

A Study on the Development of a Computer Program to Improve the Performance of Archery Athletes

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The purpose of this study was to develop a computer program to process effectively the information generated about the performance of archery athletes in an attempt to help coaches improve the performance of the archers.

After consulting the archers and coaches, 30 variables, which are related to an archer's skills, physique, psychology, and the equipment used, were selected as independent variables with performance records as dependent variables. The collected raw data on these factors and records were processed and a system to record the output in terms of statistical analysis and graphic processes was developed.

The system, in which programs are written by a turbo C version 2.0, was constructed with a menu-driven method and operated on an IBM-PC compatible model. The implemented system has a pull-down menu by which the user can easily operate the system to get the output he needs. The main menu involves four subdivided menus-the system, data input, informational retrieval, and output. All the menus have their own submenus to make them easier to use. For example, the system menu has a pull-down submena which helps the user in operation : help, exit to DOS, and quit.

The user can utilize information retrieval techniques in selecting the corresponding submenu or information that was processed statistically/graphically from the raw data such as trend graphs, scatter diagrams, regressions, etc. In consideration of extensibility, the system programs were modulated into processing units. If required, and additional operation can be applied to the system.

The benefits obtained from this system are as follows :

1. All the output data in archery can be stored and used by a simple operation on the computer.
2. The coach and archer can easily analyze the trend of changes in records.

INTRODUCTION

1. Necessity and Aim of the Study

The first requirement for the scientific training of good archers is to help them develop their innate ability and reinforce their shooting technique. To achieve this goal, it is necessary to grasp the individual archer's strengths and weaknesses and analyze his or her competitive ability.

An accurate analysis requires objective data. The coach's subjective knowledge alone, though it may be important, cannot create an accurate and complete analysis of the performer's ability. A subjective analysis always tends to lead to inaccurate judgment and information. From this arises the necessity of computer programming to process accurate and complete information about the performer's ability and the massive amount of information from actual competitions.

Archers need accurate, repeated, and steady shooting practice in a completely calm frame of mind. Even a slight momentary slip will cause a great difference at the end of an arrow's flight. To maintain a completely still posture, archers must maintain physical and psychological stability by overcoming all forms of stress. Persistent strength and psychological equilibrium are required to repeat the same precise shooting actions. To achieve good scores, archers must use the best equipment and facilities, and handle them skillfully. Archery is constituted of key factors which are physical, psychological, technical, and instrumental. A tremendous amount of research materials are available relating to these factors and they should be analyzed and processed to produce an output which is accurate and objective.

The aim of this study is to develop a computer program in which these materials are continually analyzed, processed, and stored as information so that both coaches and archers can easily refer to the relationship between these variables and established records for the improvement of the archers' performance. The computerization of reference materials is the aim of this study.

2. Selection of Variables for Analysis

The researchers consulted the archers and coaches when they selected the variables which they thought might have an effect on records in archery contests. They also discussed the selected factors with the archers and coaches before they made the final decision on the variables for analysis.

Table 1. Analysis Variables
Log of progress

Date			Weather		Sleep		Name		Health			
Physical aspect	Condition	Why ?	Body weight(kg)	Heart rate	State	Time	Physical Training	The day before	Appetite	Disease	Injury	
	1				1	from			1		Area :	
	2				2				2		Degree :	
	3				3				3		Small :	
	4				4	to			4		Medium :	
5				5				5		Big :		
Psycho logical aspect	Mental training	Mental Condition	Desire	Anxiety	Confidence	Expectancy	Anxiety before competition	Concentration(Grid)				
	1	1	1	1	1	1	1					
	2	2	2	2	2	2	2					
	3	3	3	3	3	3	3					
	4	4	4	4	4	4	4					
5	5	5	5	5	5	5						
Technical aspect	Competition Practice environment Adaptation (Competition management)	Windy		Rainy		Competition management (Extreme situation)	Distraction of mind					
		AM	PM	AM	PM		State	What kind of thought				
		State	Adaptation	State	Adaptation							
		1	1	1	1		1	1				
		2	2	2	2		2	2				
	3	3	3	3	3	3						
	4	4	4	4	4	4						
	5	5	5	5	5	5						
	Shooting state	Drawing state	Holding state	Release movement	Cluster of arrow	Change of aiming point		Amount of practice The day before				
						Up/down	Left/right					
1		1	1	1	1	1	1	1				
2		2	2	2	2	2	2	2				
3		3	3	3	3	3	3	3				
4	4	4	4	4	4	4	4					
5	5	5	5	5	5	5	5					
Equip ment	Tuning state	String Height	Nocking Point	Tiller Height	Equipment Change	Reason						
	1											
	2											
	3											
	4											
5												
Records	Single round	90(70)	70(40)	Grand	90/70	70/60	50	30	Total	Reason for anxiety		
		50										
		30										
		Total										
Un-success and cause					Successful attempts							

