Annual Planning, Periodisation and its Variations

Author: Tudor Bompa (CAN)

The annual plan is often viewed as the most important tool for the coach to guide athletes' training over a year. Such a plan is based on the concept of periodisation, which has to be viewed as an important concept to follow if one intends to maximise his athlete's performance.

The main objective of training is to reach the highest level of performance at the time of the main regatta of the year. But in order to achieve such a task one has to carefully plan the main activities of a crew, to create the best training menu, and to periodise the dominant abilities such as endurance and strength in such a way that will result in the highest probability of meeting the annual training goals.

Considering the above goals, and the high level of knowledge of my audience, I will be focusing in this presentation mostly on the concept of periodisation and its variations.

Periodisation

Periodisation is a process of dividing the annual plan into small phases of training in order to allow a program to be set into more manageable segments and to ensure a correct peaking for the main regatta of the year. Such a partition enhances a correct organisation of training, allowing the coach to conduct his program in a systematic manner.

In rowing, the annual training cycle is conventionally divided into three main phases of training: preparatory, competitive and transition. Both the preparatory and the competitive phases are also divided into subphases since their tasks are quite different. The preparatory phase, on the basis of different characteristics of training, has both a general and a specific subphase, while the competitive phase usually is preceded by a short pre-competitive subphase. Furthermore, each phase is composed of macro- and micro-cycles. Each of these smaller cycles has specific objectives, which are derived from the general objectives of the annual plan.

High levels of athletic performance are dependent upon the organism's adaptation, psychological adjustment to the specifics of training and competitions and the development of skills and abilities. On the basis of these realities, the duration of training phases depends heavily on the time needed to increase the degree of training and to reach the highest training peak. The main criterion for calculating the duration of each phase of training is the competition calendar.

The athlete trains for the competition for many months aiming at reaching his highest level of athletic shape on those dates. The accomplishment of such a goal assures very organised and well-planned annual training, which should facilitate

psychological alterations. Organisation of an annual plan is enhanced by the periodisation of training and the sequential approach in the development of athletic shape.

The needs for different phases of training were inflicted by physiology because the development and perfection of neuro-muscular and cardio-respiratory functions, to mention just a few, are achieved progressively over a long period of time. One also has to consider the athlete's physiological and psychological potential, and that athletic shape cannot be maintained throughout the year at a high level. This difficulty is further pronounced by the athlete's individual particularities, psycho-physiological abilities, diet, regeneration and the like.

Climatic conditions and the seasons also play a determinant role in the needs of periodising the training process. Often, the duration of a phase of training depends strictly on the climatic conditions. Seasonal sports, like rowing, are very much restricted by the climate of a country.

As the reader may be aware, each competition and, for that matter, the highly challenging training that is specific to the competitive phase, has a strong component of stress. Although most athletes and coaches may cope with stress, a phase of stressful activities should not be very long. There is a high need in training to alternate phases of stressful activities with periods of recovery and regeneration, during which the rowers are exposed to much less pressure.

Periodisation of Biomotor Abilities

The use of the concept of periodisation is not limited to the structure of a training plan or the type of training to be employed in a given training phase. On the contrary, this concept should also have a large application in the methodology of developing the dominant abilities in rowing (endurance and strength).

Figure 1: The Periodisation of Dominant Abilities in Rowing

	Preparatory			Competitive		Transit
	General Preparation	Specific Preparation		Pre-Competition	Main Competition	Transit
Strength	Anatomical Adaptation	Max strength	Conversion to Musc. End.	Main-tenance	Chps	Rehab.
Endurance	Aerobic Endurance	Development of Foundation of Specific Endurance		Specific Endurance		Aerobic Endurance

Periodisation of Strength Training

The objectives, content and methods of a strength training program change throughout the training phases of an annual plan. Such changes occur in order to reflect the type of strength rowing requires muscular endurance (the capacity to perform many repetitions against the water resistance).

The Anatomical Adaptation - Following a transitional phase, when in most cases athletes do not particularly do much strength training, it is scientifically and methodically sound to commence with a strength program. Thus, the main objective of this phase is to involve most muscle groups to prepare the muscles, ligaments, tendons, and joints, to endure the following long and strenuous phases of training. A general strength program with many exercises (9-12), performed comfortably, without "pushing" the athlete, is desirable. A load of 40-60% of maximum, 8-12 repetitions, in 3-4 sets, performed at a low to medium rate, with a rest interval of 1-1:30 minutes between exercises, over 4-6 weeks will facilitate to achieve the objectives set for this first phase. Certainly, longer anatomical adaptation (8-12 weeks) should be considered for junior athletes and for those without a strong background in strength training.

The Maximum Strength Phase - Ever since it was found that the ergogenesis of rowing is 83% aerobic and 17% anaerobic, the importance of strength has diminished in the mind of many coaches. In addition, the rowing ergometer has captivated the attention of most coaches. Often the rowing ergometer is used at the expense of strength training.

All these changes in training philosophy favoured the development of aerobic endurance to high levels. The results were to be expected: rowing races were never faster than now. However, what coaches should observe in the future is that to spend the same amount of time for the further development of aerobic endurance might not result in proportional increases in performance. One should analyse whether or not his athlete has maximised his endurance potential? Or, is there anything else which could improve the rower's performance?

In our estimation now is the time to add a new ingredient to the traditional training menu: maximum strength (which is defined as the highest load an athlete can lift in one attempt). This shouldn't frighten anybody! Nobody proposes to transform the rowers into weightlifters! As illustrated by the following figures, maximum strength has to be developed only during certain training phases of the annual plan.

Why train maximum strength anyway? A simplified equation of fluid mechanics will demonstrate this point: $D \sim V^2$

That is that drag (D) is proportional to the square of velocity (V^2).

Assuming that a coach has concluded that endurance has been developed to very high levels, spending more time on it might not bring superior performance. He might decide that in order to cover the 2,000m in superior speed the rowers have to increase the force of blade drive through the water (say by an average of 2 kg per stroke). But, according to the above equation for any additional force pulled at the oar handle, drag (water resistance) will increase by the square of blade's velocity. If one pulls against the oar handle with an additional 2kg (our example), according

to the above equation, drag increases by 8kg! Therefore, the need to increase the level of strength has been demonstrated.

The duration of the maximum strength phase could be between 2-3 months, depending on the rower's level of performance and his needs. The suggested load could be between 70-90% of maximum, performed in 3-6 sets of 3-8 repetitions with a rest interval of 3-4 minutes.

The Conversion Phase - Gains in maximum strength have to be converted into muscular endurance; this type of strength is dominant in rowing. During these 2-4 months, the rower will be exposed to a training program through which progressively he will be able to perform tens, and even hundreds, of repetitions against a standard load (40-50%) in 2-4 sets.

The Maintenance Stage - Strength training must be maintained through some forms of land training, otherwise detraining will occur, and the benefits of maximum strength, and especially muscular endurance, will fade away progressively. And, rather than being used as a training ingredient for superior performance at the time of the main regatta, the reversal of such gains will decrease the probability of having a fast race.

A training program dedicated to the maintenance of strength will address the weakest link in the area of strength. It could be organised 2-3 times per week, following water training and could consist of either elements of maximum strength, muscular endurance or a given ratio between the two. In either case it has to be of short duration and planned in such a way as to avoid to unrealistically tax athlete's energy stores. Certainly, exhaustion is not a desirable athletic state.

The Cessation Phase - Prior (5-7 days) to the main competition of the year, the strength training program is ended, so that all energies are saved for the accomplishment of a good performance.

The Rehabilitation Phase completes the annual plan and coincides with the transition phase from the present to the next annual plan. While the objectives of the transition phase are through active rest, to remove the fatigue and replenish the exhausted energies, the goals of rehabilitation are more complex. For the injured athlete, this phase of relaxation also means to rehabilitate, and restore injured muscles, tendons, muscle attachments, and joints, and should be performed by specialised personnel. Whether parallel with the rehabilitation of injuries, or afterwards, before this phase ends all the athletes should follow a program to strengthen the stabilisers, the muscles which through a static contraction secures a limb against the pull of the contracting muscles. Neglecting the development of stabilisers, whether during the early development of an athlete or during his peak years of activity, means to have an injury prone individual, whose level of maximum strength and muscular endurance could be inhibited by weak stabilisers. Therefore, the time invested on strengthening these important muscles means a higher probability of having injury free athletes for the next season.

Periodisation of Endurance

During an annual plan of training, the development of endurance is achieved in several phases. Considering, as a reference, an annual plan with one main regatta (Olympic Games), endurance training is accomplished in three main phases: 1) aerobic endurance, 2) develop the foundation of specific endurance, and 3) specific endurance.

Each of the suggested phases has its own training objectives:

1. Aerobic endurance is developed throughout the transition and the long preparatory period (4-6 months). The main scope of the development of aerobic endurance is to build the endurance foundation for the regatta season and to increase to the highest level possible the rowers' working capacity (the cardio-respiratory system). The whole program has to be based on a high volume of training (20-28 hours per week).

2. The development of the foundation for specific endurance has an extremely important role in achieving the objectives set for endurance training. Throughout this phase, a representation of the transition from aerobic endurance to an endurance program has to mirror the ergogenesis of rowing (the aerobic-anaerobic ration expressed in percentage). Some elements of anaerobic training are introduced, although the dominant training methods are: uniform, alternative, long, and medium distance interval training (2-5 km).

3. Specific endurance coincides with the regatta season. The selection of appropriate methods should reflect the ergogenesis of rowing, its ratio being calculated per week (3-5% anaerobic alactic, 8-12% anaerobic lactic, and the balance aerobic endurance). The alteration of various types of intensities should facilitate a good recovery between training sessions, thus leading to a good peak for the final competition.

Variations of Periodisation

Figure 2 attempts to illustrate the periodisation of dominant abilities in rowing with the goal of peaking for the Olympic Regatta. This attempt is an adaptation of figure 1, but at this time it considers the time factor.

Figure 2: A Suggested Periodisation of Dominant Abilities for Rowing in 1992

<table>
<tr><td colspan="3">1991</td><td colspan="8">1992</td></tr>
<tr><td>Oct.</td><td>Nov.</td><td>Dec.</td><td>Jan.</td><td>Feb.</td><td>Mar.</td><td>Apr.</td><td>May</td><td>June</td><td>July</td><td>Aug.</td><td>Sept.</td></tr>
<tr><td colspan="7">Preparatory</td><td colspan="3">Competition</td><td colspan="2">Transition</td></tr>
<tr><td colspan="2">Anatomical Adaptation</td><td>Maximum Strength</td><td colspan="4">Conversion to Muscular Endurance</td><td>Main-tenance</td><td>Chps</td><td>Off</td><td>Rehab</td></tr>
<tr><td colspan="6">Aerobic Endurance</td><td>Found Specific Endurance</td><td colspan="3">Specific Endurance</td><td>Off</td><td>Aerobic Endur-ance</td></tr>
</table>

Assuming that the coach may decide that in order to take his athletes to higher levels of performance, additional strength is desirable. In such a case a variation of the standard periodisation (figure 2) is suggested by figure 3.

In order to achieve this goal, two phases of maximum strength of six weeks each are proposed (total 12 weeks), each of them being followed by phases of muscular endurance so necessary in rowing (a total of 14 weeks). Such an approach is more desirable for elite athletes with very high endurance capabilities, whose progress in the past two years did not materialise. It is expected that this novelty in periodisation will bring the additional ingredient for a higher step in athletic proficiency.

