PROCEEDINGS OF B.A.S.M. AND COACHES' CONFERENCE
INVERCLYDE NATIONAL RECREATION CENTRE
LARGS, AYRSHIRE.

24th - 26th November 1967

'FORCE PLATES' in the Study of the Sprint Start.

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The design of our particular force plates attached to the starting blocks makes use of semi-circular sensing elements and wire resistance strain gauges. These are connected into Wheatstone bridge circuits operated from a 3 Hz a.c. source. The unbalanced signal is then amplified and fed to an ultra-violet recorder giving as output a series of lines on a moving paper which represent the forces applied during the start and certain timing marks for the gun and positions down the track. The analysis of the forces is carried out by a semi-automatic transference to paper tape suitable for subsequent digital computer working.

Six recording channels are necessary to give adequate information in the vertical plane for the forces, three for each foot. No lateral forces are measured. The lines or traces from each foot represent the force normal to the block, the force tangential to or along the surface of the block and the torque or turning effect about a horizontal axis across the block. The final representation of the analysed data is to some extent a matter for choice and experiment. We are currently resolving the forces to give the following information:

1. The resolved forces for each foot at any instant in time.
2. The angle at which it is applied to the ground.
3. The position at ground level at which the force occurs.
4. The resolved total force for both feet at any instant in time.
5. Its angle to the horizontal.
6. Its position as in (3) above.
7. The vertical and horizontal impulses, being a measure of force multiplied by the time during which it is exerted.

Also being measured are the times during which each foot exerts its starting force, the total time on the blocks, the reaction time and a time through the first 20 feet as recorded on the paper trace from photo-electric devices down the track. Timings are accurate to 2 thousandths of a second but there is some difficulty in ascertaining when the application of force begins as it is a relatively slow process for such timing intervals. We also obtain a subjective assessment from the athlete.

We are approaching the study in as general and scientific manner as is reasonable. Our search is aimed at giving us an understanding of the movement of the athlete from the blocks and more specifically an attempt to optimise his performance by subsequent recommendations on block spacings and angles and stance. There is some evidence to suggest that it is possible to save 1/10 second on the time for 100 metres by optimum starting.

Results so far obtained are inadequate for general conclusions but give some evidence of the relative importance of the parameters chosen. We have found, as might be expected, that there is very definite correlation between the total time of the forces exerted on the blocks during the start and the athlete's time to the 20ft. timer from the start of force exertion, i.e. the quicker off the blocks the quicker down the track. Rear foot performance seems to vary very considerably between athletes and does not necessarily give rise to good or bad times. The magnitude of the force exerted is only important when it is exerted in the optimum direction. It was found from the records on one athlete carried out on different days that while on the first day the forces exerted were larger, his times were not as good as on the second day. This seems to be due to the fact that these forces were applied much more vertically so that the horizontal component was much less than on the second day. It is doubtful whether reaction times are within our control, these seeming to vary consistently between athletes. There is still a great deal of work to be undertaken but we are beginning to see some results for our work on the sprint start.

Running concurrently with this work, a plate is being designed to study forces during running and jumping. It is 3 feet square and most of the parts are now made. Similar work will be carried out on this. The task has been to raise all frequencies in the platform and support to a level in excess of 300 Hz. This is necessary to avoid interference between real effects and platform vibration. It has, we hope, been achieved using a honeycomb plate supported on high stiffness columns.

The combination of mechanical engineering and physical education is perhaps unusual but we believe that if optimum performance and understanding are required then such combinations of expertise are necessary.

DISCUSSION

Mr. Anderson asked if it was known what distance was lost when blocks were not used.

Mr. Blader stated that, based on his team's experience, approximately $1\frac{1}{2}$ yds. were lost when blocks were not used.

DEMONSTRATION OF THE 'FORCE PLATE'

In conjunction with his talk at the commencement of the Conference dealing with the theoretical aspects of the use of the force plate, Mr. Blader gave a practical demonstration later in the day, using athletes provided by the Scottish Women's Amateur Athletic Association.

This proved to be a highly successful session and provoked considerable interest on the part of both athletes and coaches, particularly the athletic coaches who were in attendance at the Conference.