THE U.S. OLYMPIC TRAINING MANAGEMENT SYSTEM RESEARCH PROJECT, ITS THEORETICAL FOUNDATION, AND PRACTICAL POTENTIAL

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The following paper describes the basic outlines of the United States Olympic Training Management System Research Project, of which the author is currently director. Following the project description, various mathematical relationships between training and performance that have been researched and analyzed by the author during the past two decades and that serve as a theoretical foundation for the Olympic Training Management System's development are discussed.

Introduction

What is the Olympic Training Management System? The Olympic Training Management System is designed to be a cooperative effort between athletes, coaches, and sport scientists to utilize knowledge and experience the most efficient way possible.

Because one of the main advantages of the Western world is its technology, it seems logical to apply that technology to athletics in a systematic, widespread fashion. To my knowledge, the Olympic Training Management System (OTMS) which at this moment is still in a developmental and experimental stage, is the first such attempt to accomplish this type of application. The objective of these efforts is shown in Figure 1.

USOC Training Management System

The Objective

The objective of our effort is to dramatically increase the efficiency of Olympic training the United States.

This will be achieved by creating a computerized network which will provide instantaneous access and use of the knowledge, experience, and skills of the best sports scientists, coaches, and athletes to local coaches and athletes throughout the nation.

This system will be referred to as:

"The United States
Olympic Training Management System"

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Fig 1

The OTMS is a multi-level system. It can be used as a manual or computer-enhanced evaluation system. By creating a computerized, nationwide network, instantaneous access and use of the knowledge, the experience and the skills of the best scientists, coaches and athletes in the nation will become accessible to local coaches and athletes across the country. (Figure 2)

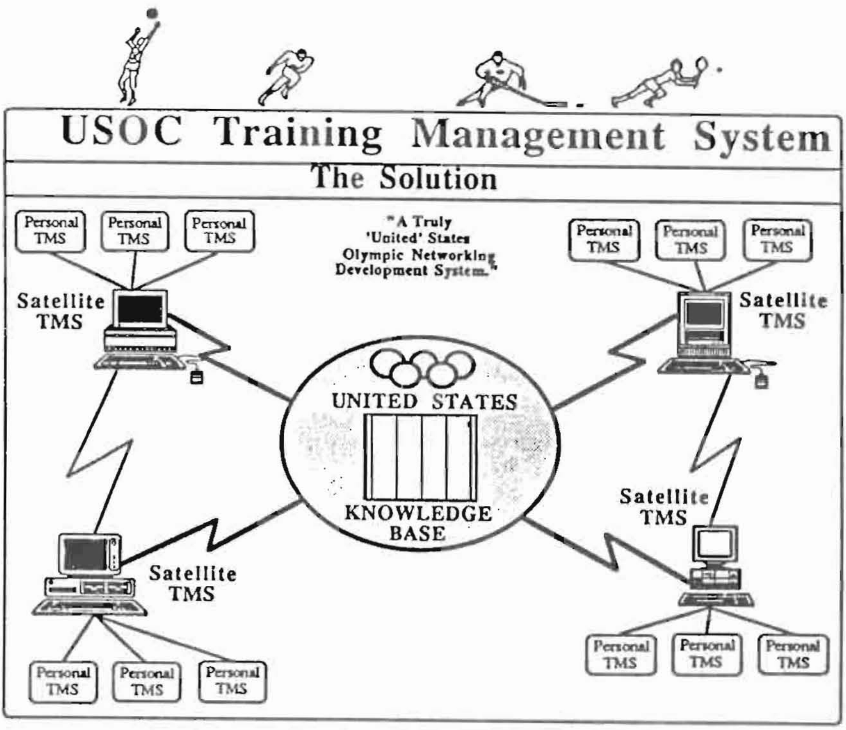


Fig 2

In brief, the system will consist of a Mainframe computer located in Colorado Springs, which will contain a knowledge base. This OTMS brain will contain training data from thousands of elite athletes, plus similar data from literally thousands of less accomplished athletes in all Olympic sports. It will also contain information about athletic training provided by many different expert sources, including sports scientists, coaches, and elite athletes.

Key Elements in the system are shown in Figure 3.