Figure 3: A Suggested Variation of Periodisation for Rowing

<table>
<tr><td colspan="3">1991</td><td colspan="9">1992</td></tr>
<tr><td>Oct.</td><td>Nov.</td><td>Dec.</td><td>Jan.</td><td>Feb.</td><td>Mar.</td><td>Apr.</td><td>May</td><td>June</td><td>July</td><td>Aug.</td><td>Sept.</td></tr>
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</table>

In many walks of life improvements were often the result of challenging the tradition. It is expected that variations of periodisation signify such a challenge.

Background and Experience with Long Term Build-Up Programmes for High Performance Rowers

Author: Theo Körner (GER)

Competition as Goal of the Training and Long-Term Build-Up

The entire training in high performance sport is aimed at competition where athletes can show their best possible performance. The preparation of the athlete determines the outcome of the competition. Winning is the ultimate goal for all athletes, coaches and officials. The rowing events at the 1988 Olympics showed that the level of performance has risen further. Between 1984 and 1988 the times achieved by competitors decreased by 0.7% while, at the same time, the density in quality of participating Olympic finalists further increased.

A similar increase in the performance of rowers is to be expected for the future. The race strategy is still offensive as shown by its structure (behaviour at start, middle, and finish). Out of the 14 winners of the 1988 Olympics, twelve had been placed first or second after 500m and nine out of the 14 winners had a leading position after 1000m, whereas four had been placed second, and only the eight were in third place. Three women's crews decided their races on the last 500m (finish). From the above it becomes clear that the winning crews judged their potential for performance correctly and managed their race tactics in different ways.

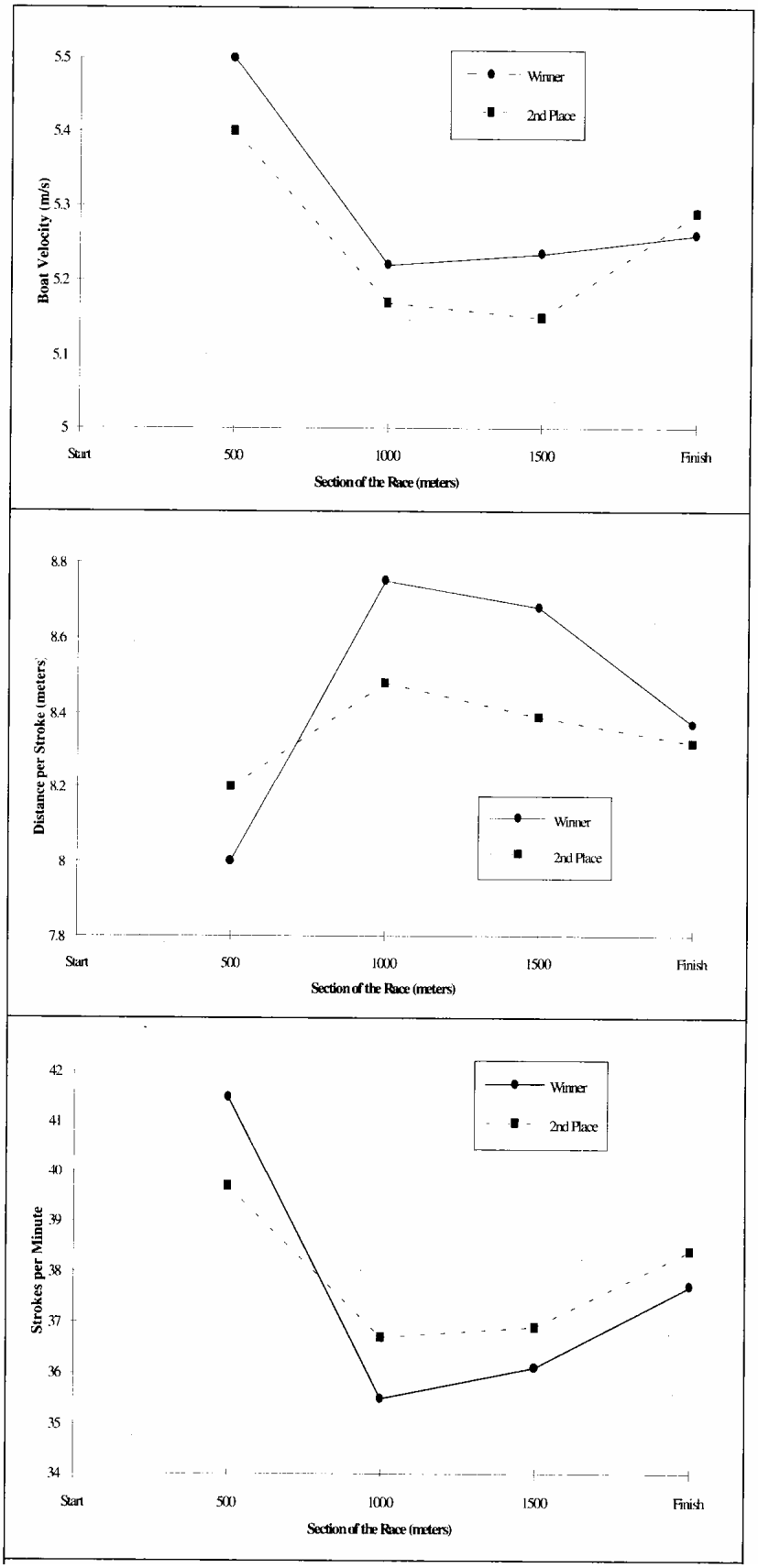
An analysis of the races of winning and second placed crews clearly shows that the former have a higher and more consistent speed over the entire distance of the course. The winning performance was not achieved through higher rating but primarily through a higher stroke efficiency, i.e., the distance covered per stroke. Winners showed both greater economy (i.e., the ratio of rating to stroke efficiency) and performance of their movements. Both are reflected in the consistency of their second, third, and fourth 500m stretches (Figure 1). The higher ability to perform allows them a more offensive tactic during the start phase.

Factors Determining Performance in Competition

The competition expresses the complex potential of each athlete to perform. The goal of training is to prepare for the race. We distinguish four main groups of performance determining factors for rowing competition:

- Personality
- General and specific fitness
- Co-ordinative abilities and technical skills in rowing
- Tactical abilities

Figure 1: Race profiles of male rowers at the 1988 Olympics. The graph shows boat velocity (m/sec; top), stroke efficiency (m/stroke; middle), and ratings (strokes/min.; bottom) for the four 500m stretches of winning and second place crews. Results represent the average of all boat categories.



Personality

During training as well as racing all actions are regulated consciously. The athlete has to have a clear understanding of what he is aiming for and has to be able to realise these ideas. The contents of his aims need to be well understood and his actions require consistency. The needs on the personality profile rises with the goals.

General and Special Fitness

Rowing belongs to the category of strength endurance sports as the 2000 meters take between 5:30 and about 8 minutes, and about 210 to 240 strokes at an average rating of 30 to 38 per minute. With its high demand on strength during the drive (about 500 Newtons (N) per stroke) and a workload of about 1100 to 1200 Nm/sec, rowing at the top level is a sport requiring well-developed sub-maximal physiological capacities. The special fitness abilities relevant to rowing include:

1. specific ability in strength endurance such as aerobic, alactic and lactic capacities
2. maximal strength during the drive
3. specific maximal strength of main muscle groups (arm flexors, hip and back extensors)
4. specific strength endurance abilities of the main muscle groups
5. specific strength of antagonists

The different stages in a race impose specific and differentiated demands on the fitness of athletes. Tasks, contents and proportions of the fitness training are given by the demands of a rowing race, whereby the extent to which one can train these abilities, their orderly relationship, as well as the relative importance of the various conditions for performance have to be considered.

Co-ordinative Abilities and Technical Skills in Rowing

If the rower wants to achieve exceptional results in competition he/she has to have consistent and well-established co-ordinative abilities. For practical reasons, these include skills that are determined by technique:

1. the acquisition of a highly efficient rowing technique to reach maximal acceleration per stroke under conditions of sub-maximal workload as is in a race,
2. the consistency in the repetition of the rowing movement in training and races with varying ratings or changes in external conditions such as wind, waves, and current,
3. a certain flexibility in rowing technique necessary to change boat category or tactic for different races,
4. using the individual structure of movements within a certain boat (category), i.e., the choice of seating of each rower within a boat to maximise the performance of the crew.

The results we are aiming for in a rowing event demand technical skills from a rower enabling him/her to use all trained abilities (fitness) for the most efficient acceleration of the boat.

Tactical Abilities

In the light of the steadily growing density of performance in rowing competitions, race tactics and the tactical behaviour of athletes becomes increasingly more important. Tactics in this context means goal-oriented and an efficient way of planning a race.

The Choice of Training Means and Methods Based on a Physiological Analysis of Rowing Races

A rower utilises three different energy-providing metabolic pathways during a race:

1. the anaerobic-alactic metabolism at the start which covers the first 10 strokes;
2. the anaerobic-alactic metabolism after the start covering the following strokes for up to 60 to 90 seconds, and
3. the aerobic metabolism pre-dominant from about the second minute to the end of the race. These different pathways of energy production are not separate metabolic events.

Rather, two or three different forms of energy supply are generally operating at the same time during a workout. The relative percentage of the different energy supplies involved depends on the type of competition and the training condition of the rower. To examine the performance of a rower we normally use the level of lactate as a parameter for anaerobic lactic capacity, and the oxygen intake (VO_2) as a parameter for the aerobic capacity. According to physiologists, the fast twitch fibres (FTF) are used only partially, i.e., at the start. In contrast, the contribution of slow twitch fibres (STF) as the biological and structural correlate to strength endurance dominates during the main part of the race - especially in the middle stage (85 to 90% of the entire racing time). Therefore, rowing performance is based mainly on STF and strength endurance. In general, the percentage of STF in rowers is 70 to 80%.

Glycogen and triglycerides (fat) stored in muscle cells represent the most important substrates for the energy supply during a rowing race. Although glycogen is the main energy substrate in muscle cells, it does not normally limit performance. Glycogen is utilised as an energy substrate especially during the first third of a race. This can be seen by the levels of accumulating blood lactate, the end product of anaerobic glycolytic metabolism. The increase in blood lactate concentration is greatest during the initial phase of up to 90 seconds.

Triglycerides - especially those in STF - decrease steadily during the first third and more rapidly during the middle stage of a race. They partially contribute to the overall energy supply as an energy substrate. Therefore, even when working at maximal capacity during a race and at a stage where medium term endurance is required, rowers are still able to make use of the well-adapted fat utilisation system as a source of energy. Hence, elevated cellular levels of glycogen and triglycerides within the muscles are an essential energy requirement for competition.

From physiological parameters such as oxygen consumption, heart rate, blood lactate, and respiratory indices, it is possible to draw qualitative conclusions regarding the relative contribution, relation and importance of the various energy-

supplying components during a rowing race. Oxygen consumption in men as an index of aerobic energy supply reaches its maximum of 5.5 to 6.5 litres/min (steady state) 1.5 to 2.0 minutes after the start. The tidal volume (volume of air breathed in) behaves in a similar way, while the heart rate plateaus at its maximal level (between 180 to 200 beats/min) 30 to 40 seconds after the start.

