

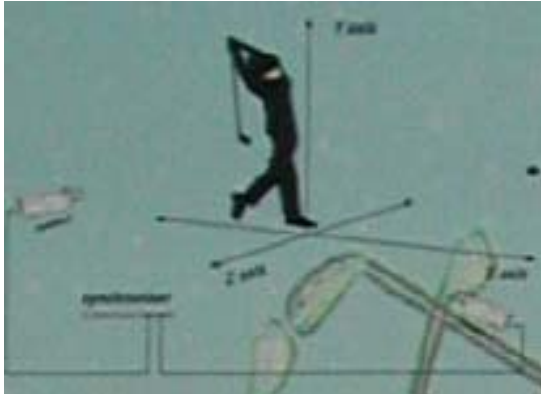
# Golf Biodynamics

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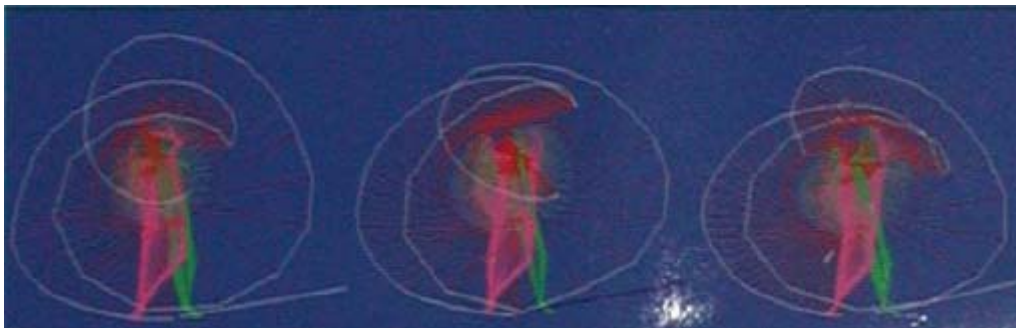
This Study was conducted at the University of Ljubljana. Institutes involved are: Faculty of Sport, Institute of Sport, Biomechanical Laboratory, Faculty of Electrical Engineering and PGA Slovenia

## Kinematics

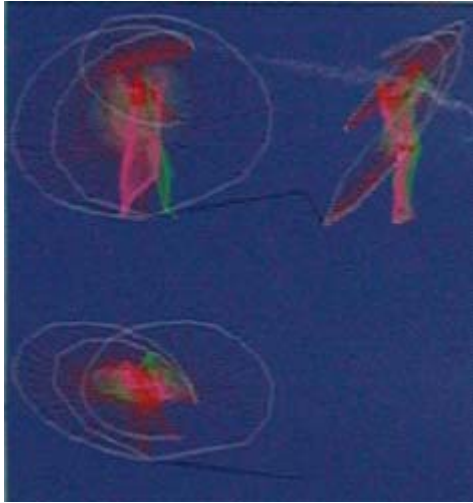


**Fig. 1** Measurement setup for the kinematic analysis. Subject was filmed with a video camera and the measurement was taken for all three body-axes. Z-axis: transversal-axis, y-axis: sagittal-axis, x-axis : longitudinal-axis

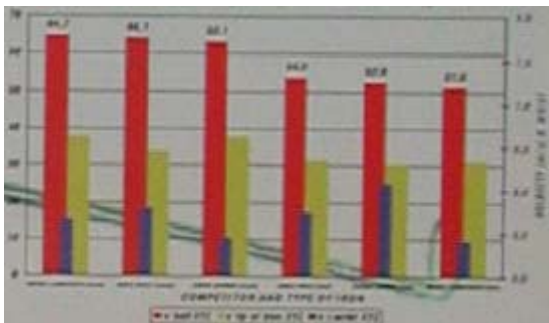
This kinematic analysis of the golf stroke is one of the first such studies in Slovenia made in golf, with which we wished to find some of the basic technique parameters used with two different kinds of clubs. The results showed quite large individual differences between the players involved in the experimental kinematic measurement procedure. Further such studies seem to be called for, thereby giving Slovenian golf players relevant support in their training process, perfection and control of that type of motor technique which would be the key to their success in golf. The following parameters can be measured with kinematic analysis: paths trajectories, angles, velocities, angular velocities, and accelerations for individual body points or segments. This data can be obtained by transferring the video picture to a computer. Then we define each body point for each view with the method of digitalisation. These digitised points are the analysed by special mathematical programmes on a computer.



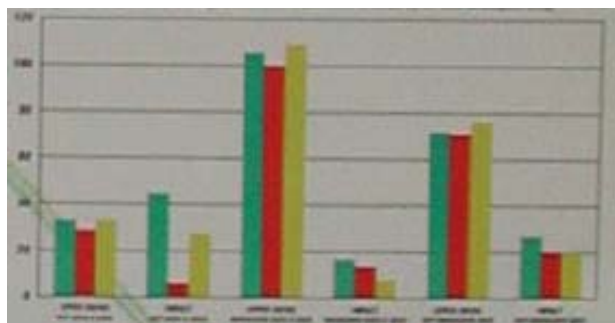
**Fig. 2** Path of the tip of the iron – Comparison between three players



**Fig. 3** Kino gram of a stroke (Side front and above view)



**Fig. 5** Comparison of velocity at impact between right wrist (blue), ball (red) and tip of iron (yellow)



**Fig. 6** Comparison of angles in upper swing and impact position between Subject 1 (green), Subject 2 (red) and Subject 3 (yellow)