As shown in Table 1, the factors for analysis were categorized in such different components as physical, psychological, technical, and instrumental ones. Coaches kept a log of progress when the records were measured. Physical and psychological states were recorded at a time of pre-measurement and the variables related to techniques and facilities were recorded at the time of measurement. Particularly in regard to psychological variables concentration of the mind was measured by using the grid right before the measurement of records. Heart rate was taken prior to the use of the grid.

DESIGN OF THE SYSTEM

The computer program for the control of archers' competitive ability is to provide a tool which can keep on classifying and analyzing the variables which may have an effect upon a performer's record. The program developed so far involves the results of archer's training, the analysis of archers' psychological states and general checkups on the individual archers, which are usually recorded in the coach's daily log of progress. Since these data are computerized and processed automatically, the coaches can spend more time on actual and substantial training. All the operations were programmed by the pull-down menu system so that menu selection is quite easy. As for the programming language, a turbo C version 2.0 is used and it works effectively on IBM-PC which is widely used now.

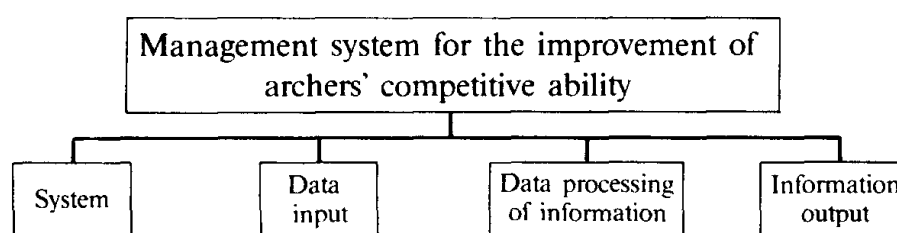


Figure 1. Data management system for the improvement of archers' competitive ability

1. Design of the system

In the system menu are included to provide convenience for users of the program. The data input menu is a module which forms a file with the data produced by archers and coaches. The file includes individual archer's personal background, a checkup sheet for the performer's control, and the coach's daily log of progress. The submenus were provided to enable the users to register, refer to, change, and delete the items in question. The information process and the output menu can produce a statistical and graphic output, and display so that the user can see and read both. Fig. 2 shows a DFD(Data Flow Diagram) which indicates a general flow of data.

As Fig. 2 shows, the original data are input and stored in the pertinent file. Once data are filed, all the processing such as checking, data outputting, graphing, scatter clagram, etc. can be done item by item. For example, in

