# NEWSLETTER NUMBER 6

## JULY 1978

## FORCE PLATFORM GROUP

## INTERNATIONAL SOCIETY OF BIOMECHANICS

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Newsletter Edited by Barry D. Wilson (Secretary)
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Brisbane,
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(The Newsletter is circulated free to members of the Force Platform Group. Membership enquiries to the Secretary).

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## 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".

Since January 1976 the Force Platform Group (FPG) has produced a biannual newsletter for which FPG members are asked to pay a US $5 subscription to cover production costs and mailing.

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 this '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."

## Editor's Note

Membership in the F.P.G. continues to grow. As of July, 1978 there are 86 financial members, 12 members with 1978 dues in arrears, and 21 prospective new members. Foreign (Not Australian!) members should note that when funds are being submitted through the Banking system, please instruct the bank to indicate for whom the funds are being submitted!

Back issues (Xerox copies) of the Newsletters 1-5 are now available at a cost of $2.00 per issue. Airmail delivery from Australia is an additional $2.00 per order (Delivery time would be approximately 1 month from receipt of order).

The bibliography update which was to be included in this Newsletter will be included in the next Newsletter January 1979 - provided items are submitted for inclusion in the bibliography. In addition to the subscription forms which now appear in the back of the Newsletter is included a force platform register/bibliography form. Please take the time, if you have not already done so, to fill this out and send it to me.

Finally, to those persons who have contributed to this Newsletter, thank you.

BARRY D. WILSON.

## TABLES OF CONTENTS OF PREVIOUS F.P.G. NEWSLETTERS.

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## ADDITIONS TO THE FORCE PLATFORM REGISTER.

The following are persons with interests in force platform research.

The information is based on replies to questionnaires sent out with

Newsletters 2 and 3.

Dr. Juerg U. Baumann,
Kinesiology Laboratory,
Felix Platter Spital, Pav. E.,
Burgfelderstr. 101
CH 4000 Basel, Switzerland.

Kistler 9261A ,
Visicorder,
EMG - Radiotelemetry,
Cinematography - synchronized locams.

Gait analysis in neurogenic orthopaedic disorders.

Dr. Kazuhiko Watanabe,
Department of Physiology,
School of Medicine,
Toho University,
5-21-16 Ohmorinishi,
Ohtaku, Tokyo,
Japan.

50 x 50 cm strain guage.
C.R.T. and pen recorder.
EMG, Electrogoniometers, cameras.

Postural control mechanisms.
Ski techniques.

Maciej Piatkowski,
Osrodek Bodawcsy "Polsport" - Warszawa
Konopacka str. 19 Poland.

3 component, tensiometric force platform
Oscilloscopes, computers systems.

Biomechanical systems - force transmittion.
Modelling.
Human body vibrations.

A FORCE PLATE IN USE AT GENTOFTE HOSPITAL, HELLERUP, DENMARK.

Eric C. Jansen, M.D.

Design of computing: Robert E. Larsen, M. Eng. Sc., Biomechanical Laboratory, Gentofte Hospital.

Design of the force plate: Department of Mechanical Technology, Technical University of Denmark.

General:

The platform has been in use since spring 1976. The subjects of investigationsare a) evaluation of postural stability during physical/surgical treatments, b) comparison of postural stability and stability of gait, c) comparison of vertical force on a force plate and on an instrumented treadmill.

Construction details:

The force plate (Fig. 1) is of a size of 450 mm x 300 mm. The surface is a 0.5 mm aluminium plate covering the force plate. To avoid horizontal movements, the aluminium plate in two of the ends is attached to an outer frame. This way of fixation reduces the vertical signals by $\leq$ 2%.

Under the aluminium cover is a 2.5 mm glass fibre layer. The bottom layer is a 50 mm thick balsa wood board. Aluminium profiles on two of the sides are points of fixation for the suspension profiles. The force plate is connected to an outer frame by Z-shaped stainless steel profiles, one in each corner. The vertical part of the suspension measures 1.0 x 10 mm. A resistive strain gauge is glued on each of the broad sides of each of the four suspension profiles.

The outer frame is made of heavy iron profiles placed on concrete.

First point of mechanical resonance begins at 103 Hz measured by an exitation force of 120 N.

For gait studies the walkway is 5.10 meters before measurement and 1.25 meters after measurement.