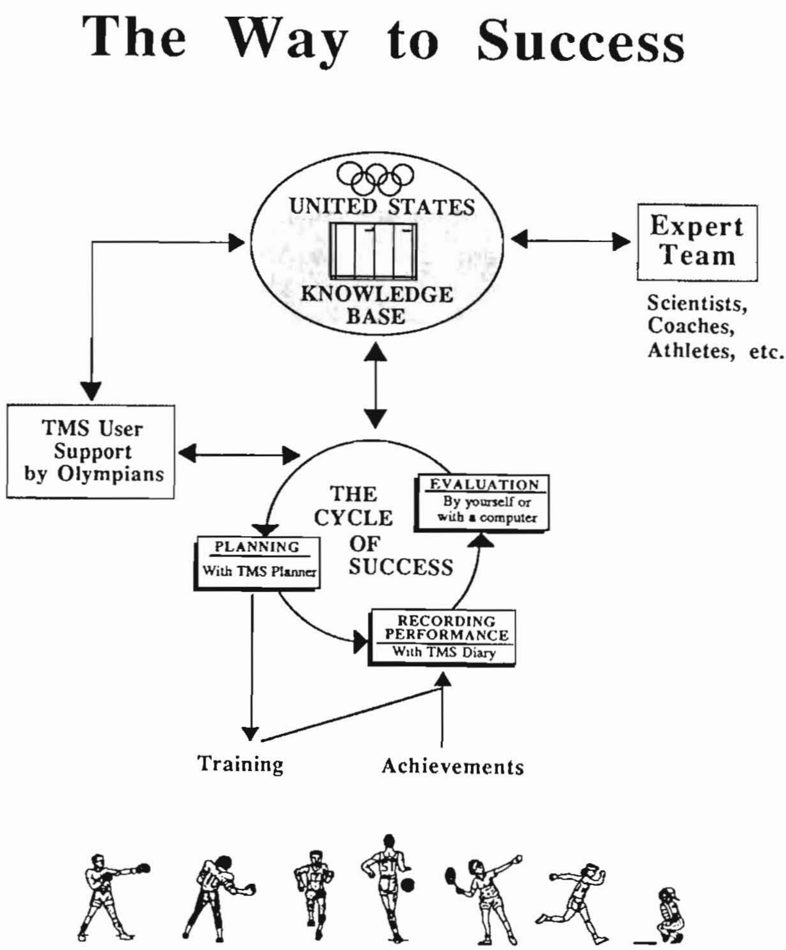


Fig 3

A team of experts comprised of expert researchers, coaches, and successful world class athletes will be the resource from which the database and training programs will be developed. It will consist of: archival storage and retrieval of data; analysis and problem solving capabilities, and facilitates Satellite Work Stations and Personal training management.

The satellite training management work station provides synapses between users and the Colorado Springs Center and allows direct contact with coaches and athletes on the one hand and Colorado Springs on the other. They also guarantee error-free data transfer from coaches and athletes to the Colorado Center.

The field interface tools consist of the planner, the diary and the sample training program. The planner holds forms for the planning, tracking and evaluation of the yearly training. The diary is in the form of a simple, portable booklet, that helps the athlete plan and record his/her training on a daily basis. The sample training program is an event and age specific guide for creating an individual training program.

Processing of data may be done in several ways. The athlete can either enter his/her training data into the system personally via a personal computer through a modem. Or, information in the training diary may be sent to a local work station for expert service. If he/she wishes, he/she can also receive individualized training programs that can be shared including what other successful athletes in the event at his/her age and ability level do for training.

Using the methods of artificial intelligence, as greater and greater amounts of data are fed into it, the system will gain problem solving abilities, will be able to make inferences accurately, and will feed these back to the coaches, athletes and scientists requesting them. It will be possible for a coach or athlete to use one of many satellite centers planned to be located across the country, feed in data or a problem needing a solution and obtain training advice from the system. In addition, the expertise of elite athletes such as Olympians and of many of the nation's best coaches will be available as part of this networking system. This computerized network will disseminate information instantaneously to anyone with access to the system. Note, however, that it is not planned to be just another kind of network. The new element in this will be "service."