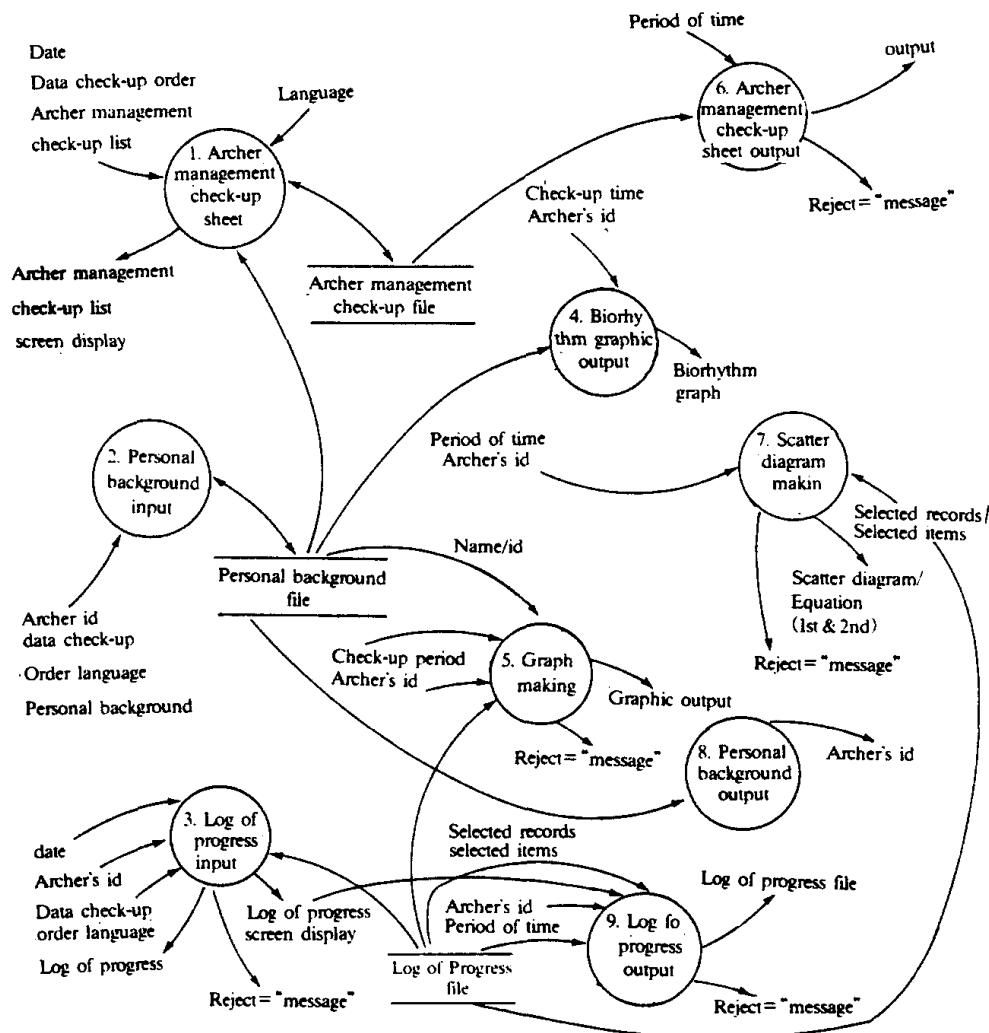


Figure 2. Data flow diagram

graphing, the archer's name, number, period of time, and other selected items are input and then the graph can be output. The rest of the processing will be discussed in the next chapter.

2. Application of the System

For the operators' convenience' sake, the system modules utilize the pull-down menu method by which the operation can be performed selectively. If the enter key is pushed in the main nenu shown in Fig. 3, a submenu will be displayed by a pull-down method as mentioned in "The design of the system". The operation is easy for any user because the items to select for treatment are also displayed by the pull-down method.

For example, if an archer registered in the personal background file is selected for study, biorhythm is output and other related reference materials can be output according to the combination of study items either from the archer management checkup file or the log of the programs file.

System	Archer's data input	Treatment of related information	Related information output

Figure 3. Early screen display

If the archer's name, period of training, and physical condition are selected for study, either a dispersion, a regression curve(linear, curvelinear equation) of the archers' records and physical condition, or graph of record trend will be output. As shown in Fig. 4, the relationship between archer L's pre-measurment anxiety and his records is output in a quadratic equation.

Moreover programs are modulated by processing unit and, if an addition of other items is nessessary, the items can be added to the original program after programming them, making an extension of the system very easy. Apart from the flow of operation, the Korean font is built in for an effective run of the system and to present attractive types of letters. Only a dispersion chart, a regression analysis, and trend graphs are presented as examples for the reference program.