Transduction:

The transducer signals are amplified seperately, and passed through 120 Hz low pass filter.

Besides the amplified signals from each of the corners it is also possible to get the total vertical force or other combinations of transducer signals.

Instrumentation:

The readings are displayed on an eight track Hewlett-Packard oscilloscope or on an ABEM Ultralette UV-recorder. The readings are stored on a LYREC eight track instrumentation tape recorder.

Signal Processing:

For computing recordings of postural stability is the block diagram (Fig. 2) demonstrating the pathway.

By this computing a sway number is based on the variations of center of pressure on the force plate. The sway number is indicated in cm mean deflection in the transversal and in the sagittal directions.

For illustration a plot of the deflections in the two directions are made routinely. Output of the computer is ready for the patients record.

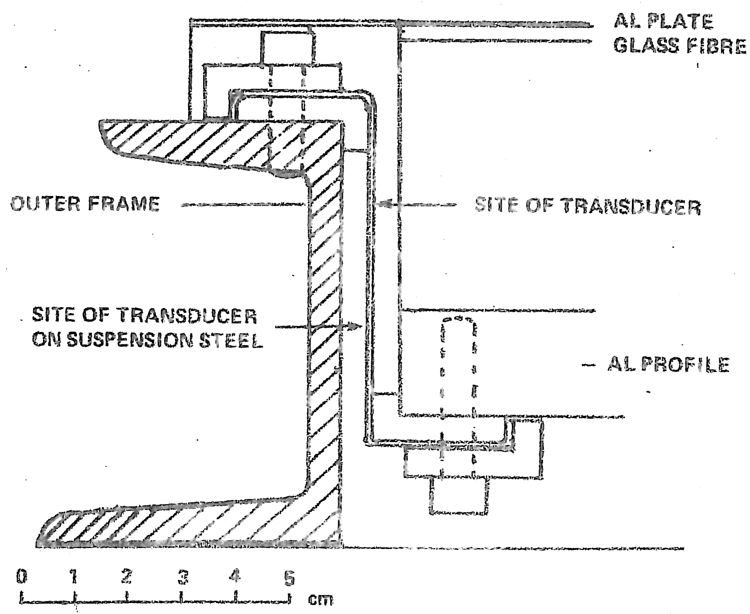
Clinical Implementation:

The system is placed in the basement of the hospital near to the clinical departments.

Bibliography:

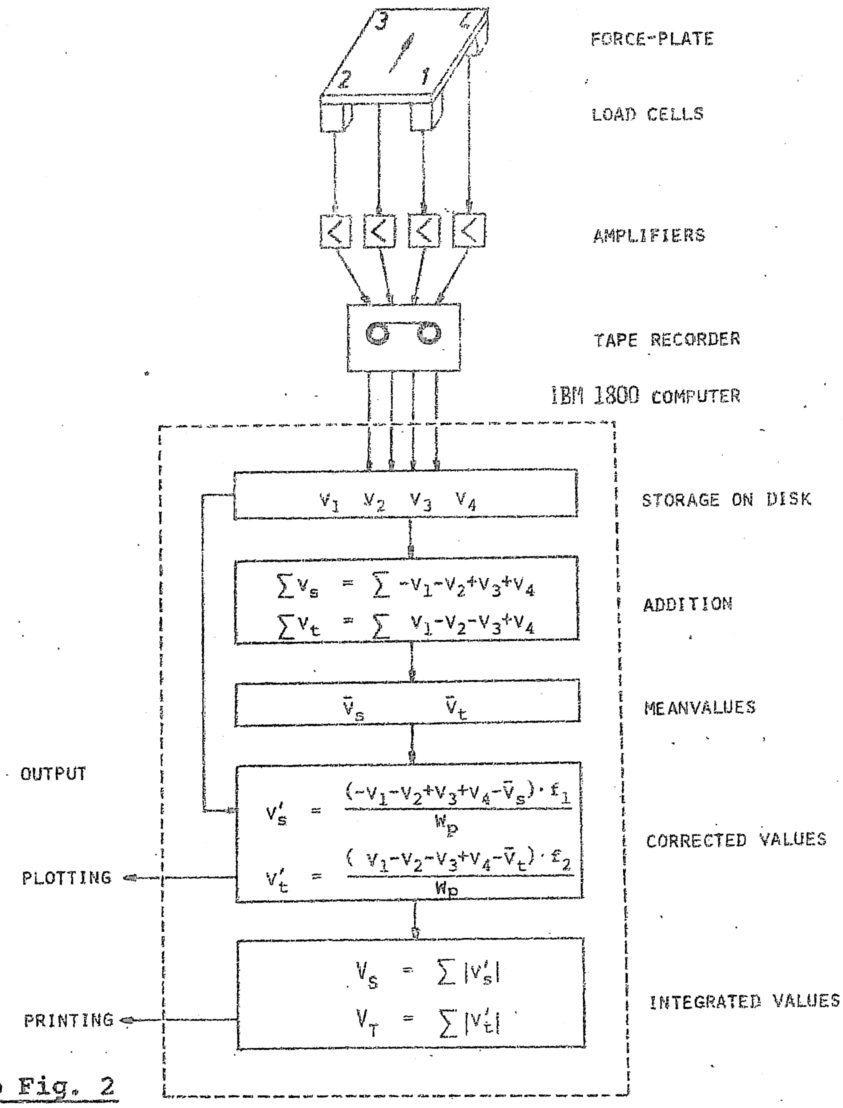
Erik C. Jansen, Robert E. Larsen and Mogens Brix Olesen: Quantitative Romberg test. Measurement and computing of postural stability. Ugeskrift for Laeger (Danish with English summary). In press.