A great many variables and rules for sports success will be monitored in the training management system. (Figure 4)

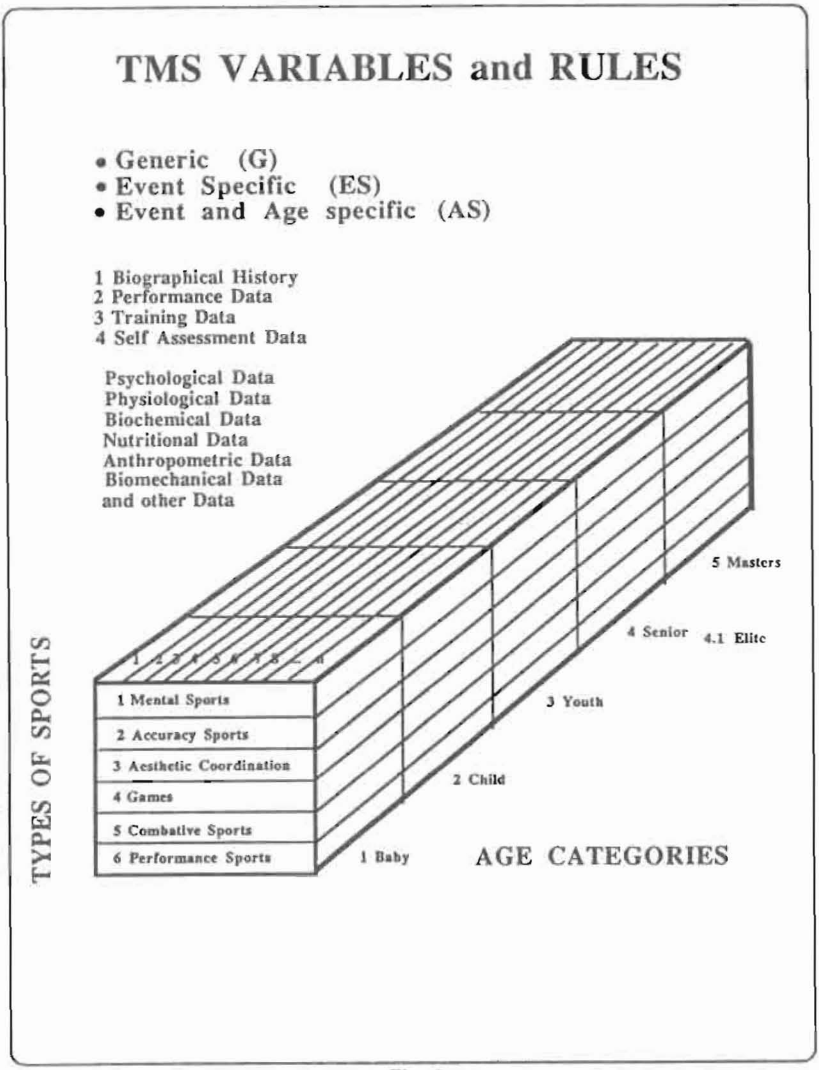


Fig 4

Generic, event specific, and event and age specific variables will be monitored. Primary focus will be on personal history data, performance data, training data, and self-assessment data. For example, the monitoring of performance and training data will be very helpful for scientists wishing to perform research from the standpoint of their specific discipline. For instance, psychologists, physiologists, biochemists, nutritionists, anthropologists and biomechanists will all have easy entry for their research.

There are many different types of sports; such as accuracy sports (archery), aesthetic coordination sports (gymnastics), games (soccer), combative sports (boxing), performance sports, etc. There are approximately 300 different sport events. These all require different types of training, as well as different research approaches. This makes this project gigantic. In addition, OTMS research is planned to include all age groups.

In the following part of this presentation the primary illustrations will use data about an athlete who has been involved in the training management system for two years, since the beginning of the project.