The rate of oxygen consumption clearly shows that the energy supply required is covered mainly by 1.) alactic and lactic metabolism during the first 1.5 to 2.0 minutes, and 2.) aerobic metabolism during the middle and final stages of the race. Therefore, the race speed during the middle stage is determined mainly by the athlete's aerobic capacity.

Oxygen consumption is a useful parameter representing the oxygen transport capacity of the respiratory and cardiovascular system. To use the oxygen transported for energy supply, the aerobic metabolism of glycogen and triglycerides within the muscle cells have to be increased through adaptation. As the muscles' capacity to use oxygen and the energy required for general movement differ from one person to another, rowers with identical maximal oxygen consumption can have different sporting performances.

The behaviour of lactate accumulation under racing conditions is of great importance for the planning of training. In general, physiological analyses reveal that during a race the degradation of glycogen with concomitant accumulation of lactate operate at maximal speed after an initial period of 5 to 10 seconds, and reaches a maximum within 40 to 60 seconds. While oxygen consumption subsequently increases, the production of lactate decreases sharply. It reaches its lowest rate in the last part of the middle stage before increasing again slightly during the last few strokes. The energy supply:

1. during the first 10 to 15 seconds of the race, i.e., the most demanding part of the entire race (acceleration phase at the start), is covered by alactic metabolism (Feldberg, 1963),
2. in the second phase of the start (phase of maximal speed and, to some extent, transition phase to the middle stage) is predominantly lactic, and
3. during the concluding stages of the race still includes lactic metabolism, however, to a lesser degree.

The absolute levels of blood lactate achieved during maximal work in a race are influenced significantly by the rowers' aerobic capacity. Blood lactate in rowers with poor aerobic capacity increases early and steeply, reaches its maximum during the race, and can not be elevated further at the finish of the race. Early and high concentrations of lactate in muscles diminish their aerobic production of ATP within mitochondria (power plants of the cell), regeneration of creatine phosphate, glycolytic efficiency, contractibility, and neuromuscular co-ordination. Because of these biological relationships, high concentrations of lactate limit strength endurance and co-ordinative abilities, which are the performance-determining, conditional abilities in rowing.

The time-dependent contributions of aerobic and anaerobic components to the overall energy supply are related closely to the course of performance and oxygen consumption. Thus, between the first 10 and 90 seconds of a race, i.e., when the physical output reached its highest level, the energy required is covered mainly anaerobically with a contribution of 78.9% at the 10 second point and 46.8% at the 90 second point. The corresponding oxygen consumptions at these two points are

42.8% and 88.7%, respectively. These percentages can be contrasted to the maximal oxygen consumption achieved at later stages. The high oxygen deficit produced in the first stage of a race needs to be compensated by an equivalent supply of anaerobic energy.

Oxygen consumption reaches a relative steady-state only after the second minute of a race. At this stage, the energy required for an almost constant physical output is covered 84% through aerobic means. However, it becomes clear that the overall energy requirements generally exceed the total aerobic capacity, and therefore are dependent on an additional, continuous lactacidic or alactacidic energy supply.

Although the rower tries to exploit anaerobic capacity to its full extent during the final stages of a race, the remaining output derived from it is relatively small, especially if the demand for anaerobic energy was high during the start phase.

For an event of 7 minute duration (corresponding to a 2000 meter race), the total energy requirements average 70% aerobic and 30% anaerobic. The aerobic portion is comprised of 10% lactic and 20% alactic energy supply. The aerobic and alactacidic energy supply together contribute about 90% of all performance-determining, physiological components. Considering quantitative aspects, these two components must be the main determining factors for competition.

To logically deduct adequate training methods in an aim-oriented manner, a knowledge of the temporal changes of contributing energy components to the overall energy supply of a competitive workout is needed. In addition, their relative contribution must also be considered to develop all biological systems involved.

Selection and Application of Training Means and Methods

The physiological processes relevant to a rowing race are applied to the different forms of training depending on the selection of particular training methods:

- Workouts over short distances with maximal speed, such as start training or speed training of maximum 10 to 12 strokes, are alactic. The alactic capacity is important for racing. This part of the training process is highly responsive based on a small potential that is limited by the size of energy depots and the primary involvement of FTF. Therefore this kind of training should be applied for short periods only and to a carefully dosed extent. The development of this capacity in relation to the entire competition is limited though effective in combination with the aerobic potential.

- The training of the anaerobic lactic component is also directed mainly towards competition. Although the size of the lactic ability is also limited, it can be trained to a much higher degree than the alactic capacity. Lactic and aerobic capacities should be trained proportionally. As mentioned earlier, an exaggerated lactic training of the racing stages between 250 and 1000 m does influence the aerobic capacity. On the other hand, a high aerobic capacity will not be utilised to its full extent during a race if it is not supplemented by anaerobic capacity.

- In the light of the entire training process, the aerobic capacity is most important and determining component to be trained.

It is possible to develop aerobic capacity using different methods as can be seen from several successful crews. Although the literature suggests various stimulus thresholds for training, it is generally recommended to work around the aerobic threshold of 2 mM.

In the context of this conference, I was asked about methods of endurance training in the long-term build-up in the GDR. For more than 20 years we practised aerobic training in the boat in the form of extensive long distance training of relatively high volume, and at the aerobic threshold (2 mM lactate). The average volume of a training session is about 20 to 25 km long distance training (90 to 120 min) with one break to turn around. The average boat speed is selected so that the athlete can keep it constant over the entire training distance. The rating is mostly between 18 and 20 strokes per min, the heart rate is 140 to 160 per minute, and blood lactate about 2 mM (Table 1).

Table 1: Outline of the Long Distance Training Methods

Boat Category	Km	Rating	Heart Rate	Lactate
1x	20-25	18	140-148	up to 2mM
2-, 2+, 4-, 4+	20-25	18-20	148-156	up to 2mM
8+, 4x	20-25	18-20	152-160	up to 2mM

The minor differences between different boats result from the specific character of each boat category, their difference in speed, and the resulting feature of impulse during each stroke. The heart rate is taken several times during a training session. Lactate levels are checked every 1 to 2 weeks. The coach checks the speed of the boat by taking times at defined checkpoints.

Long distance training at a steady workload requires a relatively high volume of work. If sufficient time (4 to 5 hours) for the recovery is allowed, it is possible to conduct two training sessions of this type per day. Towards the end of the training session the average boat speed decreases slightly because the rowers get tired. The heart rate, however, remains constant at the required level. On the other hand, if the boat speed is kept constant the heart rate and lactate will rise. We have kept the heart rate constant to allow a second training session a day.

As the energy basis of this type of general endurance training is primarily fat, energy stores are not depleted and are replenished before the next training session. The results of such training at the aerobic threshold (blood lactate of 2 mM) are:

- highly economical performance of movements,
- a well developed oxygen transport system (VO_2, capacity of blood to bind oxygen, efficient network of capillaries down to the level of the muscle cell),
- a well developed mitochondrial utilisation of oxygen, and
- fat deposits within muscle fibre bundles (as observed by muscle biopsy).

It is important that the threshold of the stimulus is always reached in order to prevent the long distance training from becoming marathon training.

Training stimuli can also be directed with a change of the boat category or the structural features of the stroke (i.e., the way of giving the impulse). To try and elevate the intensity of long distance training to the anaerobic threshold (4 mM lactate) results in complex consequences. During long term long distance training at a constant rating of 20 to 22, the boat speed increases mainly as the result of a change in the structure of the stroke (higher input of strength, change in the strength/time-curve, changed usage of the various muscle fibres, higher speed during the drive). As a result, the training volume decreases and recovery times increase.

In the GDR, long distance rowing as a method to train the aerobic capacity, starts with 10 to 15 km per training session for young talent in children's rowing groups. Once the talents are 14 to 15 years old, the volume of each training session is increased to 20 km and further until the senior age where the training volume is maintained.

The training stimulus originates mainly from the increasing boat speed as the result of a steadily increasing stroke efficiency. Impressive results can be achieved in competitions out of this effective long distance training and without special lactic or alactic workouts. For these reasons the alactic and lactic training generally does not start until shortly before the racing season (April). The long distance training is continued throughout the racing season. Long distance training comprises about 90% of the entire work on the water, while about 4% is intensive work (including races).

Dependent on the characteristics of the impulse applied during the rowing training (strength endurance training), different morphological and metabolic adaptations can occur. These adaptations take place independently of the distribution of the various muscle fibre types and the intended methodological aim.

In practical terms it is important whether to emphasise the first or the middle part of the drive or whether the athlete trains in the 1x or 8+. The knowledge of the above will help the coach to avoid unwanted training results.

I should not forget to mention general fitness training. All aerobic training sessions like jogging, cross-country skiing, swimming, or others, are organised methodologically and based on the same principal of long distance rowing (2 mM lactate).

The general strength endurance training takes up a special part in the training process as a whole. The exercises are characterised to train local strength endurance abilities (leg, arm, back, and abdominal muscles). During the preparation period we normally have 2 to 3 sessions a week. The intensity is directed by the number of repetitions of each exercise, the sum of repetitions of all exercises, and the speed of movements. In general, there are 10 to 12 exercises each with about 300 to 400 repetitions of a maximal frequency of 30 reps/min. Blood lactate and heart rate may increase slightly (up to 4 mM after completion of the exercises).

The above describes how the intensity of training sessions for special and general fitness influence the entire training process. It is necessary to organise and guide these complex effects in a proper way.

Long-Term Build-Up

Training of Talented Children

The first stage of the long-term build-up begins with the training of 10 to 14 year old children. Their training depends on their situation at school, and emphasises:

- the early and continuous guarantee for a squad of suitably talented children through development of a bond to rowing,
- the development of rowing skills and abilities and their application in competitions, and
- the increased development of the basic, general foundations of sport as prerequisites for the later development of rowing performance (co-ordination, fitness, and motor skills and abilities).

The annual ratio of general to rowing training should be 60 : 40% (Table 2).

Table 2: Training Guidelines for Children (45 weeks of training)

Age Group (years)	10	11	12	13	14
Sessionsς per week	3	3	3-4	3-4	4
Hours per week	3-4	4-5	4, 5-6	4, 5-6	5-8
General training (hrs/yr)	90	110	120	120	150
Rowing (hrs/year)	60	70	80	80	100
Rowing (km/year)	-	-	500	600	800

ς A training session as the basic training unit represents an entity regarding its content, time and its organisation. General fitness training comprises games, gymnastics, strength exercises, running, and jogging. Exercises are conducted in a way that aims for a general training preparation for rowing. Rowing includes: A) The development of sculling technique in the single, double, and quadruple scull up to a level that allows competition. B) Rowing training that primarily develops special fitness and racing abilities according to planned race tactics. The basic training method during the preparation stage is the endurance method at the stimulating level.

Training of Talented Youths (14 to 16 years old)

Centres for high performance (KJS) enable the co-ordination of sport and school. In these centres there are two groups of athletes aged 14 to 15; 1.) those who have been members of the children's rowing programme and thus are educated already in rowing, and 2.) newly recruited athletes who show good general athletic condition but have not yet rowed. They have to catch up quickly with those in the first group with regards to their rowing skills and abilities. Athletes of both groups are normally at about the same level when they are 15 to 16 years old.