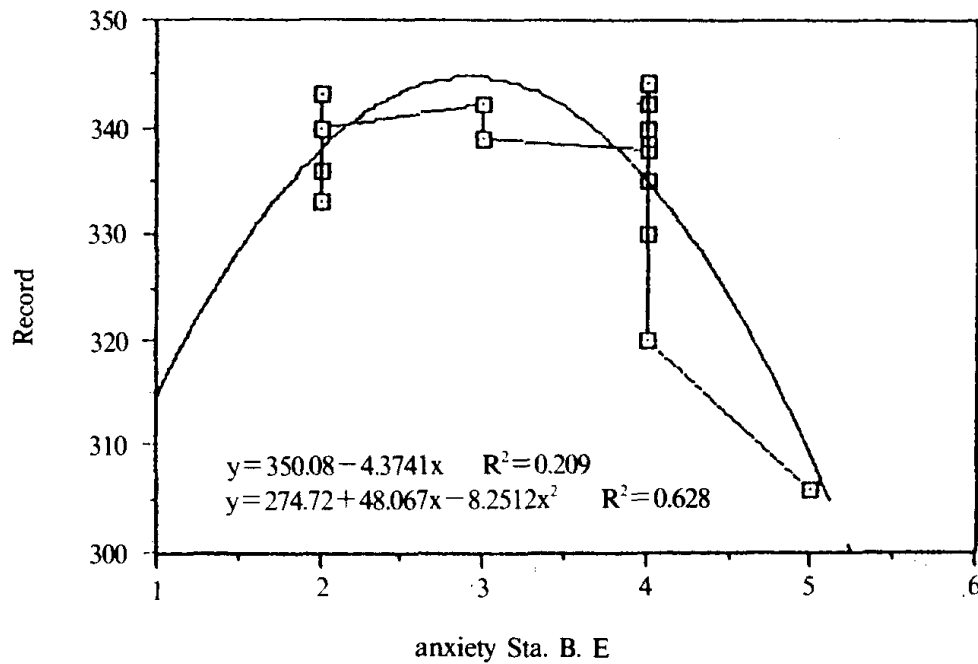


Figure 4. An example of a regression curve output

RESULTS AND APPLICATION

1. The Trend of Changes in Records

The trend of changes in records is what both coaches and performers are keenly concerned about. By apprehending the trend, first, the archer can see his true position ; second, he can retrace the variables and can analyze the causes which brought a sudden rise or a sudden drop ; third, he will have a stronger motivation for better records and participate in training more positively ; fourth, he will learn a better use of the materials for his conditioning control. Knowing the trend of changes in records is extremely important not only for the archer's record control but for the development of better training methods. Some coaches and performers make their own charts by putting down daily records on graph paper. Fig. 5 shows an example of archer K's record changes.

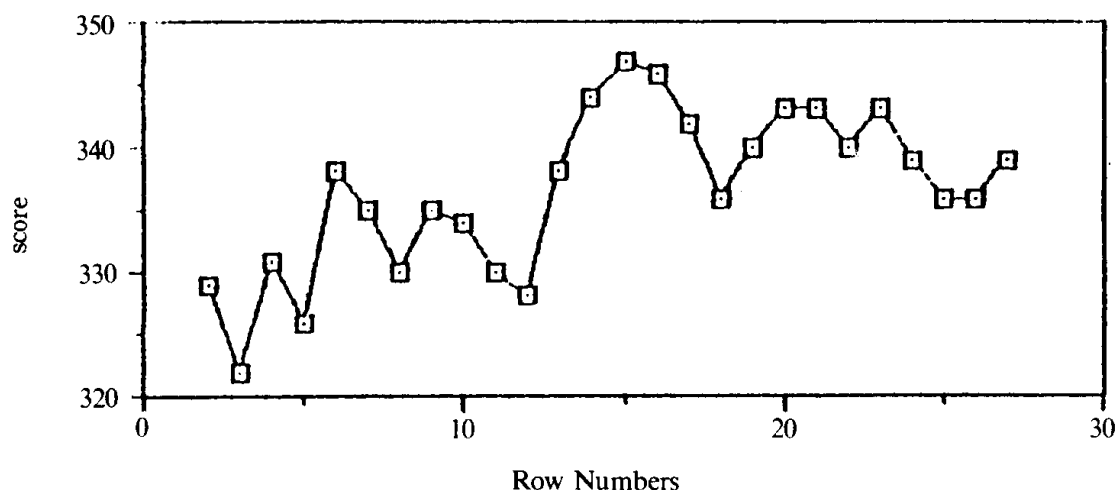


Figure 5. A trend of changes in records

2. Relations between variables and Records

The researchers had a number of discussions with the archery coaches and performers prior to the decision of the variables which might affect an archer's competitive ability. Some of the variables suggested lacked objectivity and theoretical support, but if they were suggested for empirical reasons of the coaches and archers, they were selected as significant variables. The variables were classified in 4 categories.

(1) Physical variables

Fig. 6 shows the relationship between bodyweight and records. The archers with a bodyweight of 57.6kg showed better record results than those

