected in power spectral density analysis, Agressologie, 17B, 15-20.

Travis, R.C., 1944, A new stabilometer for measuring dynamic equilibrium in the standing position, Journal of Experimental Psychology, 34, 418-424.

Mr. M. Dhanendran

Wall J.C., Dhanendran, M. and Klenerman, L. (1976). A method of measuring the temporal distance factors of gait. Biomedical Engineering, 11, 12, 409-412.

Dr. J. Ellis

Ellis, J. Tri-plane analyzer: Electronics in motion. Journal American Podiatry Association, August 1976.

Ellis, J. Orthotic control of abnormal foot motion. Journal American Podiatry Association (In press).

Professor K. Fidelus

Fidelus, K., Kania, H., Stanoszek, W. Porownanie skutecznosci skokuwzwyz technika Fosbury Flop, Przerzutowa Wych. Fiz. Sport. 3: 33-41, 1973. (Efficiency of Fosbury Flop and Straddle technique in the high jump).

P. Francis

Francis, P., L.E.D. Drivers: Useful tools in biomechanics. Biomechanics VB, ed. PV. Komi, 1976.

John L. Hagy

Load Cell supports for Dynamic Force Plate, by C.W. Keller, L.M. Musil and John L. Hagy. 9th Aerospace Mechanism Symposium, John F. Kennedy Space center, October 17, 1974.

A Dynamic Force Plate by C.W. Keller, John L. Hagy, David H. Sutherland, Roger, A. Mann, M.D. at the 19th annual meeting of the Orthopedic Research Society, January 31, and February 1, 1973.

Quantitative Analysis of Total Hip and Knee Replacement by Roger A. Mann, M.D., John L. Hagy, and Loren J. Larsen, M.D. at the 41st annual meeting of the American Academy of Orthopedic Surgeons, January 17-22, 1974.

Push off Phase of Gait by Roger A. Mann, M.D., John L. Hagy, and Sheldon R. Simon, M.D. at the LeRoy C. Abbott Orthopedic Society Proceedings, April, 1974.

Dr. S. Konz

Konz, S., and Desai, G. Lifting forces for nine lifting heights. Agressologie. Vol. 17A, 55-59, 1976.

Dr. D.I. Miller

Miller, D.I. A biomechanical analysis of the contribution of the trunk to standing vertical jump take-offs. In J. Broekhoff (ed.) Physical Education, Sports and the Sciences Microform publications, Eugene, Oregon, 1976.

Dr. Per Tveit

Lier, Arne: Rekrutteringsprosjekt, preliminaer rapport. Norges Idrettsforbund, Oslo, 1975.

Serck-Hanse, Fin: Transducere for Biomedisinsk teknik. Nordisk Tidsskrift for Medico Teknik, København, 1972.

Tveit, Per: Variation in Horizontal Impulses in Vertical Jumps. NIH, Oslo, 1975, 1. pp. 15.

Tveit, Per: (2) Horisontale impulser/koordinasjin - i vertikale satser med og uten svikt - før og etter oppvarming. NORA nr 34, NIH, Oslo, 1975, 2, pp. 25. (Summary in english).

Tveit, Per: Metoder og instrumentering ved biomekanisk kraftregistrering. NORA nr 30, NIH, Oslo, L975, 3. pp. 26. (Summary in english).

Dr. R.J. Whitney

Dewar, M.E. Body movements in climbing ladders, Ergonomics (In press).

Dewar, M.E. Safety factors in the use of ladders (submitted to Ergonomics)

Dr. J.T.M. Wright

Prentice, D.E. and Wright, J.T.M. A platform for measuring the walking forces by the bovine foot. Journal of Physiology 219, 2-4, 1971.

"Overload"

<u>CORRESPONDENCE RECEIVED</u> (see Register for addresses)

Professor Alain Connan has just completed an experiment on forces delivered in karate chops and kicks. He reports of forces up to 400Kg for the fist and up to 900Kg for the foot. Owners of fragile force platforms beware!

Dr. Morris Milner read a paper entitled "Current Status: An Overview of Gait Laboratories in Existence with General Review of Present Projects, Methodology and Purposes" to the Applied Physiology Study Section of the N.I.H. Sponsored Workshop on Locomotion Research on March 9, 1977, in San Diego. He is in contact with many gait laboratories throughout the world, some of which have not yet been included in the F.P.G. list.

Professor Bernard Isaacs is planning an official opening of his new gait laboratory in July 1979, to be followed by an international conference.

Dr. Gideon Ariel of Computerized Biomechanical Analysis Incorporated, one of the first commercial ventures in biomechanics research, reports that his work with cat locomotion progresses satisfactorily. He has begun to use the biokinetic data in the formulation of modelling the different levels which control locomotion.

Professor John P. Paul writes: "We now have two Kistler force platforms, giving us six analogue outputs relating to three moment components and three force components for each transducer. The information may be output on ultraviolet light galvanometer or digitised and recorded on a PDP 12 digital/analogue computer. Our researches refer to the forces and load actions generally transmitted by normals and the disabled in activities corresponding to normal function. We are analysing the locomotion of normal young healthy volunteers, of patients disabled with arthritis of both kinds, and also patients who have been treated with prosthetic joint replacements. These studies are complementary to studies on the amputee in which we are studying not only the amputated limb and its prosthesis but the contralateral limb. Similarly we are analysing the load actions transmitted by patients wearing braces on the lower limb and analysing function of the affected and contralateral site".

Dr. Alan Goodship of the Department of Veterinary Anatomy at the University of Bristol, England has a specially made Kistler platform, 600 mm by 900 mm by 110 mm deep, which he is using to study the gait of horses. The main purpose of the research is to set up testing procedures for the early diagnosis of lameness.

Too late for inclusion in the Register is the following entry:-

M.R. Lindsay, P. Squire and C.G.I. Hussell
Dunfermline College,
Cramond Road North,
Edinburgh EH4 6JD, Scotland

(a) Kistler (b) Mike Lindsay's own design (see Catalogue)

S.E. Laboratories recorder, XY plotter, cameras.

Sports techniques, postural sway analysis.

Kistler have replaced their 9261 A force platform with a new modified version to be known as the Type 9281 A11. The code A11 denotes the standard model with an aluminium top, but the major modification, the introduction of independently pre-stressed transducers, makes the change to a steel top a relatively simple procedure. Also simplified are the new mounting bolts which are concentric with the transducers and thus the internal stress problem of mounting is eased. A single 8-way armoured cable replaces the 8 separate amplifier cables. Changes of specification are as follows:-

| | 9281 A11 | 9261 A |
|---|---|---|
| ranges Fx,Fy | ± 10 kN | ± 5 kN |
| Fz | - 10 to + 20 kN | 0 to + 10 kN |
| Natural Frequency | > 1 kHz | > 200 Hz |
| Height | 100 mm | 60 mm |

The new model is now available and Gustav Gautschi will have one on demonstration at the Congress in Copenhagen.