**Tab.1** Kinematic Variable

Parameter	Wood		
	Subject 1	Subject 2	Subject 3
Velocity of the ball at impact	44.72	46.06	48.62
Velocity of the tip of iron at impact	32.87	33.40	37.08
Velocity of right wrist at impact	5.67	5.86	6.45
Takeoff angle of the ball	21.38	22.75	21.30
Angle between hip and arm in upper swing	29.80	33.35	33.45
Angle between hip and arm at impact	6.38	10.30	10.53
Angle between shoulder and arm in upper swing	100.28	101.35	100.48
Angle between shoulder and arm at impact	14.30	17.38	8.67
Angle between shoulder and hip in upper swing	71.67	72.88	76.02
Angle between shoulder and hip at impact	26.34	27.64	28.55

Parameter	Iron		
	Subject 1	Subject 2	Subject 3
Velocity of the ball at impact	61.86	64.04	63.72
Velocity of the tip of iron at impact	21.51	21.78	20.36
Velocity of right wrist at impact	8.52	7.75	8.06

## Heart Rate measurement of golf players

The aim of this study was to find the heart rate most suitable to competitive conditions. The competitive results are namely affected by various factors among which functional indicated capability test for the players heart rate was assumed to be the criterion of the players functional capabilities. Changes in heart rate capabilities which are influenced by: physical loading, configuration of the terrain, physical tension and stress before, during and after the stroke, climatic conditions, etc. Marked oscillations in heart rate were mostly found in the stroke preparation phase. A high heart rate immediately before the stroke results in a lower level of intra-muscular co-ordination and therefore causes a lessened precision of the stroke.

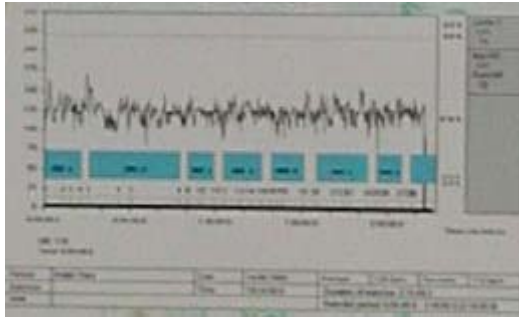


Fig. 4 Heart rate during the match

## Tensio-Myography (TMG)

Is a method of detecting the contractile characteristics of skeletal muscles with a technique of selective measurement of radial deviations (shifts) of a muscle belly in time. The contractions are provoked with individual tetanic electrical stimuluses in isometric conditions. This method allows determination of the contractile characteristics of muscles and in consequence, the ratio of fast and slow muscles fibres, balance between the antagonists and agonists, symmetry of muscular groups and possible muscle injuries. From the point of view of golf, this method gives information of muscle typology, muscle symmetry or asymmetry and level of inter-muscle co-ordination of muscles which are activated in golf.



Fig. 7 TMG Measurement Setup

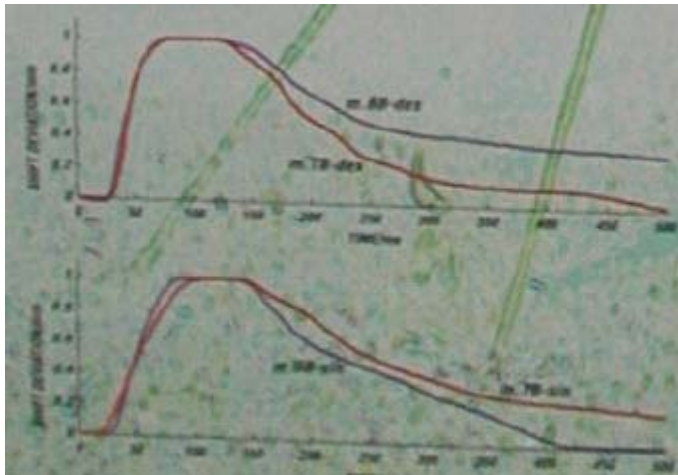
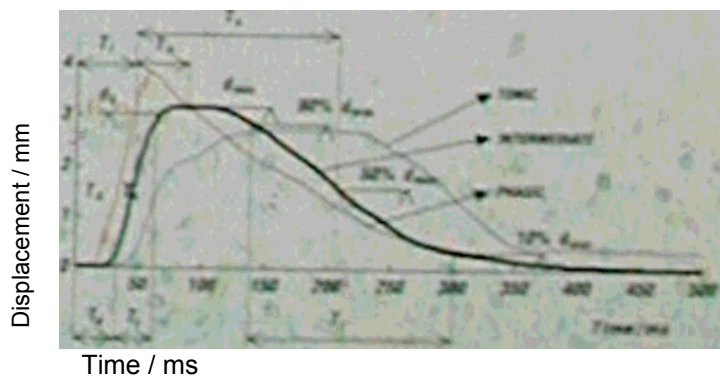


Fig. 8 TMG Results with shift deviation in mm on y-axis and time in ms on x-axis



Time / ms

Parameters	Description	Average	Unit
$T_d$	Delay time	39.2	ms
$T_i$	Initial Time	46.4	ms
$T_c$	Contraction time	26.3	ms
$T_s$	Sustain time	172.4	ms
$T_r$	Relaxation time	116.1	ms
$D_m$	Maximum Displacement	3.1	mm

Fig. 9 Tensio-Myographie (TMG) Parameter definitions and muscle assignments