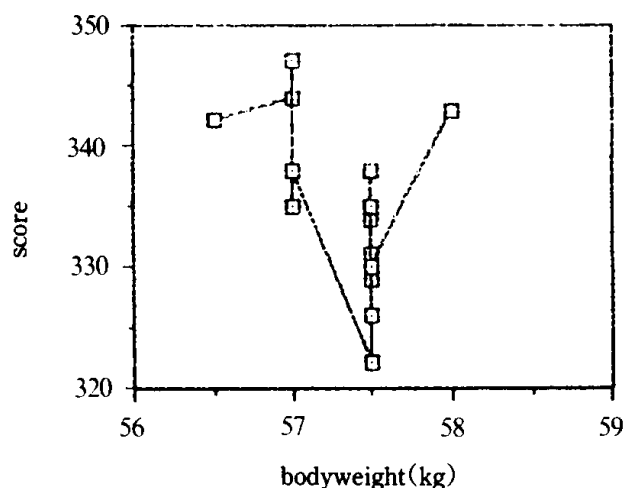


Figure 6. Bodyweight and records

with a bodyweight of 56.5–57kg. The trend of changes in bodyweight and that in records are compared in Fig. 7. The comparison reveals that records increase as bodyweight decreases. An attempt was made to determine the cause by examining the amount of practice and the psychological state in relation to records, but it failed to reach any conclusion. Landers(1988), who analyzed the relationship between body fat and records, reported that the archers with less body fat achieved better records.

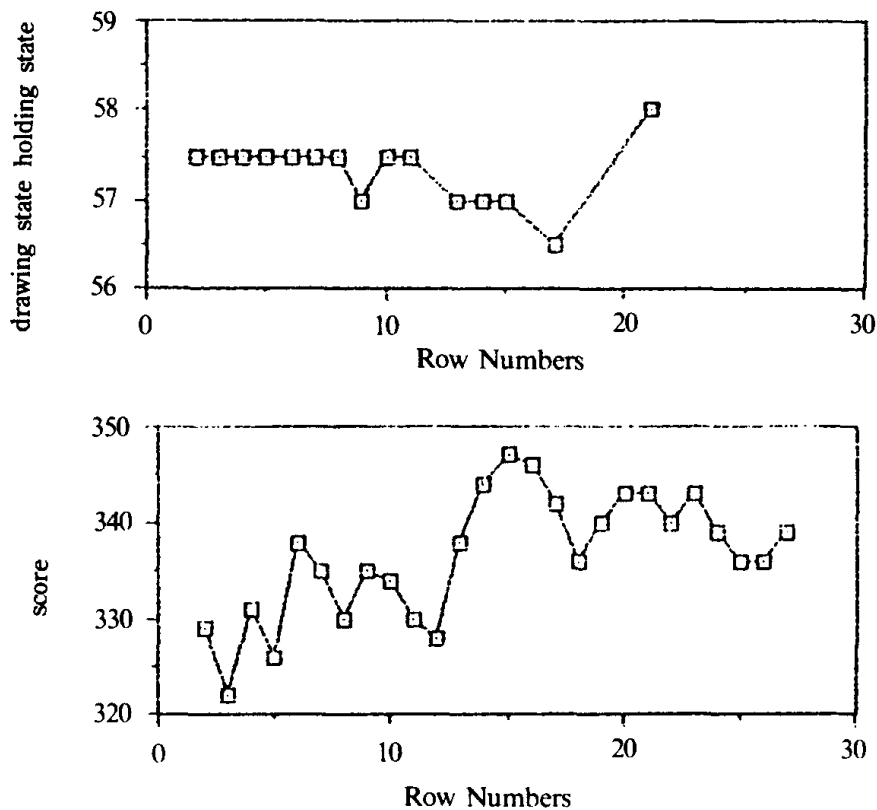


Figure 7. Bodyweight and trends in record changes

(2) Psychological variables

There was an apprehension that the performers might not grasp the concepts(motivation, confidence, and expectancy)accurately, but an interview with them gave the researchers an affirmative answer. The graph below shows that archer K's confidence and expectancy are very hard to distinguish from each other. An interesting finding is that the archer made better scores when in an ordinary frame of mind than when he was full of confidence.