In general, athletes at this stage have to be educated further in their competitive sculling technique. Competitions are conducted in all sculling categories. More emphasis is put on the 1x and 4x. The technique for sweep oar rowing at a competitive level is not taught until athletes are 15 to 16 years old. At regattas for 16 year old rowers there are only two events in sweep oar categories. Special fitness training for rowing is achieved mainly by the long distance method, with a proportion of aerobic to anaerobic training of 95: 5%. Strength training is done in

the form of a strength endurance circuit training. The technique for lifting maximal weights is taught with power exercises (50 to 60% of maximal strength). The general fitness training aims for the development of general technical sport skills, conditional and co-ordinative abilities. It includes games, jogging, callisthenics, cross-country skiing, etc.

Training of Talented Juniors (17 to 18 years)

The aim at this stage is the successful participation at national and international junior championships in the boat categories of FISA. Athletes specialise in either sculling or sweep rowing when they are 17 years old.

The coaching is directed towards perfecting rowing technique. In addition to their special boat category, all rowers master the 1x and 2- at the competitive level. This enables individual training and testing of rowing skills and abilities.

To develop conditional abilities, the volume of specific training increases, using long distance training as the main method. Competitions start in April. The ratio of aerobic to anaerobic training is 95 : 5%, and strength endurance takes up most of the strength training. Maximal strength training is introduced for the first time as a block of 4 to 6 weeks training during winter. General fitness, conditional and co-ordinative training is conducted all year round, especially in winter. Training means are determined as in all other age groups.

Table 3: Training Guidelines for Juniors (45 weeks of training)

Age Group (years)	**15**	**16**	**17**	**18**
Sessions per week	8-10	8-10	10-12	10-12
Hours per week	12-15	12-15	15-18	15-20
General training (hrs/yr)	300	325	400	400
Rowing (hrs/year)	300	325	410	450
Rowing (km/year)	2,900	3,200	4,000-4,500	4,500-5,000

Table 4: Guidelines for the Training of 19-21 year old Senior B and Senior A Rowers (48 weeks of training)

Age Group (years)	**19**	**21**
Sessions per week	10-12	10-12
Hours per week	18	20
General training (hrs/yr)	400	450
Rowing (hrs/year)	500	550
Rowing (km/year)	6,000 (12 km/hr)	7,000-8,000 (13-14 km/hr)

Training of Adults with a Long-term Build-up of Performance

The rates at which training demands increase are determined through permanently controlled adaptation of the stimulating levels of training volume and intensity. The GDR training system is extensive in principle. This demands a relatively extensive, medium-sized stimulus. The aerobic capacity is established slowly but with stability, and at a high level.

Long-term Build-up Training for 18-year old Novices

The following represents the main goals, methods and means of a 4 year build-up programme for 18 year old novices, based on our experiences in the GDR. Training objectives for the different years are as follows:

1st year Build-up of the technical and conditional basis for rowing at the competitive level.
2nd year Reaching top national Senior B level, and approaching the top class at the national Senior A level.
3rd year Stabilisation of performance at the national top level, and approaching international level.
4th year Achieving and stabilisation of performance at the international level.

Chart A is an example of a build-up programme based on my personal experiences as a coach, and that of other coaches.

Periodisation of the Annual Training Programme

The process of training and development of performance has to be planned systematically and in the long-term. Such a training plan needs to consider natural laws of growth and maturation of athletes, the phases in development of the athlete's ability to perform, as well as the peak of the athlete's performance.

The principles of periodisation make use of an aim-oriented development of the sporting abilities towards a peak performance using the most suitable and appropriate developmental stages of the training year. Periodisation considers the following:

- the developmental stage of a squad of a particular age group with regards to morphology and function,
- the present level of rowing skills and abilities, as well as training means and methods required for further development,
- the changing time periods in training effects on performance,
- the right combination and succession of training means and methods, and
- the external conditions according to the time of the year (winter, summer, ice and daylight).

Periodisation of an annual training programme is shown in Chart B.

Both training objectives and the amount of time necessary for their achievement (see Chart B showing an annual training programme), require that the preparation period is further subdivided into smaller sections, often referred to as macro cycles (Harre, D., Matvejev). These sections span over several weeks (meso cycles) and

contain several complete micro cycles, i.e., training plans on a weekly, daily, or training session basis.

If there are two training sessions per day their order of succession is also important for the overall workload. Aerobic training sessions can succeed each other without any problems. An aerobic workload following an intensive workload (strength endurance, lactic training session) does even provide an advantage in assisting the removal of lactate. In contrast, it is not advisable to plan several successive workouts with intensive workloads (strength endurance, lactic rowing session), as both the removal of lactate and the restoration of energy stores are not yet completed.

In the light of an entire training programme and its periodisation, the aerobic training is obviously the central part of long-term and annual training processes.

Our own experiences, as well as those of Matvejev, Roth, and Harre, point out that the endurance capacity requires extraordinarily long-term morphological and functional changes and adaptations of the athlete. The volume and intensity of these long-term processes need to be planned, secured and developed carefully, using the appropriate dosage and stimulation throughout the entire training programme.

Glossary

Aerobic: occurring in the presence or with the aid of molecular oxygen, e.g., metabolism.
Alactic (=alactacidic): without accumulation of lactic acid, e.g., during or after exercise.
Anaerobic: occurring in the absence of molecular oxygen, e.g., metabolism.
Antagonist: (in the context of this manuscript) a muscle whose action is in the direct opposite of that of another muscle.
Condition: (in the context of this article) fitness.
Creatine phosphate: most readily available, biological form of energy.
Extensor: general term for any muscle that extends a joint.
Flexor: general term for any muscle that flexes a joint.
Glycogen: polysaccharide, the chief carbohydrate storage material in humans.
Glycolytic: pertaining to, characterised by, or promoting glycolysis.
Glycolysis: the anaerobic conversion of glucose to the simpler compounds lactate and pyruvate, resulting in energy stored in the form of ATP.
Lactate: anionic form of lactic acid.
Lactic acid: end product of glycolysis.

Abbreviations

ATP:	Adenosine triphosphate, biological form of energy
F:	strength
Fmax:	maximal strength
FTF:	fast twitch fibres
HR:	heart rate
KH:	carbohydrates
L or La:	lactate
m:	metre(s)

min:	minute(s)
mM:	millimolar, chemical unit for concentration
N:	Newton, physical unit of strength
RQ:	respiratory quotient
s:	time
sec:	seconds
STF:	slow twitch fibres
v:	velocity
VO_2:	oxygen uptake
VT:	tidal volume (volume of air breathed in or out)
W:	Watt, physical unit of workload

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Translated to English by I. and R. Stocker

Chart A: Four Year Programme for an 18 year old Novice to Top International Rower

First Training Session: Creating the bases for Rowing Technique and Fitness at the Competitive Level			
Training Objective	**Central Issues of Training**	**Training Means and Methods**	**Time Ratio (%)**
- Development of technical rowing skills in lx and 8+ up, to the competitive level - Continuous build-up of aerobic capacity - Training of alactic and lactic capacities with the beginning of the season	- Technical training in lx and 8+ until mastering these boats - Conducting more and more long distance training as rowing skills improve - After mastering the stroke rate at long distance training, start with alactic stroke training to improve fitness (starts, fast strokes)	- Application of training methods for beginners. Combining individual and crew training (lx and 8+) upon mastering the basics in rowing technique -Training distances increase up to 20 km with a stroke rate of 16 to 20 as rowing skills increase followed by: - Start exercises, speed changes (ratings)	70 2
- Development of partial general strength endurance	- Beginning of build-up of general strength endurance training - General aerobic and co-ordinative training	- Strength training in group and during circuits - Jogging, games and callisthenics	18 10
Second Training Season: Achieving Top National Class Senior B and Approaching Top National Senior A Level			
Training Objective	**Central Issues of Training**	**Training Means and Methods**	**Time Ratio (%)**
- Complex general training - Further stabilisation of rowing technique and crew adaptation - Further build-up of aerobic capacity	- Specialising in sweep oar rowing or sculling in different boat categories - Long distance training of 20 to 25 km depending on boat category, variability	- Specialisation in rowing technique according to talent, ability, prospective and individual performance in lx and 2- - Long distance training, HR of 144 to 160, lactate of 2 mM, rating l8-20, keeping boat speed as constant as possible attention to stroke efficiency	60
- Build-up of lactic and alactic capacities	- Third stage of preparation: Start training, speed of movements - Training of lactic mobilisation: 500 m, 1000 m	- Start exercises and ten stroke pieces during long-distance training - Work on feeling for boat speed; 500, 1000 and 2000 m	3
- Development of general strength and strength endurance	- Development of maximal strength - General aerobic particle strength endurance of agonists and antagonists - General endurance training, training of co-ordination, stretching and exercises for warm-up	- Second stage of preparation (winter): Weight training at 80 to 100% of Fmax - Strength endurance programme, 10 to 12 aerobic exercises at 4 mM lactate, circuit with 1500 repetitions	3 15
- Improving general athletic training as bases for specific performances		- Jogging, cross-country skiing, games, swimming, callisthenics	19

Third Training Season: Stabilisation of Performance at the National Top Level, and Approaching International Level			
Training Objective	**Central Issues of Training**	**Training Means and Methods**	**Time Ratio (%)**
- Specialisation in main boat category, fine-tuning of rowing technique - Stabilisation of individual and crew rowing performance - Increasing aerobic capacity of movements in the boat - Extending lactic and alactic mobilisation - Increasing strength and strength endurance - Increasing general fitness as basis for specific performance	- Optimising seating of crew members emphasising specifics of each seat and the specific performance in movement - Continuation of proof of individual and crew performance - Long distance training with increasing stroke efficiency (stimulus threshold) at a constant stroke pattern - Start, speed, l0 x 10 strokes with rating of 40, distance pieces of 500 and 1000 m - Developing F max - Further development of strength endurance - Strengthening of general ability to perform break in rowing training - Arthromuscular balance	- Subjective and objective criteria of harmony, behaviour of boat and ability to perform - Training in lx, 2- and 8+, training in groups, sparring - Long distance 20-25 km, heart rate, 2 mM lactate, rating of 20, time controls - Distance pieces, aerobically with 4 mM - Incorporation of start- and speed pieces in endurance training, removing lactate - 4 to 5 weeks of cycle' of maximal strength training - Strength endurance programme with 1,500 reps - Jogging, games, callisthenics	60 3 3 15 19
Fourth Training Season: Achieving and Stabilising Performance at the International Level			
Training Objective	**Central Issues of Training**	**Training Means and Methods**	**Time Ratio (%)**
- Maximal increase in performance in selected boat category - Highest possible performance of aerobic and competitive capacity - Increasing alactic and lactic capacity - Optimising the development of general strength and strength endurance - General fitness training for high performance in specific sport	- Training primarily in selected boat category, some training in small boats to develop individual potential further - Optimal development of aerobic and anaerobic performance over the year - Alactic performance - Producing a good ratio of maximal strength to strength endurance - Further development of strength endurance - Aerobic development with general equipment - Stretching and relaxation, co-ordinative exercises	- Improving harmony in selected boat category at increasing boat speed in the transition between aerobic and anaerobic stage (no marathon rowing) - Long distance training, 20 to 25 km, rating 20, HF 37 - 40/15 sec, Lactate 2 to sometimes 4 mM - Training with lactic mobilisation distance pieces over 500 and 1,000 m - Starts, series of short pieces, 10 x 10 strokes, etc. - Fmax is not over-emphasised, 70-100% - Stabilising aerobic character of strength endurance at the 4 mM La level, circuit training - Jogging, games, callisthenics, skiing, swimming	60 3 3 15 19