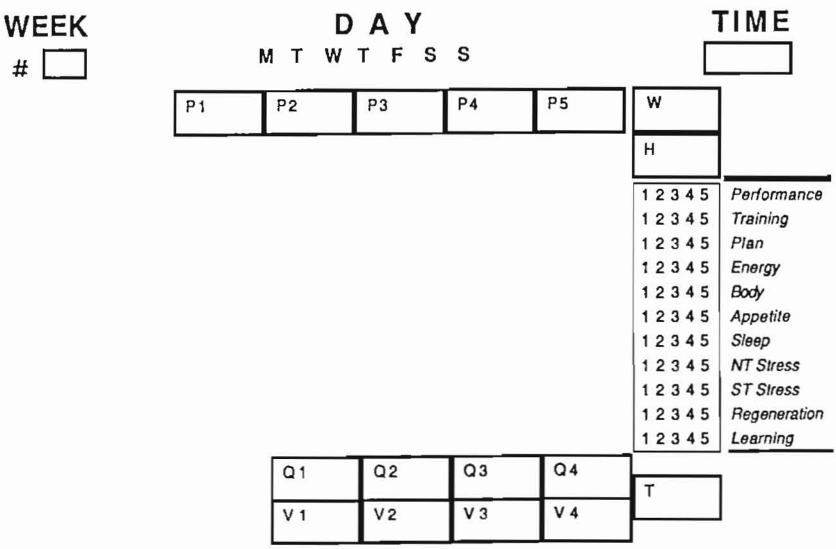
Method

Subject of analysis

The athlete discussed is Mike Buncic, an elite, world class discus thrower. Buncic currently leads the United States rank list in his event. For the effective use of this training management system, individual rather than group analysis is extremely important. The use of individual analysis is the key to success here, because it is the way to uncover significant relationships that become lost and undecipherable when you deal with group analysis. (Pataki 1982a, 1982b, 1983, 1984.). For the purposes of our discussion, one person's daily data represents a statistical group.

The diary and self-assessment page is shown in Figure 5.

DATA BASE FIELDS



The following variables are considered in this statistical analysis: performance, (P1 = discus competition, P2 = discus training performance, P3 = squat performance, P4 = power clean performance, and P5 = jump performance); training data, (V1 = amount of throws of discus, Q1 = technical quality of throws in percentage, V2 = number of sets lifting, Q2 = Intensity of lifting in percentage, V3 = number of sprints, Q3 = intensity of sprinting in percentage, V4 = number of jumps, Q4 = intensity of jumps), and duration of training session.

The following words about the self assessment data must be defined: "performance" means motivation to achieve maximum performance; "training" means motivation to train; "plan" means comfort with plan; "energy" means the athlete's level of assessed energy; "body" means body comfort; "appetite" and "sleep" are self explanatory, "NT stress" means stress away from training, "ST stress" means special training stress, "regeneration" refers to the amount of regeneration the athlete did; and "learning" refers to the amount the athlete learned.

The methods of analysis used in this paper include graphical comparison analysis and relational analysis. The basic statistical parameters and functions include minimum/maximum, mean standard deviation, correlation, and autocorrelation.

Hypothesis

For thousands of years it has been known that there is a relationship between training and athletic performance, yet that relationship has seemed to be a very elusive one. The central problem has been that of validating the existence of the relationship and of determining how great that relationship is. The end objective has normally been twofold. First athletes, coaches and spectators have always wanted to be able to predict performance. Perhaps even more important, knowing the exact relationship between training and performance would allow the design of a modeling process that would lead with certainty to improvement in performance.

Results

Tables 1, 2, and 3 depict statistics relating to performance level, training volume, and the variability of performance level, but do not show the time frame of these variables.

STATISTICS OF PERFORMANCES (MB 1988)

	DISCUS COMPETITION	DISCUS TRAINING	SQUAT	POWER-CLEAN	STANDING L. JUMP
N OF CASES	4	43	6	13	1
MINIMUM	64.98	59.00	550.00	352.00	3.27
MAXIMUM	68.92	70.30	660.00	396.00	3.27
MEAN	66.44	65.49	610.00	377.77	3.27
STANDARD DEV	1.80	2.07	43.82	14.35	.