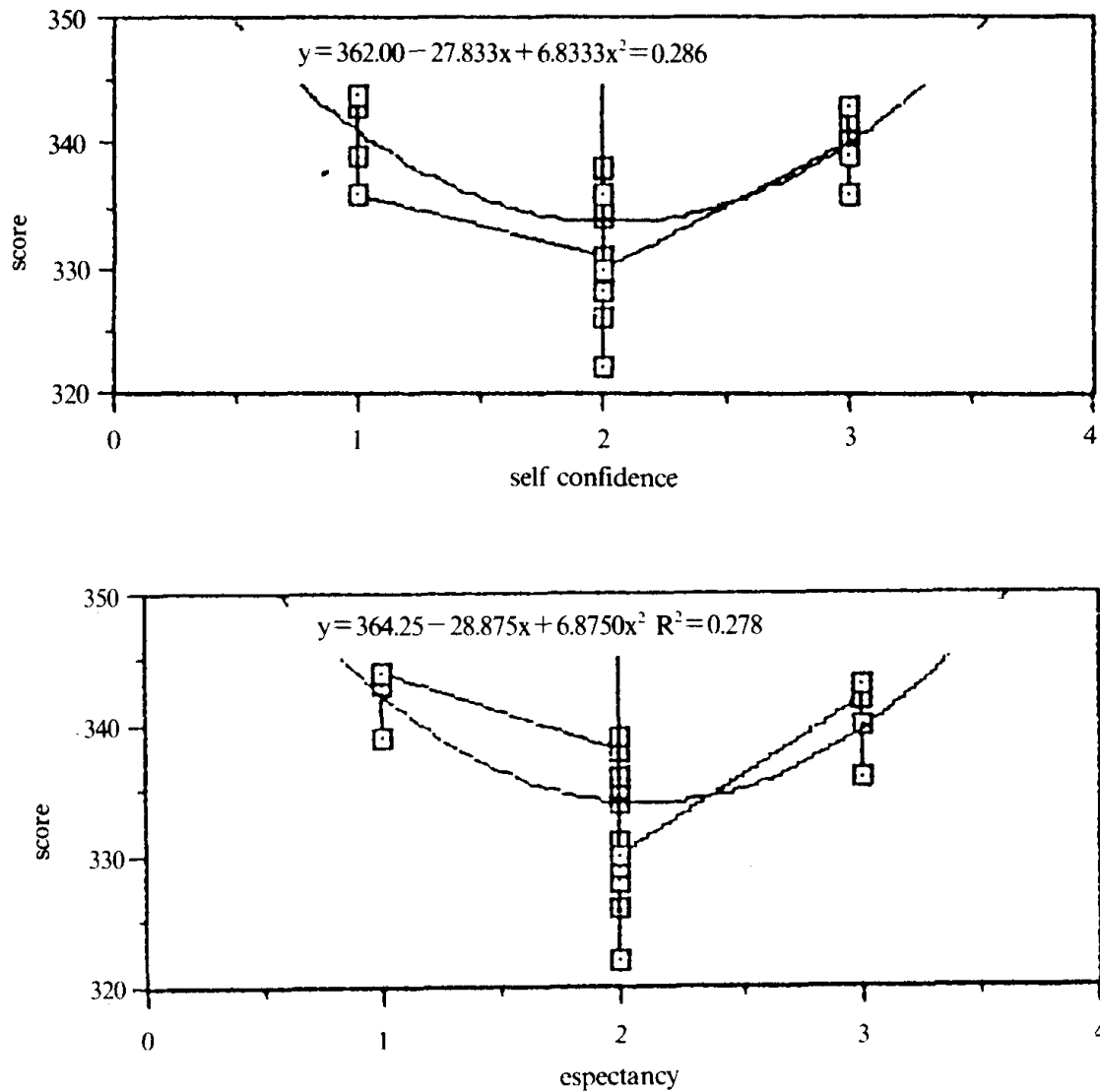


Figure 8. Confidence, expectancy, and records

(3) Technical variables

a) Relationship between drawing, holding, release and records.

The archers were asked to put down their feelings in relation to the archer's position on the supposition that the respective position (drawing, holding, and release) may affect an archer's record differently and that these positions should be directly related to records. It is also believed that the archer must maintain a correct posture to achieve good scores. However, Fig. 9 reveals no relationship between an archer's feelings and his/her records.