Jorgen Eriksen, Erik C. Jansen, Robert E. Larsen and Mogens Brix Olesen: Postural stability following thiopental and propanidid anesthesia. Acta Anesthesiologica Scandinavica. In press.




Legend to Fig. 1

Suspension construction of the force plate.




<u>Legend to Fig. 2</u>

Block diagram including the force plate system and the pathway for the computed calculations. Signature $V_1$ - $V_4$ indicate the transducer signals $V_s$: sagittal vector, $V_t$: transversal vector $\bar{V}_s$, $\bar{V}_t$ : mean values of the vectors $V'_s$ , $V'_t$ : the electric vectors are corrected into spatial by use of the persons weight ( $W_p$ ) and force plate characteristics in the sagittal ( $f_1$ ) and transversal ( $f_2$ ) directions.

$V_S$ , $V_T$ : mean number of centimeters of sway.

# THE DESIGN AND CONSTRUCTION OF A NEW DEVICE FOR MEASURING THE VERTICAL AND THE HORIZONTAL COMPONENTS OF THE SUPPORT REACTIONS DURING HUMAN LOCOMOTION.

Yuli Toshev, Petar Baev
Central Laboratory of Biomechanics, Sofia

## Introduction:

In human walking the magnitude and direction of the force exerted on the ground by each foot varies with time. We can resolve this force in three mutually perpendicular directions and represent the components by time functions. For prognostic and diagnostic purposes it is very important for the surgeon to be able to obtain quantitative information about the vertical and also about the horizontal components of the support reactions. Developments in the design of artificial limbs and orthotic appliances also demand greater knowledge of the forces involved in locomotion.

Some devices (1) allow measurement only of the vertical components of the support reactions and some other (2, 3) allow only one-step analysis of the forces. A new device for measuring the vertical and the horizontal components of the support reactions during human locomotion is described below.

## Description of the Device:

On consideration of the response of human beings to vibration applied to the feet it was decided that for accuracy to about 2 per cent the device should have a linear frequency response from zero to about 50 tr/s. The waveform of walking force is composed mainly of low-frequency components lying almost entirely below 15 to 20 tr/s (1).

Fig. 1 gives a general impression of the device. It may be noticed that the bulk of the device is below ground level and the surface of the platforms is on ground level. The device consists of two parallel separate walkways. Each of them consists of two 1.8 m long and 0.3 m wide forceplates - modules (I, II, III, IV). It is possible to use more modules in the device. The vertical component V of the external forces are oriented along the axis $z$ and the horizontal component H along the axis $x$.