BODY WEIGHT

N OF CASES	139
MINIMUM	253.00
MAXIMUM	266.00
MEAN	261.35
STANDARD DEV	2.37

Table 1

STATISTICS OF TRAINING (MB 1988)

	DISCUS THROWS [n]	LIFTING [n sets]	SPRINTS [n]
N OF CASES	222	222	222
MINIMUM	0.00	0.00	0.00
MAXIMUM	95.00	23.00	50.00
MEAN	17.05	4.45	2.07
STANDARD DEV	25.81	6.48	5.51
SUM	3784.00	989.00	460.00

STATISTICS OF QUALITY AND INTENSITY OF TRAINING

	QUALITY OF THROWS	INTENSITY OF LIFTING	INTENSITY OF SPRINTING
N OF CASES	222	222	222
MINIMUM	0.00	0.00	0.00
MAXIMUM	100.00	100.00	90.00
MEAN	33.69	30.90	15.95
STANDARD DEV	42.19	40.34	31.43

Table 2

STATISTICS OF SELF-ASSESSMENT

	PERFORMANCE MOTIV.	TRAINING MOTIV.	COMFORT WITH PLAN	FEELING OF ENERGY	BODY COMF.
N OF CASES	181	195	195	195	195
MINIMUM	2	2	2	1	1
MAXIMUM	5	5	5	5	5
MEAN	3.36	3	3.87	3.39	3
STANDARD DEV	0.61	0.81	0.90	0.71	0.8

	APPETITE	SLEEP	NON TRAIN. STRESS	TRAINING STRESS	REGENERATION
N OF CASES	195	195	195	195	195
MINIMUM	1.00	1.00	1.00	2.00	2.00
MAXIMUM	5.00	5.00	5.00	5.00	5.00
MEAN	3.69	3.73	3.76	3.87	3.58
STANDARD DEV	0.77	0.83	0.89	0.79	0.71

	LEARNING
N OF CASES	184
MINIMUM	2.00
MAXIMUM	5.00
MEAN	3.55
STANDARD DEV	0.71

Table 3

Figure 6 shows the time series of the sport and training performance level of the athlete. This figure suggests a similar level between his competition and training performances.

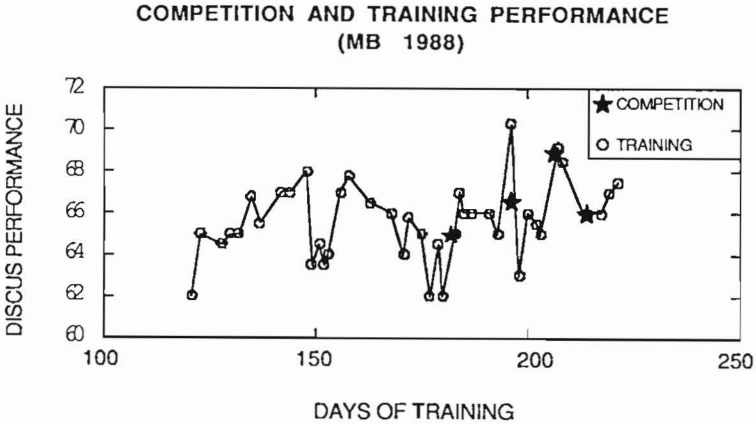


Figure 6

His training performance level is very high, at a world class level (average: 65.49 meters). His competition average is 66.44 meters. But his peak form occurred without realization of his potential. Note the significant cycles of high and low performances, probably caused by training load.

Knowing that the Olympic Games are held at the end of September and into October, we know that the athlete's performance level peak should coincide with this period. Are there some definable regularities which would indicate regular periods of upgoing or downgoing performance?

Autocorrelation analysis indicates that in relation to actual performance there is a four-day downgoing trend of the correlation which after about the eleventh day goes up again then drops down again in the fifteenth day (see Figure 7).

PERIODS OF DISCUS THROWING PERFORMANCE
(MB 1988)

PLOT OF DTRAINP
NUMBER OF CASES = 43
MEAN OF SERIES = 65.486
STANDARD DEVIATION OF SERIES = 2.045

PLOT OF AUTOCORRELATIONS

LAG	CORR	SE
1	.263	.152
2	.160	.163
3	.137	.166
4	-.105	.169
5	-.056	.171
6	-.028	.171
7	-.218	.171
8	.044	.177
9	-.040	.178
10	.052	.178
11	.304	.178
12	-.024	.190
13	-.176	.190
14	-.138	.194
15	-.323	.196
16	-.218	.208
17	-.089	.213
18	-.095	.214
19	-.066	.215
20	-.002	.216
21	.101	.216
22	.254	.217
23	.027	.224
24	.026	.224
25	-.047	.224
26	-.033	.224
27	-.003	.224
28	.048	.224