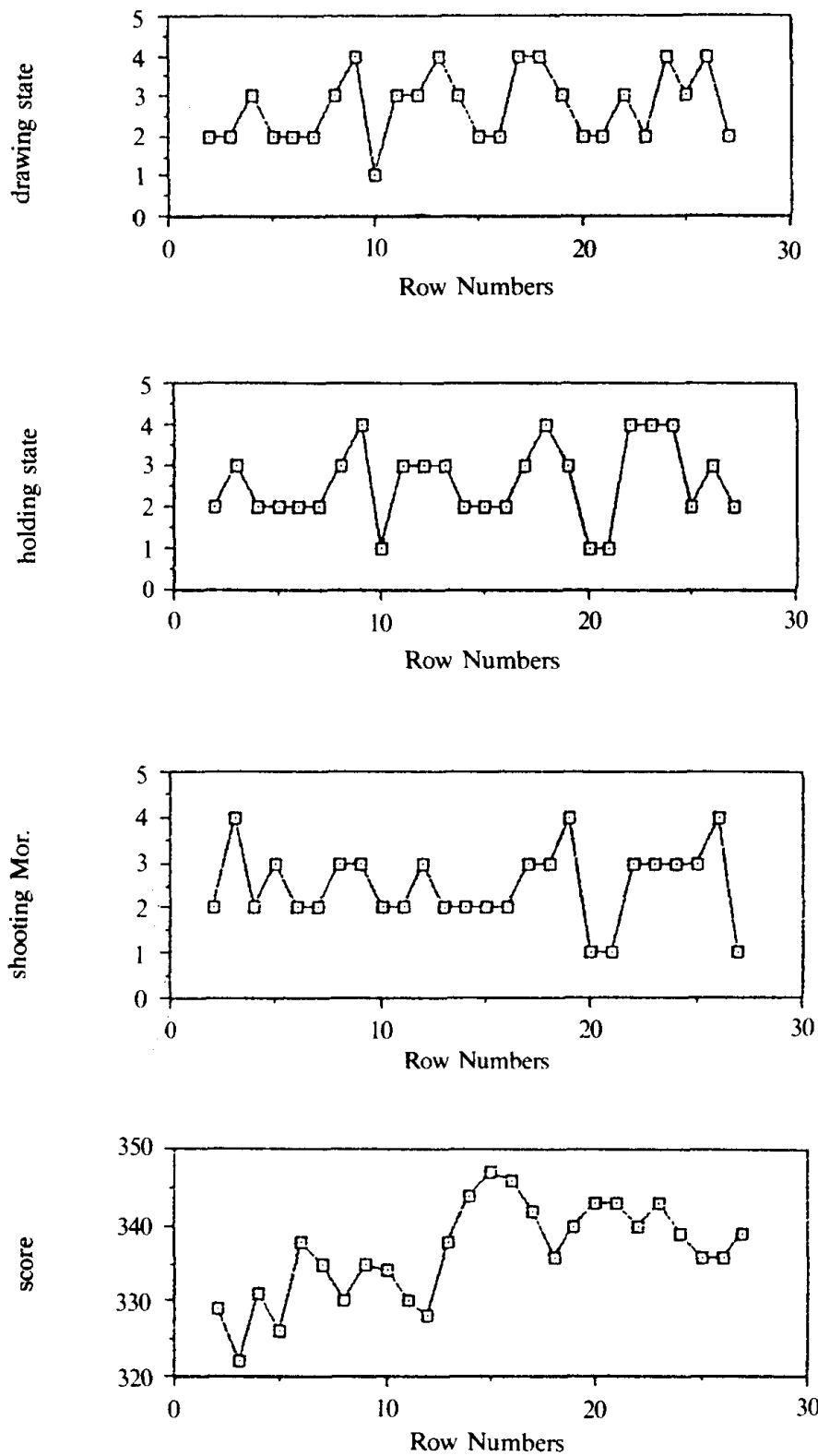


Figure 9. Drawing, holding, release, and records

b) The amount of training the day before

In the archery competition, the archer's condition has a great effect on performance and conditioning control is essential. The amount of practice and ingestion of nutrition the day before the contest is the most important factor. It is known that the soviet archery team, which Balob coached over 10 years, usually had a day off two days before the contest and had a very light aiming practice on the day before the contest. Obviously, the team wanted to achieve a better conditioning level.

Fig. 10 shows the relationship between archer L's amount of practice and records. The archer makes high scores when he has a normal or intense practice.