Chart B: Example of an Annual Training Programme for Senior A (European Conditions)

Period	Training Objectives and Tasks	Central Issues of Training	Training Means and Methods	Weekly Sessions	Training Hours
1st Preparation Phase					
September	- Build-up of aerobic capacity - Improving rowing technique - Developing general strength endurance	- Endurance training, rating 20, HR 140-152 - Structure of stroke, turning points - Local muscle endurance	- Long distance 20-25km, lx, 8+ - Correcting movements, video -Strength endurance programme 1, 1500 reps, circuit	6-8 2	10-14 3
November	- Diverse athletic training	- Aerobic development, stretching, relaxing	- Jogging, games, callisthenics	3	2-3
2nd Preparation Phase					
December	- Stabilising aerobic capacity - Stabilising rowing technique - Development of strength and strength endurance	- Endurance training, rating 20, HR 140-160 - Correcting individual technique - Local Fmax - Strength endurance	- Long distance, rowing tank 20-25 km - Fmax 80-100%, about 200 reps - Strength endurance programme 2, circuit training	5 3	10 6
February	- Diverse athletic training	- Aerobic, co-ordination, stretching, relaxing	- Jogging, cross-country, skiing, games, callisthenics	4	4
3rd Preparation Phase					
March	- Development of aerobic capacity - Stabilisation of rowing technique - Developing strength endurance	- Endurance training rating 20, HR 148-168 - Technique in specific boat category - Stroke efficiency, stroke structure - Local strength endurance	- Long distance rowing 20-25 6-8 12-14 km, lx, 2-, 8+, Lactate 2 + 10 km with Lactate 4 - Individual and crew technique - Strength endurance programme 3, circuit training	6-8 3-2	12-14 6-4
April	- Additional training	- Aerobic, co-ordination, stretching, relaxing	- Jogging, games, callisthenics	3	3-2
Competition Phase					
May	- Developing and stabilising aerobic capacity - Developing alactic and lactic capacities - Polishing technique at high rating - Maintaining strength endurance	- Endurance training rating 20, HR 152 - Alactic series (starts) - Distance piece training - Fast turning points - Stable stroke and movement structure at elevated ratings - Local strength endurance	- Long distance 20-25 km, lx, 2- and 8+ - 10 x 10 strokes at 38-40, selected boat 3 x 500 racing pace, or similar - Changes in rating, fartlek*, feeling for increasing pressure with increasing rating - Strength endurance programme 4	5 1 1 1	8-10 1 1 1.5
August	- Additional training to relax rowing training	- Aerobic, co-ordination, stretching	- Jogging, games, callisthenics	Championships	

**Fartlek* is steady training with variations of rhythm as desired by the athlete(s).

Identification and Guidance Scheme of the Rowing Association of the German Democratic Republic

Author: Theo Körner

1. Rowing Talent in the German Democratic Republic

What do we, in East Germany, regard as a talent in rowing? In the dictionary "Sport A to Z" talent in sport is described as "the level of ability to achieve high performance in sports." For rowing in the German Democratic Republic (GDR) and probably most other countries, the standard of high achievement in sport is winning a gold medal at the Olympic Games (OG) or World Championships.

Based on this formula, GDR rowers have won 73 gold, as well as 66 silver and bronze medals in the men's events between 1966 and 1988, taking into consideration that they did not participate at the 1984 OG and the 1965 European Championships. Within this period of time only 15 boats missed out on the finals. In 1988, GDR, for the first time, was not represented by an eight in the men's event. Similar records have been achieved by GDR women at the OG and by juniors at FISA (Fédération Internationale des Sociétés d'Aviron) Junior Championships.

What are the characteristics of successful GDR rowers? The following are examples of individual rowing careers of talented athletes:

Thomas Lange, SCC Halle: born in 1964, 190cm tall, 93kg body weight, medical student. Started rowing in 1973 (at the age of 9). National children's champion in the single scull and quadruple scull in 1975 (age of 11); FISA junior champion in the double scull in 1980 (age of 16), and single scull in 1981 and 1982; World champion in the double scull in 1983 (age of 19) and 1985; winner at the International Rotsee Regatta in 1984 (GDR did not participate at the Los Angeles OG) and 1986 (subsequent hand surgery); World and Olympic champion in the single scull in 1987 and 1988, respectively. This is a classical career of a rowing talent.

Siegfried Brietzke and Wolfgang Mager, SC DHfK Leipzig: both born in 1952, 191 and 190cm tall, respectively. Started rowing in 1967 (age of 15). FISA Junior champions in the coxless four in 1969 and the coxed pair in 1970; Olympic champions in the coxless pair in 1972 (age of 20), and the coxless four in 1976 and 1980 (without Mager who had surgery on his finger). Brietzke was a three time Olympic champion and four time World champion (75, 77, 78, and 79).

Olaf Förster, SCE Dresden: born in 1962, 196cm tall. Started rowing in 1982 (age of 20), previously a swimmer. Member of the 1984 national team (no participation at the OG); third in the coxless four in 1985 and coxed pair in 1986; stroke of the World and Olympic champion coxless four in 1987 and 1988, respectively.

Karsten Schmeling, SG Dynamo Potsdam: stroke of the 1988 Olympic champion coxed four. Born 1962, 200cm tall. Started rowing at the age of 13. Third in the coxless four at the FISA junior championships in 1979 (age of 17), FISA junior champion in the coxless pair in 1980; second in the coxed pair and eight at the World Championships in 1981 and second again in 1982 and 1985 in the eight; third in the coxed four at the World Championships in 1985; World and Olympic champion in the coxed four from 1986 to 1988.

The above serve as some examples of GDR rowing talent or, more precisely, the development stages of successful rowers in Olympic categories. As can be seen, the GDR has educated Olympic champions in many different ways (Table 1).

Table 1: Recruiting (as a % of Total) of National Team Members from Different Educational Rowing Programs over the Last Few Years.

	Starting as a School Rower		Starting as a Youth Rower	
Year	**Male**	**Female**	**Male**	**Female**
1980	26	28	74	72
1985	59	57	41	43
1986	48	33	52	67
1987	52	33	48	67
1988	63	48	37	52

Youth rowers normally start their rowing training at the age of 14-15 years.

2. Talent Requirements to Achieve High Performance

To be able to recognise talent for high performance rowing, it is important first to define the goals for talented athletes to be identified. The Rowing Association of the German Democratic Republic (DRSV) clearly decided to concentrate on Olympic rowing events for men and women. As a consequence, the GDR selects and prepares athletes for the "heavy" boat categories and does not identify talent for lightweight rowing.

A statistical analysis of former world and Olympic champions gives valuable and clear information (Table 2). This available information clearly defines some anthropomorphic requirements of successful rowers. Additional requirements to height and weight include:

- The capacity to perform long arcs of motion (determined by the athlete's height and length of arms and legs). The rowing arc for sweep oar and sculling is 85 to 90 degrees and 105 to 110 degrees, respectively.
- An extraordinarily high strength endurance needed for the drive (400-500 Nm/FIHD).
- An extraordinary endurance capacity of the cardiovascular system, e.g., VO_2 max of 6.0 to 7.0 litres.

This suggests that a world class rower must have a body height above average and well proportioned body weight. Based on these physical parameters, the athlete must be able to perform correspondingly.

*Table 2: Average Height and Weight of Former GDR Olympic and World Champions**

Gender		Year	Average Height	Average Weight
Men	Olympic Games	1980	1.92 m	90 to 100 kg
		1988	l.95 m (1.90 - 2.0 m)	
Women	Olympic Games	1980	l.79 m (1.72 - 1.88 m)	75 - 85 kg
		1988	1.82 m	71 - 85 kg (average 78 kg)

*The average age of winners from the GDR has been 24.8 years for men (1970 to 1984), and 22.2 years for women (1972 to 1984). The average number of years of training for the two groups has been: 9.5 and 12 years for men for sweep oar and sculling, respectively (increasing slowly to 10 years in the case of male sweep oar); and 8.0 years (increasing to 9 to 10 years) for women.

The athlete's performance must be proportional to his/her physical condition. Of course, it is pertinent that athletes are able to bring into action the above mentioned requirements for high performance. For this reason the GDR does not neglect to further the athlete's personality, including his/her intellectual abilities, way of sporting living, and level of motivation. The sum of all these characteristics will finally show up in talent and will be responsible for good performances in the boat in situations where it really counts.

Often smaller and lighter rowers adapt more quickly to a certain rowing technique and engage themselves in more training and competition. However, in the end, motivated heavyweights of the open categories will be superior to lightweights due to the physical limitations of the latter.

Any athlete in the GDR can become a rower. However, in the light of the above mentioned aims and requirements directed towards Olympic boat categories, not all of them will be chosen as talent for rowing. This is consistent and logical for our talent identification scheme.

3. Organisation of the Talent Identification Scheme and the Guidance of Talent

In general, sport in the GDR is supported greatly by the government, and, for this reason, it is possible to place sports at a high level within the organisational structures of the society. Rowing too can profit immensely from the resulting high social status of sport. Although this kind of support seems objective, it is important that the possibilities such a system offers are used in a proper sense. For example, while these excellent and objective conditions effect some sports in a positive way (e.g., rowing, swimming, track and field, cycling, canoeing, and sailing), they fail to do so in other sports (e.g., soccer, wrestling, volleyball, skiing, and others). It is obvious that the latter sport disciplines have failed to develop an effective mechanism of action to develop talent.

Rowing in the GDR uses all the advantages the country offers in the search for talent, its identification and development. Big sporting events, such as the *Spartakiade* (national games) for children and youths, and the gymnastic and sport festivals form the classical and social backgrounds for mass sporting activities. For example, villages, cities, councils of smaller and larger regions, as well as the GDR as a country, organise annual championships and *Spartakiade* for children and youths every second year. This support of sport together with schools (ministry for education, sport councils of smaller regions) organise huge sporting competitions

for all sports at a smaller (every year) and larger regional and state levels (every second year for children aged 10 and above). Schools and regional governments have to provide support and help in the organisation of these events. The results achieved at these sporting events are regarded as social happenings and judged on a regional basis (point scoring system, awards, etc.).

Rowing events also take place within this structural framework, and the DRSV uses them to scout and recruit children for our sport. Through additional promotions, leaflets, exhibition windows, personal approaches, and talking to parents, the DRSV aims to have constantly about 1,500 to 2,000 ten to 14 year old children in rowing centres. This goal is achieved largely due to hard work in scouting.

What are the characteristics of young talent? The GDR tries to recruit and care especially for those children promising to reach the ideal size needed for rowing. As only 3% of the population in the GDR are going to be 1.90 m or taller, a major problem exists to recruit these children into rowing, especially as other sports (e.g., European handball, swimming, volleyball, track and field, canoeing, etc.) also require tall children. Youths are first selected according to given height norms (Table 3).

Table 3: Height Norms (in cm) for Children.