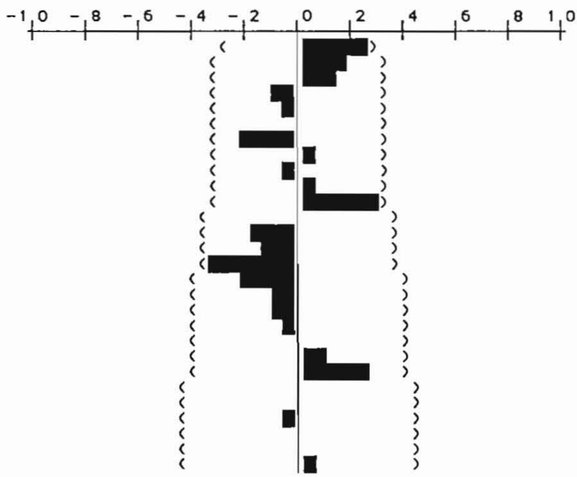


Figure 7

One of the implications of this finding suggests the importance of not peaking in the middle of the week if a competition is to occur at the end of the week. This same pattern is found in partial autocorrelations.

These correlations cannot help but stimulate our curiosity. Additional questions come immediately to mind. For instance, what lies behind the cycles? Are they affected by training?

Figure 8, "Time Series and Correlation of Discus Training Performance and Number of Training Throws," suggests no synchronous correlation between training and performance. The effect of training clearly comes later. This fundamental problem occurs after much analysis.

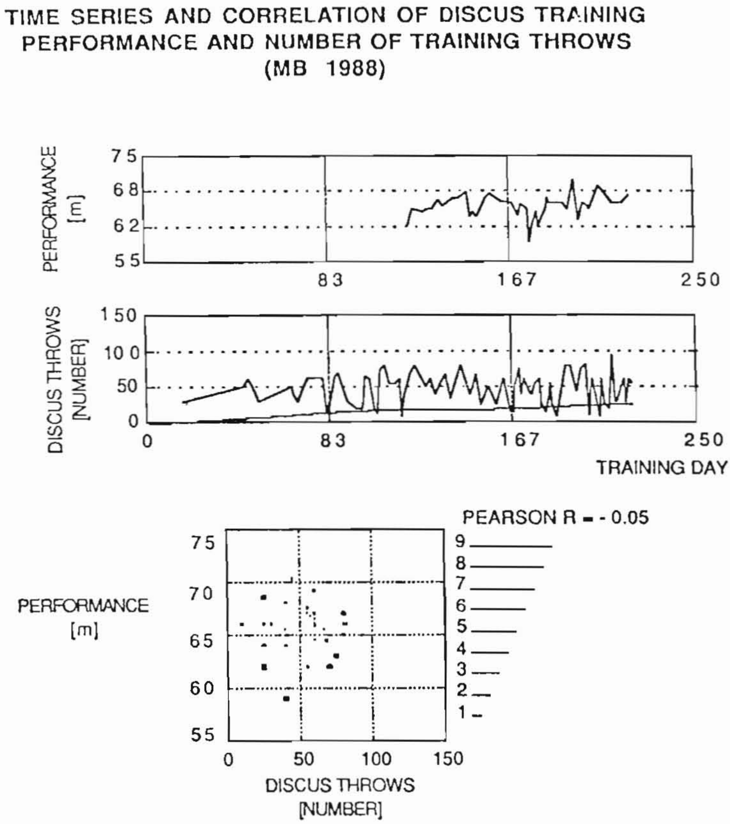


Figure 8

This research indicates an asynchronous transformation caused by the training load, resulting in improved performance. This transformation can be validated mathematically by cross-correlation analysis done by lagging, a shifting of the two time series in relation to each other. Previous research on the subject is summarized in Figure 9.