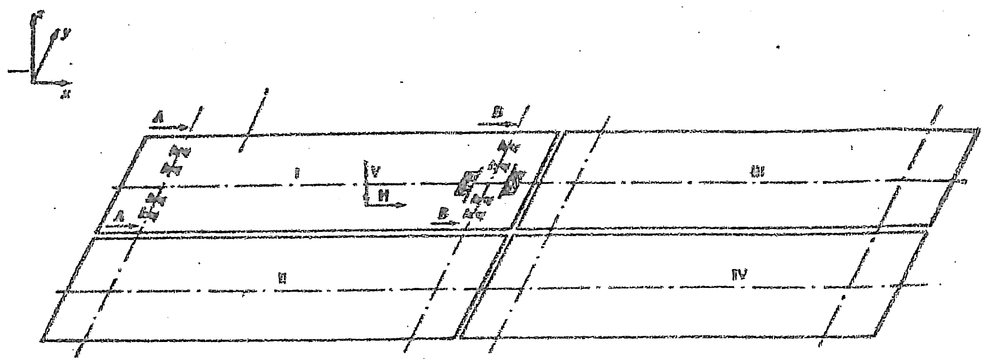


Fig. 1

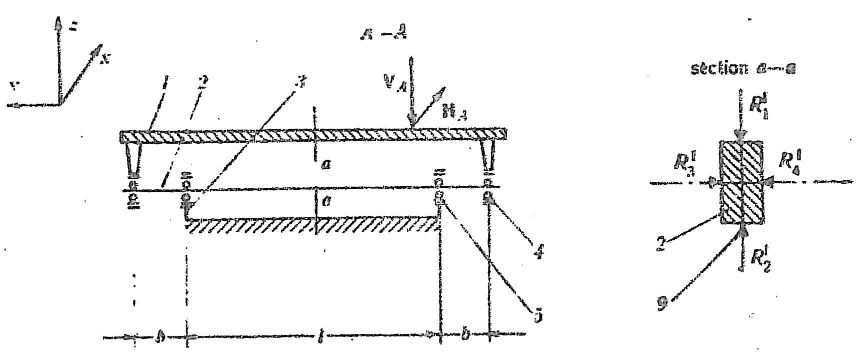



Fig. 2

Each module consists of platform 1 of a very high rigidity (cast from duralumin) supported near each end by two identical tensometric beams 2 (Fig. 2). The platform 1 is supported on the one tensometric beam 2 by means of the external bearings 4 and the tensometric beam is supported on the cantilever 3 through the internal bearings 5 (Fig. 2). The cantilever 3 is supported on the ground. The other tensometric beam 3 is supported on the bush 6 by means of the internal bearings 5 and the bush 6 is driven in the self-setting bearing 7 supported on the ground through the bearing support 8 (Fig. 3).

This construction secures full static definiteness of each module. The centre sections of the beams (Figs. 2,3) are struck over with the strain gauges 9. The strain gauges for measuring the vertical component V from module I and module III (the one walkway) are connected in temperature-compensated semibridge (Fig. 4). The strain gauges $R_1^{I}$ and $R_{1'}^{I}$, (module I) are connected in consecutive order in one arm of the semibridge. In the same arm (also in consecutive order) are connected the corresponding strain gauges $R_1^{III}$ and $R_{1'}^{III}$, (module III). Analogous is the connection of the strain gauges $R_2^{I}$, $R_{2'}^{I}$, $R_2^{III}$ and $R_{2'}^{III}$, in the