Gender	**Age (years)**				
	10	**11**	**12**	**13**	**14**
Early developed					
Male	152	160	166	174	183
Female	156	165	171	174	176
Normally developed					
Male	149	155	161	169	175
Female	150	156	165	170	174

To ensure we reach tall children, we use various different approaches, especially:

- Advertising and scouting in schools;
- Relocating children from other sport disciplines where they haven't succeeded;
- Reviewing schools at a later time to recruit slow developers;
- Scouting on the streets (for those who have not yet been recruited);
- Scouting children who live in an area without established rowing facilities.

Recruited children are brought to boys' and girls' sections of rowing clubs where they are coached. It is the aim to guide children in a way that ensures a long lasting bond between them and rowing. Coaches or clubs try to involve parents of young rowers in the process of coaching by informing them about the progress their children make. That way they can get them more interested in supporting their children's ambitions.

There is a rather high general burden on selected children. They have to do their classes and homework, they have to get good results at school, and they also have to travel to each training session. All this has to be in agreement with their own and their parents' interests. As the results at school decide university entrance or an apprenticeship for a chosen profession, the training is quite often stopped if a child starts to perform poorly at school. For these reasons, the GDR tries very hard not to lose any talented school aged children. The aim is to send about 120 to 140

talented children (80 boys and 60 girls) to special sport schools for children and youths (KJSs) once they have finished grade 7. Between grades 8 (13-14 year olds) and the final year of high school (grade 12), or until finishing an apprenticeship, the government starts supporting children and youths to a greater extent. At this stage talented young athletes are gathered for the first time in sport schools (i.e., KJS). All KJSs are affiliated with high performance centres of various sport federations (sport clubs). KJSs have as many classes as there are disciplines in a particular sport (rowing: eight), and the syllabus is identical to that of other government schools. Talented athletes are coached by club coaches. As the capacity of KJS classes is normally filled to only about 60 to 70% by primarily selected talent (e.g., Thomas. Lange), there is a second round of scouting. Those children in grades 7 and 8 (12-14 year olds) who have not yet been recruited are screened again. Although children from this second draft still need to learn how to row, they are kept together with the primarily drafted children in grade 9 (second grade in the KJS).

The novices most often come with a basic preparation obtained in other sport disciplines so that by the end of grade 9, or by the time they are 16 years old (grade 10), they have reached the same level of performance as children from the first draft. The statistics of national teams clearly show that it is possible to obtain similar results by going either way. However, to continuously provide the numbers of talented young athletes required at the senior level, both ways are necessary.

The large number of junior World champions coming from the GDR shows that this is the right track in developing talent. After the junior age, about 40 to 50 male and about 30 female rowers change every year from the KJSs to the senior level. As the KJSs are affiliated with the sport clubs, these rowers have been training in sport centres (clubs) for several years and hence guarantee a consistent supply at the senior level.

Although the GDR tries very hard in advertising and educating, it is still very difficult to provide the numbers of young rowing talent required for all of the Olympic boat categories. The decline in birth rate from 300,000 (15 years ago) to 170,000 today does have its influence on the various squads. Since more rowers are not available for the squads, it is important to choose talent even more carefully.

4. Methods for Guiding Talents

As mentioned earlier, the selection and guidance of talent to the top is based on a unified general concept of the DRSV, Sports Association of the GDR, and the government institutions (e.g., schools and technical education). This work is based on a general programme applicable to all talent of the different high performance sports. This is one of the advantages in the GDR. Specially prepared and educated coaches are responsible for the guidance of talent. Schools and parents are actively involved in this process. Medical care and selection is guaranteed by a well-organised medical programme, while regular schooling and professional education is guaranteed by special schools based at sports institutes.

Ten to 14 year old talented students usually remain in their normal classes. Those who encounter difficulties at either school or general education still remain in their classes but will be relieved totally or temporarily of their commitments as sport talent.

Talented students in KJSs (i.e., members of centres for high performance) are eliminated from sport programmes if they fail to reach set goals, have medical setbacks or encounter personal problems. They either finish their schooling at the KJS or return to the school they originally came from (there is the same syllabus up to grade 10 for all schools in the GDR). Apprentices, high school and university students finish their education independently of their performance in sport. These obligations concerning both sides guarantee each athlete that he/she does not encounter any disadvantages in his/her schooling or profession after terminating his/her sporting career. Responsible people at the coaching centres take care of this process at the children's level, whereas at the KJSs it is the responsibility of the centres for high performance. There is legal support for this process.

5. Training of Talent

5.1 The Training of Talented Children

In the GDR and in the DRSV there is long-standing experience in the training process of talent. The training and control programme is based on scientific analyses of previous training processes. The main essence of the programme is a precise knowledge of the progress made during training. The aim of the first level of training with 10 to 14 year old children is to develop the following foundations:

- Securing a continuous squad of suitable talent;
- Developing a closeness and bond with rowing;
- Establishing rowing skills and abilities;
- Emphasising further development of general sport abilities as a prerequisite for a career as a high performance athlete (co-ordinated fitness, and motor abilities and skills).

Table 4: Training Guidelines for Children (45 weeks of training)

Age group (in years)	10	11	12	13	14
Sessions per week	3	3	3-4	3-4	4
Hours per week	3-4	4-5	4, 5-6	4, 5-6	5-8
General fitness training (hrs per year)	90	110	120	120	120
Rowing training (hrs per year)	60	70	80	80	100
Rowing training (km per year)	-	-	500	600	800

A training session as the basic training unit represents an entity regarding its content, time and organisation. General fitness training comprises games, gymnastics, strength exercises, running, and jogging. Exercises are conducted in a way that aims for a general training preparation for rowing. Rowing includes: 1.) the development of sculling technique in the single, double, and quadruple scull up to a level that allows competition, and 2.) rowing training that primarily develops special fitness and racing abilities according to planned race tactics. The basic training method during the preparation stage is the endurance method at the stimulating level.

Experience has shown it is not advisable to put too much emphasis on rowing skills at this stage. Though children should compete in rowing events when they are 11 to 14 years old. It is more important to establish their general athletic foundation for the later development in that special discipline (talent development). The DRSV has uniform and general guidelines for training that apply to all coaches. According to this scheme, general fitness comprises 60% and special rowing 40% of the overall training during the season, with more special rowing training in spring and summer, whereas in winter (November to March) there is more general fitness training (Table 4).

5.2 The Training of Talented Youths (14-16 years)

Athletes in this age group are gathered in centres for high performance (KJSs). School and athletic training are co-ordinated. Any shortage in the numbers of talented youths will be filled with newly scouted children. Therefore, there are often two groups of athletes aged 14 to 15 years:

1. athletes already educated in rowing programmes for children;
2. recently selected athletes who show good athletic condition but who do not have any rowing experience. This group has to be brought to the technical level of the other group as quickly as possible.

In general, athletes of the KJS should achieve a rowing technique that enables them to compete successfully in rowing events. At the age of 16 they have to be able to scull competitively in all sculling categories and should be familiar with sweep oar rowing. It is not intended to have them specialise in sculling or sweep oar rowing. After having emphasised small boat rowing, we then train and compete again more often in big boats. The emphasis on training and competing in small boats does not always show the expected results. At this age it is important for all athletes to develop individual as well as team boat rowing technique and performance for all boat categories. Sculling is chosen primarily for competitive events as it allows a symmetrical strain on the body. In consideration of the fast acceleration of young athletes, the development of general fitness and co-ordination takes up a large part of the training process (about 50%). Young athletes start strength training by using

bar bells whereby most emphasis is put on the development of strength endurance [50 to 60% of maximal strength (maximum force: Fmax) with a high number of repetitions] or power (50 to 70% of Fmax). Jogging, swimming, gymnastics and games (to develop co-ordinative abilities) make up a large part of the entire training. After grade ten, athletes who are 16 years of age finish polytechnic high school and start a new phase of educational and athletic training.

5.3 The Training of Talented Juniors (17 and 18 years)

Individuals possessing rowing talent start a new part in their training upon completion of grade ten and reaching junior age. There are two professional avenues to follow: they either go to college within the KJS to prepare for the university entrance exam (*Abitur*), or they start an apprenticeship.

The training is co-ordinated with the demands of schools or professions. Important conditions for a new and unified training process are already given as most juniors live in boarding schools at the KJS. The training is now becoming more and more specialised with further training as either a sculler or a sweep oar rower. The GDR aims for proficiency in rowing technique in either sculling or sweep oar categories at the competitive level. A lot of emphasis is placed on the rowers' proficiency in rowing small boats (lx and 2-) so that training, competition and selection can be performed in the boat. All tests and selection regattas for juniors are in the single scull and coxless pair.

The general fitness training still comprises close to 50% of the overall training and is conducted primarily between November and March. During this time most training is carried out indoors because of weather conditions (cold temperature, rain, snow, and ice) and short days (during November, December, and January daylight is between 8 am and 4 pm). Strength training takes up a special position in the general training of junior men.

Priority is given to strength endurance and maximal strength training using barbells (2 to 3 times a week). In addition, rowers do a lot of running, cross country skiing, cycling and games to develop the necessary endurance capacity. In spring and summer, rowing, of course, takes larger parts of the training while the general fitness training is reduced. During this period, general fitness training is used as additional training or training to conserve strength. The amount of training increases with the age according to a systematic plan and its intensity is also increased according to the principle of stimulus adjustment. The rowing training gets more specific and more purposeful in its application of general training methods (Table 5).

Table 5: Training Guidelines for Youths and Juniors (45 weeks of training)

Years	15	16	17	18
sessions per week	8-10	8-10	10-12	10-12
hours per week	12-15	12-15	15-18	15-20
general training (hrs)	300	325	400	400
rowing training (hrs)	300	325	410	450
rowing training (km)	2,900	3,200	4,000-4,500	4,500-5,000

After talented young athletes go beyond the junior age, they move to senior training teams at centres for high performance. The training programme of the talent development programme is now completed.

6. Forms of Competition, Test and Control

The DRSV prepares an annual regatta calendar with events open for all rowers. In the spring, a long distance event is organised in the quadruple scull (rowing marathon of Berlin):

Age 12 years 5,000m
Age 13 years 8,000m
Age 14/15/16 12,000m

Table 6: Distances and Boat Categories for Age Group Regattas

Age	Distance	Gender	1x	2x	4x	2-	2+	4-	4+	8+
11	500m		x	x	x					
	250m SZ		x	x	x					
12	1000m		x	x	x					
	500m		x	x	x					
13	1000m		x	x	x					
14	1000m		x	x	x					
15	1500m		x	x	x					
16	1500m	male	x	x	x	x	-	-	-	x
		female	x	x	x	x	-	x	-	-
17/18	2000m	male	x	x	x	x	x	x	x	x
		female	x	x	x	x	-	x	-	x

The following additional tests are carried out to assist coaches in the development of young talent:

On water: test for the distance covered per stroke (*Vortriebstest*), control of rowing technique and ratings.
On land: 30m sprint (speed), 800 and 1500m running (endurance), obstacle course to test co-ordinative abilities, triple jump with both legs, 'triathlon' with medicine ball to test leaping and throwing strength.

Test results are evaluated using point lists which specify points earned for each performance. The aim of these rowing competitions and tests is to control and regulate the development of talent as well as their training methods.