Cross Correlation of Time Series of Performance
and Training Load Components (X1, X2, X3)

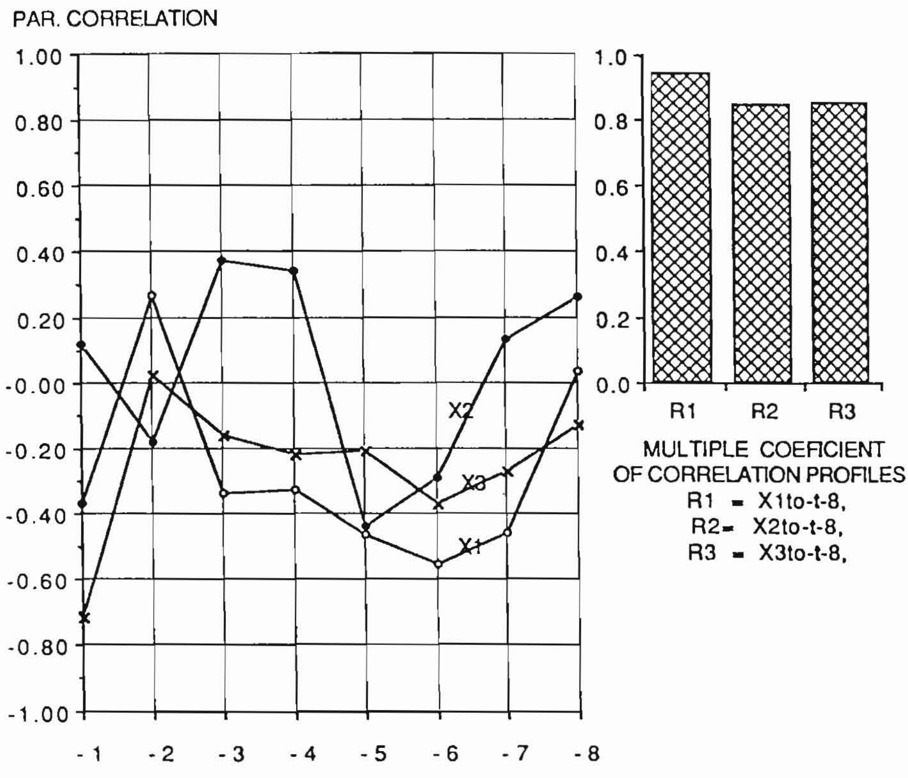


Figure 9

These results also indicate that there is no significance in a single correlation, but that the whole cycle's cross correlation profile is significant. The multiple correlation coefficient of this cross correlation is highly significant. This suggests that to improve the efficiency of training, the coach must focus on designing entire training cycles instead of single training sessions or even isolated training weeks.

There is currently no statistical package available that provides a complete tool for analysis. So, at the present time, a system is being designed for this purpose.

An illustration of the smoothed three-dimensional data is given in Figure 10.

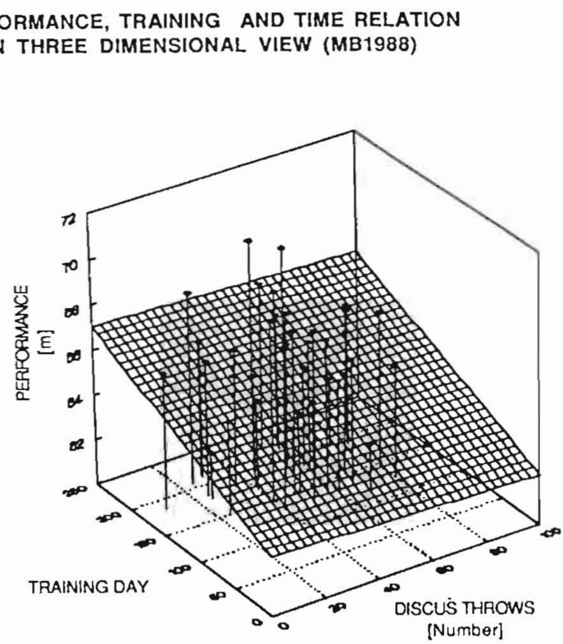


Figure 10

"Performance, Training and Time Relation in Three Dimensional View" provides relatively little information about the multi-dimensional factor system that lies behind performance variation. The most important information that this chart provides is the correlation between time spent training (number of training days) and performance. Behind the number of training days lies a multiple activity system which must be identified and clarified.