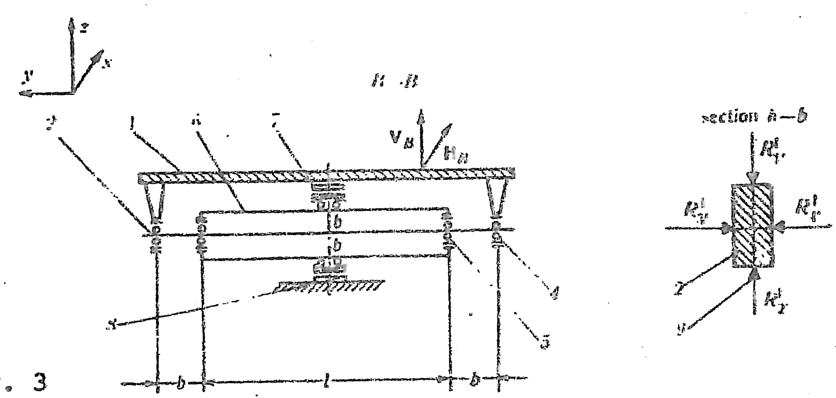


Fig. 3

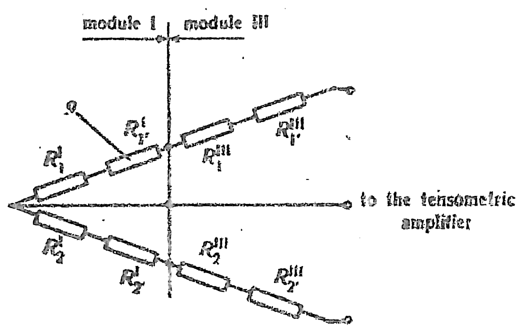


Fig. 4

other arm of the bridge. The strain gauges for measuring the horizontal component H are connected in the same way - $R_3^{I}$, $R_{3'}^{I}$, $R_3^{III}$ and $R_{3'}^{III}$, in one arm of the bridge and the strain gauges $R_4^{I}$, $R_{4'}^{I}$, $R_4^{III}$ and $R_{4'}^{III}$, - in the other.

The results of measuring are independent of the application point of the external forces. In case of using more modules, the electrical schemes are analogous - for each walkway we have two measuring semibridges - one for the vertical component V and the other for the horizontal component H.

In patients' gait, bending moments appear in the centre sections of the tensometric beams which are struck over with strain gauges. The exits of the four measuring semibridges are connected with four tensometric amplifiers. The amplifiers' output signals are proportional accordingly to the vertical and to the horizontal components of the support reactions for each foot.

Conclusions:

The above device was designed, constructed and tested. Tensometric amplifiers UMM 131 (DDR) and multichannel oscillograph 8LS-201 (DDR) are used. Calibration of each separate walkway was carried out. The accumulated measuring error was 2 per cent. The nonlinearity of the output signal was better than 2 per cent.

The new device for measuring the vertical and the horizontal components of the support reactions during human locomotion should become important in medical diagnosis and will serve as a very useful research method in biomedical engineering.

*The authors wish to thank Academician G. Brankov and Professor Y. Yolevich for their help and inspiring at all stages of the study. The authors would like to make special mention of the support given by Mrs. L. Angelova. They also desire to express their appreciation to their colleagues in the Institute of Metal Sciences of the Bulgarian Academy of Sciences for their help in making of the device.*

References:

1. Skorecki, J., The design and construction of a new apparatus for measuring the vertical forces exerted in walking : a gait machine. - J. of Strain Analysis, 5, 5, 1966.

2. Paul, J.P. Biomechanics and related bioengineering topics, Edinburg, Pergamon, 1965, 367.

3. Morrison, J.B. Bioengineering analysis of force actions transmitted by joint. - Biomedical Engineering, 3, 1968, 4, 164.

(Reprinted from : Bulgarian Academy of Sciences, Biomechanics, Sofia, Vol. 3, 1976).

## The Force Platform Group

## International Society of Biomechanics

### Subscriptions

Please complete and return this form with US $5 (or equivalent), being subscription fee for 1979, to Barry Wilson,

Department of Human Movement Studies,
University of Queensland,
St. Lucia,
Brisbane,
Australia 4067

If you wish you may send US $10 for 1979 and 1980.

Name ______________________________

Address ______________________________

______________________________

______________________________

______________________________

Amount enclosed ______________________

Please make cheques payable to Barry Wilson, Force Platform Group, International Society of Biomechanics.

Force Platform Group. I.S.B.,
c/o Dept. of Human Movement Studies,
University of Queensland,
St. Lucia, Brisbane, 4067,
Australia.

Dear Colleague,

In the 4th Newsletter was included a register, or list of members and their research interests. In order to update this register would you allow me to publish brief details of your work. Please complete the questionnaire below and return to me as soon as possible.

1) Name ....................................
2) Title (Mr, Mrs, Ms, Dr, Prof, etc.) ..........................
3) Address ..................................
..................................
..................................
4) Institution (if different to above) ..........................
..........................
..........................
5) Do you work with a force platform? Yes ______ No ______
6) If answer is No please give reasons for your interest:-

________________________________________

________________________________________

7) Please give brief details of your platform or platforms

Type ....................................

Transducers ..............................

Size of top surface ......................

Recorder .................................

Other ....................................

8) What auxilliary equipment do you use? (e.g. E.M.G., cameras, etc.)

..............................................................

9) What are the main lines of your research? (e.g. sports techniques, gait analysis, etc.) ......................................
10) Please list any relevant publications by you which have not been included in Newsletters 1 and 2. (Attach additional sheets if necessary).

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Many thanks for your co-operation.

Yours sincerely,