7. Medical Control

In the GDR the process of talent identification and development receives medical support that has to be provided by the sport medical service of the public health care system. A well organised sport medical system of institutions supports athletes in a preventative and caring way. Most of the doctors involved are specialists in sports medicine. For the talent identification, the sports medical staff of the appropriate community are responsible for medical supervision.

Starting at the age of 17, top rowers are tested 3 to 4 times per year on a rowing ergometer, and all test results are entered in a central diagnostic file of performance. Tests are conducted with stepwise increasing work loads to determine the anaerobic threshold and the maximal potential of performance. For

members leaving the KJS, a special medical programme including several training methods guarantee a systematic build-down depending on the number of years of previous training (to avoid syndromes of reduced work load).

8. Educational and Professional Training of Talent and Their Financial Support

Principally there is the same syllabus at the KJS as in government schools. The same applies for professional education, technical colleges, and universities.

Up to grade ten, talented rowers have the same curriculum (with regards to time and content) and final exams as students in government schools. Therefore the term "talented athlete" also refers to an intellectually and academically well developed person. A person who wants to excel in sport cannot be just a talented athlete. Considering the high demand arising from high performance sport, it is necessary that children don't have any problems at school. Only the period between grade 10 and final exams at high school (*Abitur*) or professional schools is extended by one year. As the successful completion of all educational programmes is required for general life in our society, we don't allow a reduction in the quality of education. Besides, parents and children would not agree to reduce education, as this could create a major problem for those athletes who have to give up their career in sports. Even after terminating their sporting career, youths that have entered the KJSs finish their education according to contracts.

Athletes at universities study according to special contracts until the completion of their degrees while employers temporarily relieve professionally working athletes for training and competition. Their salary is paid for. Athletes have to pay for food and training clothes (which are offered to them at a reduced rate). University students receive a scholarship and additional support if their studies need to be extended. The amount of money paid can reach the salary corresponding to that after completion of the degree.

It has been demonstrated that in the GDR talent identification system, parents, government, sport institutions, and athletes work together to support the talent. Parents support their children with great enthusiasm. Regarding financial support, parents have to pay about the same amount for talented as for other children up to 18 years of age.

9. Support of Athletes (Talent) After Completion or Interruption of Their Rowing Career

It has already been demonstrated that the unity of sports, school, government, and parents plays a vital role in the process of talent identification and development. As long as the career of the talented athlete develops normally, i.e., in accordance with the personal interests and those of the society, there will be no problems. If there are any problems in a selected athlete's development, such as those related to health, development of character, results at school, or if the physical development does not meet the expectations, the GDR solves the problems with adequate means.

As talented athletes between ten and 14 years of age enter the process of training without big changes to their normal life, there aren't any problems if the career

ends at this stage. Special training stops, or the athlete's coaching is reduced to a degree acceptable to both parties.

Some remarks on the rate of failure in the process of talent development. About 15 to 20% (about 100 talented athletes) of the children's programme reach the KJSs, contributing about 70% of the desired numbers of students. The (second) draft from 14 to 15 year old children comprise talent who in general have trained in other sports (about 50 children enter at this stage). About 110 students enter the junior level at the age of 16 (60 male and 50 female - loss 25%). Sixty to seventy squad members enter the senior level (40 male and 30 female - loss 25 to 30%). Every year about 8 to 12 members of the senior level reach the top (about 15%). World class rowers are scarce. The main problems causing dropouts are stagnation in growth, lack of performance development, lack of motivation, problems concerning health, or professional problems.

Translated by I. and R. Stocker

Editor's note: This paper was presented at an Olympic Solidarity Seminar in 1989 (of course, East Germany still existed as a country then). Many elements of society in East Germany were structured to strongly support sport. Some of the elements presented in this paper couldn't have happened without societal support. Therefore, we do not recommend that the East German system be copied. However, many good ideas can be obtained by studying and understanding their system.

Analysis of the Italian National Training Program for Rowing

Authors: Kurt Jensen (DEN), Thor Nilsen (NOR) and Matt Smith (USA)

In 1980, the Italian Rowing Federation initiated a systematic, national year-round training program which placed an emphasis on performance in the international competitive arena. The training program was designed to create rowing-specific technical, physiological and musculo-skeletal adaptations in the athletes. The program specifies training models which are the means to foster these adaptations, and is supplemented with close supervision of rowing technique, observation of physiological parameters and experience in international competition.

The majority of competitive rowers train throughout the year based on a periodisation of training models and intensities. Generally speaking, the autumn and winter are devoted to aerobic conditioning, strength training and technical skill enhancement. The spring and summer are devoted to anaerobic conditioning, technique refinement and model training for competitions which take place during this period. Because of these two diverse training objectives, a seasonal variability in rowing technique and fitness level has been observed (3,11). In the period since the introduction of this program, the Italian Rowing Federation has experienced significantly improved results, in terms of medals won, at the World Rowing Championships and the Olympic Games.

This study attempts to quantify the effects of the Italian program in order to increase the understanding of the emphases and adaptations affected. In addition, the training demands of long distance swimming were selected as a means of comparison because of its very similar competition and training demands. Certain assumptions were made to arrive at a standardised mode of analysis.

Assumptions

Assumptions have been made regarding the conditions of training which, when consistently applied, allow us to evaluate the physiological effects. We have assumed zero water movement and no wind conditions, and have selected a rowing shell that represents the average speed for the boat types rowed by senior men. The boat selected was a national level double scull. We assumed an average velocity over a one year period of training for 2,000 meters at 100% to be six minutes, 40 seconds or five meters per second. The boat can travel at a higher velocity over, for example, 500 meters. However, this would represent a velocity of greater than 100% because our reference velocity is that of the 2000 meter race distance.

Using the heart rate response to the various intensities of training and assuming a maximal heart rate of 200, the percentile relationship was developed. This relationship was very close to the percentile relationship between the percentage below maximum velocity of the boat at the various training velocities and

maximum boat velocity of five meters per second for 2,000 meters (see Conversion of Training Intensities in Table 1).

Table 1: Table of Conversation for Training Intensities

Principal Physiological Effects of Training	Percent of Boat Speed	Heart Rate	Stroke Rate		Boat Speed	
			Jan-April	May-Sept.	Min/km	Meters/min
Anaerobic	95% (+ or -)	190-200	30-36	32-40	3.55	282
Transportation	85-95%	180-190	26-30	28-32	3.90	256
Anaerobic Threshold	75-85%	170-180	24-26	25-28	4.25	235
Utilisation 1	65-75%	150-170	20-23	22-25	4.62	216
Utilisation 2	55-65%	130-150	18-22	20-22	5.00	200

Based on these two percentile relationships, the training models were evaluated for the number of minutes at each training intensity. Because the training models refer to many different means of effectuation (e.g., kilometres, strokes or minutes), velocity was estimated based on the given stroke rate or estimated heart rate range to estimate the amount of time spent at the given intensities. In cases of training models of varying rhythms, the amount of time spent in each range was estimated.

Training Models

The Italian training program is based on training models, each designed to create different physiologic adaptations (see models in Illustration 1). These models are placed into daily training sessions of a representative week which is to be followed for each week of the month (see example in Illustration 2).

The training year has been divided into two main periods: the preparation period and the competition period. The preparation period is considered to be from October to March (for the Northern Hemisphere) and the competition period is from April to September. Within this framework, a further division was made to separate land training from water training. In this model, water training includes training in the rowing motion, training performed in the boat and on a rowing ergometer (4).

Land training includes running, weight lifting and stretching (bicycling and cross-country skiing are acceptable alternative models). Running and endurance weight lifting were considered for their effect upon the cardiovascular system. Endurance strength is the athlete's tolerance level against fatigue in strength performances of longer duration (6). The training models for the boat, rowing ergometer, running and endurance weight lifting were considered for the training effects they produce on the cardiovascular and musculo-skeletal systems.

Strength training included maximal and power weight lifting which are not considered to have a measurable effect on the physiology. Maximal strength is defined as the greatest force an athlete is able to exert for a given contraction of muscles (6). Power strength is the ability of an athlete to overcome resistances by a high speed of contraction (6). Flexibility training (also called stretching) is also considered a type of training activity. Stretching is included in the training program for 10 to 15 minutes before and after each training session.

Strength training was restricted to the preparation period because of the necessity of devoting training time to water training in the competition period. Maximal and power strength training took place once a week in October, twice a week in November, December and January and once a week in February.

Illustration 1: Training Models

Model	Recov minutes	Heart Rate	Stroke Rate	Km	Primary Training Effect
Boat Training					
Steady state					
1. Low	-	130-150	18-22	16-20	Utilisation 2
2. High	-	140-160	20-24	16-24	Utilisation 1
3. Alternative 20+20+20 min	-	160-170	24-28	16-20	Anaerobic Threshold
Anaerobic Threshold					
1. 3x12 min.	8'-10'	160-180	26-30	16-20	Anaerobic Threshold
Interval Training - Long					
1. 3-5x10 min.	6'-8'	150-170	24-28	16-20	Transportation
2. 3-8x5 min.	4'-6'	160-190	27-32	12-16	Transportation
3. 8-10x3 min.	2'-4'	160-190	26-34	12-16	Transportation
Rhythm Variations					
1. Long 4'-3'-2'-1' x 3 (24-30), (26-32) or (28-34)	8'-10'	160-190	24-34	14-20	Transportation Anaerobic Threshold Utilisation
2. Short 3'-2'-1'-1' x 3 (26-32), (28-34) or (30-36)	6'-8'	160-190	26-36	12-14	Transportation Anaerobic Threshold Utilisation
Interval Training - Short					
1. 30/20 or 30/15 strokes x 12 (2 series)	6'-8'	170-190	30-36	12-14	Transportation
2. 17/5 strokes x 10-20 (2 series)	8'-10'	170-190	32-34	12-14	Transportation
Interval Training - Race					
1. 2 x 2000m	6'-8'	170-190	32-34	8-10	Transportation
Super Compensation					
1. 6x500m	2'-3'	Max	Max	8-10	Anaerobic
2. 3x1000m	4'-6'	Max	Max	8-10	Anaerobic
Speed Training					
1. 1x1000 and 1x500m	10'-15'	Max	Max	6-8	Anaerobic
Land Training					
Running					
1. Steady state	-	130-160	-	4-12	Utilisation 2
2. Uphill	4'-7'	170-190	-	8-10	Transportation
3. In spurts 20/10 secx10-12	4'-6'	170-190	-	8-10	Transportation
4. Anaerobic threshold 3x2 km	4'-6'	160-180	-	8-12	Anaerobic Threshold

Model	Repetitions	Series	Exercises	Primary Training Effect
Weight Lifting				
1. Max strength	1-8	4-8	4-6	Strength
2. Power Strength	1-8	3-5	8-10	Strength
3. Endurance Strength	60-80	2-3	5-6	Utilisation 2
4. Circuit Training	30-90 seconds	1-3	8-10	Utilisation 2

Flexibility: 10 to 15 minutes before and after each training session.