Curiosity makes one wonder what the three-dimensional charting of performance, training and number of training days would reveal. Local smoothing creates the pattern of these relations shown in Figure 11. Unfortunately the patterns are too complex to be useful as feedback for athletes or coaches.

PERFORMANCE, TRAINING AND TIME RELATION IN THREE DIMENSIONAL VIEW - SMOOTHED (MB1988)

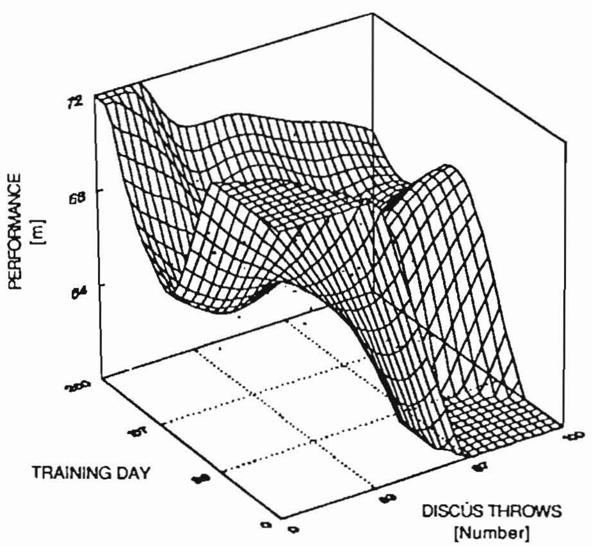


Figure 11

In a search for something immediately useful, the most important question to be asked is how can the greatest improvement in performance be achieved? To determine that, one must define what training patterns are successful. What is the relationship between the unique and the usual? How do trainings occurring before an average performance level and trainings before the best performance level differ?

The Training Management System facilitates and automates analysis. Computer routines were designed based on current research. (Pataki, 1984). Figure 12 depicts an example drawn from this research. With this model, a routine can be programmed that provides an instant answer to questions about success patterns relating to the last week of training prior to a competition or planned achievement.

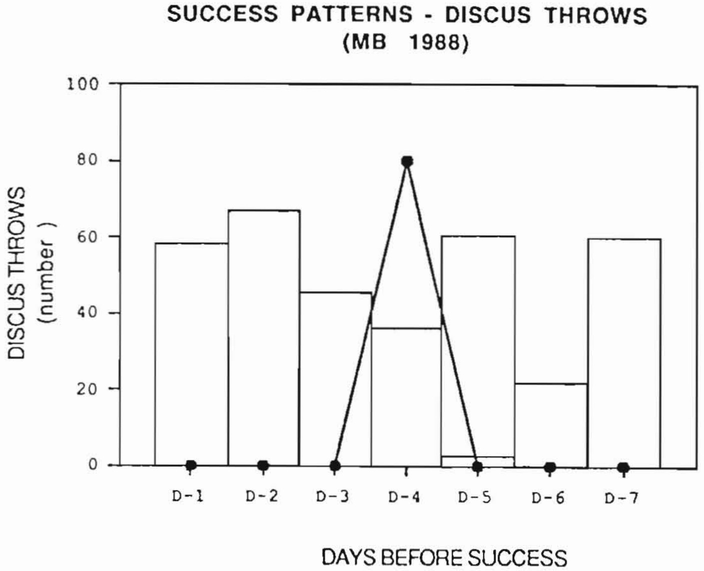


Figure 12

Conclusions

The analysis shows some partial success in uncovering some of the statistical correlations between training and performance, in other words, in showing that there is an identifiable connection between some aspects of the two. The information gained from these analyses also allows one to formulate a few tentative details of the ideal training model.

As far as the correlation between training and performance is concerned, there is a defined successful pattern of increased and decreased performance necessary for the achievement of maximum performance. An athlete's conscious awareness of this pattern should be developed as a part of a sense of efficiency. It must be used to control all activities that work toward performance improvement, including peaking at the right time.

To suggest the right training model for peaking at the right time, the "successful training pattern" method can be used. Analysis indicates that behind unique high performance lies a unique training pattern differing significantly from training that precedes average performances.

Our most important goal is to identify the mathematical models of successful training patterns which may be used as a modeling tool by coaches and athletes.

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