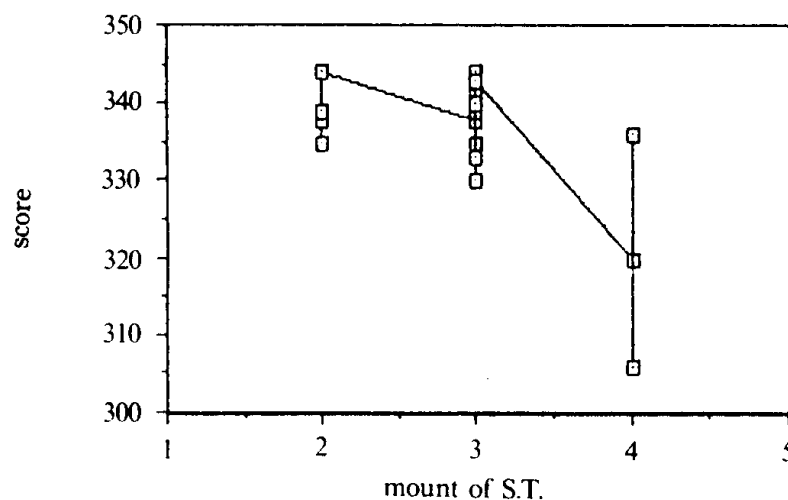


Figure 10. Pre-measurement practice and records

(4) Equipment variables

Archery equipment is not produced to meet an individual archer's preference. It is very costly and its production is very complicated. Therefore the tuning technique of ordinary equipment is very important and actually a lot of time must be spent on tuning. Tuning is mainly to adjust the different parts into a relationship of harmony. However, individual archer's peculiar characteristics should be taken into consideration. The most proper tuning should be made for the best record. Fig. 11 shows that the relationship between tuning and records was by removing tiller height 1mm by 1mm on the archer P's bow. The scores were significantly higher when tiller height was set at 5mm than at 3mm.

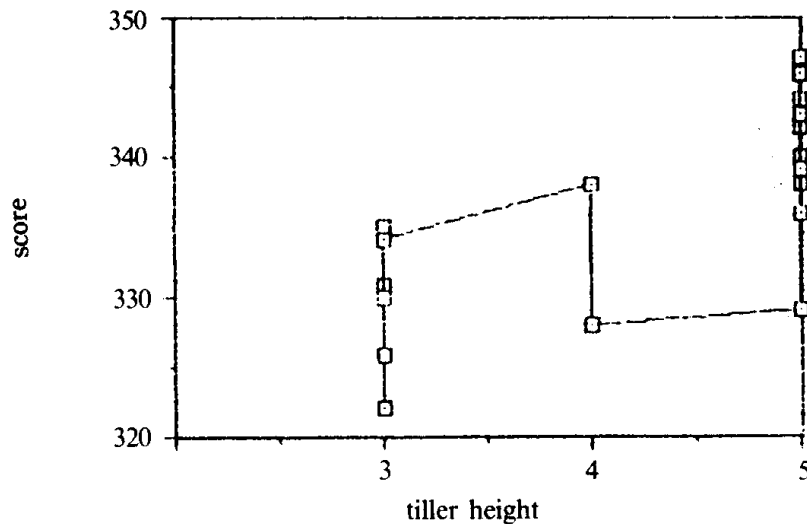


Figure 11. Tiller height and records

3. The Relationship between biorhythm and Records

The theory of biorhythm advocates that there is rising and falling rhythm between the human body and mind. This has been applied to practical purposes in industry and the realm of transportation. It is reported that the theory has been used in sports field for the training of performers since the Berlin Olympic Games. Even in Korea, the relationship between biorhythm and injuries was studied, particularly in volleyball and track and field. The theory was also utilized in archery for reinforcement training.

In the World Championship of Archery in 1991 the Korean archer Y, who was expected to achieve new records, was doing fine until he remained with final 18 contestants, but he failed among semi-final 12 contestants. It was found later that Y's biorhythm was at its lowest level. It is generally felt that biorhythm may have some effect on performance, but its correlation with records has not been proven yet. Therefore a program is planned to prove its correlation with records, apply it to actual training, and furthermore develop it to the level that records can be predicted by it. A total of 26 models will be established in which physically, mentally, and emotionally high and low periods will be included, and changes in records will be observed and checked. There will also be included a high rhythm period(+), a low rhythm period (-), and a danger period (0). As data accumulate, changes in records will be retraced to the ultimate cause. This program will be developed in Version 2.

SUMMARY AND SUGGESTION

That factor which has the greatest effect out of the 28 variables depends on the individual. Therefore it can be possible to develop a particular training program which fits a particular archer by analyzing these variables and utilizing the results. The application of new ideas is not always easy. Indefatigable research into the unknown can only find better ways of achieving these aims. Though many studies have been done on the factors which may affect an archer's competitive ability, most of the results seem to be a little short of any practical use. However, the variables selected in this study could be measured and experienced under actual competitive conditions. Some of the results were rather subjective and statistically insignificant, but the original aim of this study was not theoretical but practical. An emphasis was placed on practical uses, and the archers' subjective opinions and experiences were admitted.

The most important thing is that the results of this study have been dedicated to the stress management in archers and the concentration of the archers' mind in competition. The daily implementation of what is learned from this study was effective. The graphic output which functioned as visual feedback was very significant. The program as a whole helped the archers to learn how to control their own conditioning. To run this program effectively, the constant input of data is more important than anything else and an accurate analysis is only possible with sufficient data.

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