Illustration 2: Example Training Program for the Month of April - Italian Rowing Federation, National Rowing Centre, Piediluco

Category - Senior Open and Lightweight
Period: April

Day	Program	Recov minutes	Heart Rate	Stroke Rate	Km
Monday	A) Steady state rowing	-	130-150	20-22	20
Tuesday	A) Warm-up: Steady state rowing	-	130-140	18-22	4-6
	B) Rowing interval training 4x5 min.	4'-6'	170-180	28-32	10-12
Wednesday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing interval training 30/20 strokes x 10 - 2 series	6'-8'	170-190	30-34	14-16
Thursday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing "rhythm variations" 4'-3'-2'-1' x 3	6'-8'	160-190	26-28 30-32	14-16
Friday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing interval training 8 x 3 min.	2'-3'	160-190	30-32	12-14
Saturday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing "rhythm variations" 3'-2'-1'-1' x 4	6'-8'	160-190	28-30 32-34	12-14
Sunday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing interval training 2 x 2000 meters	15'-20'	170-190	32-34	8-10

Note: Flexibility training should be performed 10 to 15 minutes before and after each training session. Heart rates indicated are suggested for an individual with a maximum heart rate of 200.

Primary Training Effects

The training models have been assessed for the physiological effects they induce. They have been placed into one of five intensity levels. The primary physiological adaptation of each training model was examined by analysing the percent of maximal heart rate, the content of lactic acid in the blood stream and the type of intracellular fuel used for energy production (see Energy Sources for Training Intensities in Table 2).

Table 2: Table of Energy Sources for Training Intensities

Principal Physiological Effects of Training	Energy Type Used	Percent of Maximal Heart Rate	Lactic Acid Produced (mMol/l)
Anaerobic	Glycogen	95-100%	Above 6.0
Transportation	Glycogen	90-95%	4.0 to 6.0
Anaerobic Threshold	Essentially glycogen with fatty acids	85-90%	4.0
Utilisation 1	Glycogen with fatty acids	75-85%	2.0 to 4.0
Utilisation 2	Essentially fatty acids with glycogen	65-75%	0 - 2.0

The following abbreviations have been given to the primary training effects or levels of intensity:
AN = Anaerobic
TR = Transportation
AT = Anaerobic Threshold U1 = Utilisation 1 U2 = Utilisation 2

The physiological parameters for these intensity levels are presented in Table 2.

Results

The results of the analysis are presented in minutes spent per category and percentage of total training in Tables 3 and 4. The results are presented in two basic formats: Table 3 presents all training during the preparation period and the competition period while Table 4 separates land training from water training in the preparation and competition periods.

Table 3: Training Time Divided Between Yearly Periods (minutes at training intensities, assuming an individual with a maximum heart rate of 200 beats per minute)

Principal Physiological Effects of Training	Preparation Period		Competition Period		Total	
	minutes	%	minutes	%	Minutes	%
Anaerobic	0	0	439	1.6	439	0.9
Transportation	600	3.0	1,946	7.3	2,546	5.4
Anaerobic Threshold	611	3.0	716	2.7	1,327	2.8
Utilisation 1	1,122	5.4	6,044	22.6	7,166	15.1
Utilisation 2	11,550	56.0	10,382	38.9	21,932	46.3
Recovery	3,226	15.6	3,857	14.4	7,083	15.0
Strength	1,265	6.1	0	0	1,265	2.7
Flexibility	2,250	10.9	3,322	12.5	5,572	11.8
Total	**20,624**	**100**	**26,706**	**100**	**47,330**	**100**

Discussion

Prior to the 1976 Olympics no national training program had been circulated, and the most popular training emphasis was interval training. In the period following the 1976 Olympics, the first attempt was made to distribute a national training program which failed. The program was based on the program of a middle distance track athlete and was untested for rowing. Upon the change in technical leadership, the present program was adopted in 1980.

Table 4: Training Time Divided Between Land and Water Training (minutes at training intensity)

Principal Physiological Effects of Training	Land Training				Water Training				Total	
	Preparation Period		Competition Period		Preparation Period		Competition Period			
	minutes	%	minutes	%	minutes	%	minutes	%	minutes	%
Anaerobic	0	0	0	0	0	0	439	2	439	0.9
Transportation	385	4	0	0	215	2	1,946	8	2,546	5.4
Anaerobic Threshold	232	2	0	0	379	4	716	3	1,327	2.8
Utilisation 1	0	0	0	0	1,122	11	6,044	26	7,166	15.1
Utilisation 2	4,050	38	0	0	7,500	75	10,382	44	21,932	46.3
Recovery	2,480	23	0	0	746	7	3,857	16	7,083	15.0
Strength	1,265	12	0	0	0	0	0	0	1,265	2.7
Flexibility	2,250	21	3,322	100	0	0	0	0	5,572	11.8
Total	**10,662**	**100**	**3,322**	**100**	**9,962**	**100**	**23,384**	**100**	**47,330**	**100**

Land training is 13,984 minutes, which is 29.5% of total yearly training time.
Water training is 33,346 minutes, which is 70.5% of total yearly training time.

In the present Italian national training program there is no mistaking the attention given to aerobic conditioning. The clear emphasis of the training program, revealed by the analysis, is on utilisation training. Rowing is considered to be 70 to 75 percent fuelled by the aerobic metabolism which this analysis confirms (3).

The peripheral adaptation achieved from utilisation training, however, is not the only reason for the extensive amount of training within that intensity range. The other reason is the necessity to automatise the rowing motion and, therefore, the rowing technique of the athletes.

Furthermore, to train the muscles to contract at the velocity used in 2,000-meter rowing races, most of the training within the transportation training models is intended to automates proper technique at approximately the contraction speed of racing velocity. Thus, biomechanical and neurological needs are served at the same time as physiological needs in the most effective way. The emphasis on the dual mission of training is, perhaps, one of the underlying reasons behind the success of the Italian system.

While training emphasis is not exactly the same, it is interesting to compare rowing's training emphasis to that in other aerobic sports. In a paper by Madsen and Lohberg (see Table 5), a brief analysis of training intensities is made for the long distance swimmer. This was selected because of the similar training and competition demands and the similarity in workout patterns. By converting the data of this paper into a compatible format to that of the swimming study (percentage of meters at each training intensity to total meters of training), we can compare use of energy sources in the two sports. We look also at the preparation and the competition periods of the training year (7). The training of the swimmer and the rower are very similar in the lower intensity ranges taken as a whole but differ in emphasis within those ranges.

One possible explanation for these differences in lower intensity training emphases can lie in the difference of the speed of muscle contraction between the two sports. In swimming, the contraction speed can approach 40 or 50 contractions per arm per minute combined with leg kicks. Rowing has a much lower contraction speed of approximately 35 per minute using all the major muscle groups in the body.

Table 5: Comparison Between Training Emphases in Swimming and Rowing (Percent of total meters of training)

Principal Physiological Effects of Training	Preparation Period		Competition Period	
	Long distance Swimmer	Rower	Long distance Swimmer	Rower
Anaerobic	0	0	3	1
Transportation	10	11	7	12
Anaerobic Threshold	40	27	40	4
Utilisation 1	30	8	25	50
Utilisation 2	20	54	25	33

Swimming research from O. Madsen and M. Lohberg, Germany, 1987.

Conclusion

This study has quantified the emphases of the physiological adaptations defined by the Italian national training program for rowing. While such a study could not be completed from the years before 1980, it is widely known that the primary training method utilised in leading Italian clubs was interval training. The reliance of the present Italian program on the peripheral adaptation of the utilisation intensity is striking. Close observation of the Italian coaches also reveals the dual purpose use of the lower intensity training to also automatise and perfect the technique of the stroke. The improved performance of Italian crews at the international level since 1981 is clear as is the highly disciplined technique exhibited by the rowers.

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From a Beginner to a Successful International Rower: A Concept for a Systematic and Long Term Competitive Career

Author: Dieter Altenburg (GER)

To achieve top performances at the highest international level demands a systematic and long term preparation of the rower. The length of time over which the highest sporting performances can be achieved is generally determined by the natural talent of the rower himself or herself, and may last for a period of eight to twelve years.

In accordance with the appropriate goal-setting and training methods, the long term development of performance can be divided into stages within the framework of a concept extending over several years.

- Basic education
- Basic training
- Development training
- Transition training
- High performance training

The "several years" concept must involve training methods which:

1. ensure that the rowers have a leading position at the junior and senior World Championships, and the Olympic Games,
2. guarantee the speedy conversion of talent into top performances in the junior and senior categories, and
3. are careful to ensure that even rowers who are new to the training at the various age categories can achieve the requisite levels of performance when making the transition from the junior to the senior level.

Coaching of children (ages 10-12/13-14) constitutes the basic education (1-3 years) and the basic training (1-2 years), whilst the coaching of the 15-16 year old juniors constitutes the development training. These stages of basic education, basic training and development training have a particular significance, because mistakes in coaching at these levels are extremely difficult to correct at the high performance training stages, and can inhibit the achievement of the older athlete.

The attached table shows the goals and emphases of the long term development of performance from basic education to transition training.

Training Stage	Goal	Rowing Technique & Coordination Tasks	Conditioning Tasks	Competition/Tests	Training Per Week	Proportion Rowing to Land Training
I. Multifaceted Basic Education 10-12 yrs	Carrying out of various coordinated tasks for the development of an emotional attachment to the sport and to the club.	Utilizing several different motor experiences from other sports. Teaching the basics of sculling.	Create a broad basis of condition using specific and non-specific training with emphases on development of endurance and speed.	General examination of technique. Fixed rating races. Skill games on the water. General sport movement tests. General competition (games, running, swimming, etc.).	1-2 times per week 30-70 minutes	40 to 60
II. Basic Training 13-14 yrs	Multifaceted and thorough preparation through numerous training sessions per week to strengthen the emotional attachment to the sport and to the club.	Teaching basic technical requirements of the 1X. Teaching and perfecting the skills of associated sports.	Further development of specific and general endurance and speed capacity. Achievement of general strength endurance and power speed capacity.	General examination of rowing technique, skillfulness. Fixed rating races. Short and normal distance races. General sport movement tests and competition (games, running, swimming, etc.).	2-5 times per week 45-90 minutes	45 to 55
III. Development Training 15-16 yrs	Purpose-specific carrying out of actual performance tasks for rowing competition to retain the emotional connection to the sport and to the club.	Further development of rowing technique to the stage of a stable mastering of all sculling boats. Learning sweep rowing technique. Learning and perfecting the movements of associated sports. Intro to the tactics of rowing competition.	Development of overall and racing-specific endurance, teaching of speed movement tasks to master high rating in races in big boats. Further development of strength endurance and power speed. Learning how to lift weights for eventual maximal strength training.	Skill exercises and fixed rating races. Short, long and normal distance races. Sports movement tests. General competition (games, running, swimming, etc.).	3-7 times per week 45-120 minutes	55 to 45
IV. Transition Training 17-18 yrs or 19-20 yrs	Carrying out of performance-determined elements of rowing races. Achieving peak performances at the various peaks of the year (Jr. Championships, Nations Cup). Retaining the necessary level of performance during the transition to high performance training.	Consistent mastering of sculling and rowing technique in all boat classes and at all races. Further development of coordination performance. Further development of the variations in tactics in rowing races.	Further development of general and racing-specific endurance, and of speed and speed movement. Planning the workload for performance goals during the year to achieve the peak performance capacity at the main event. Further development of strength and endurance, power speed and maximum strength.	Short, long and normal distance races. General sports movement tests and general competition (games, running, swimming, etc.). Directing the training towards the principle of performance training.	4-12 times per week 45-150 minutes	65 to 35 or 70 to 30