

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

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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.

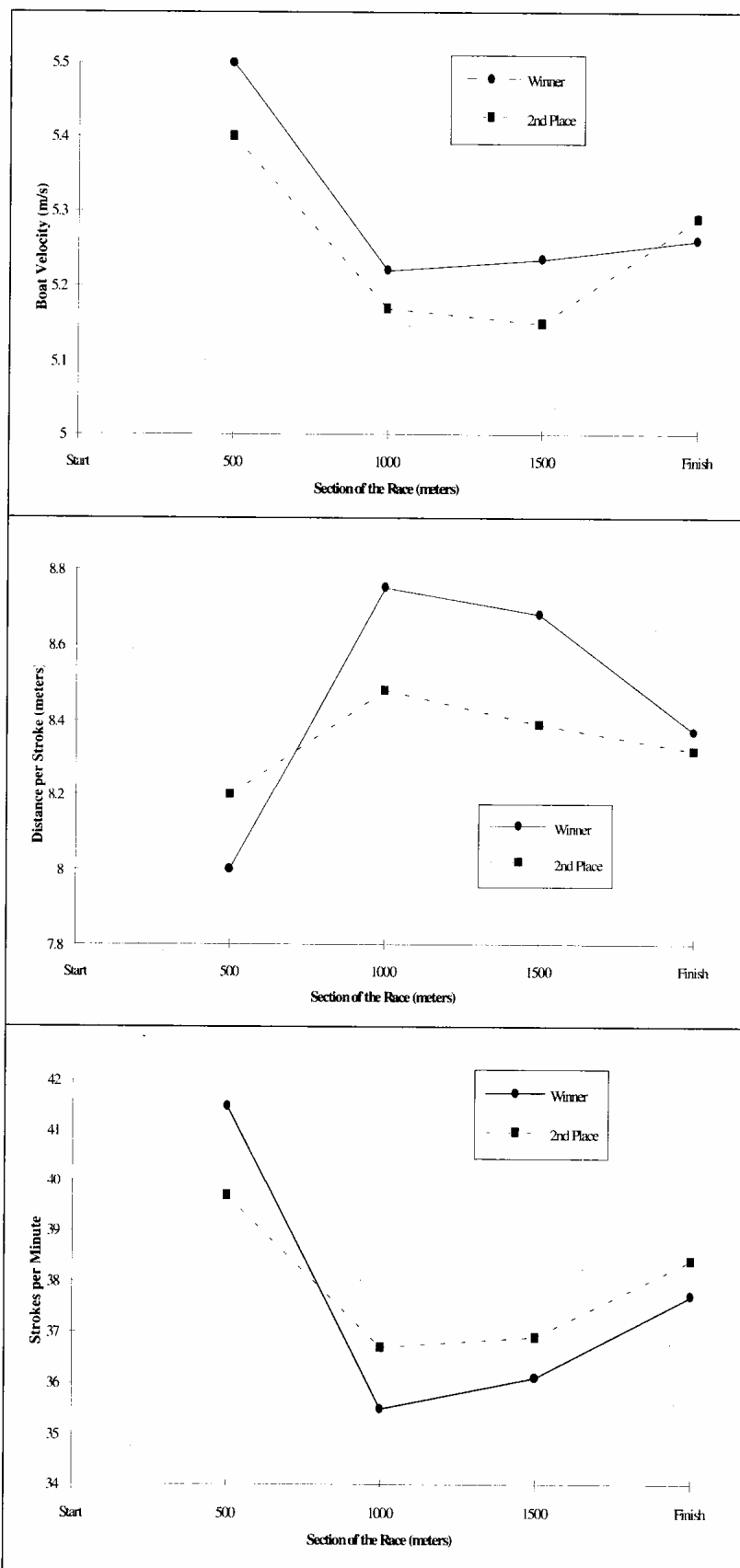
An analysis of the races of winning and second placed crews clearly shows that the former have a higher and more consistent speed over the entire distance of the course. The winning performance was not achieved through higher rating but primarily through a higher stroke efficiency, i.e., the distance 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
Sessionsζ 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

ζ 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 (years)	Group	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

References

1. Körner and Schwanitz: "Rudern," Sportverlag Berlin, 1985.
2. Training von A-Z, Sportverlag Berlin.
3. Harre, D.: "Trainingslehre," Sportverlag Berlin.
4. Matvejev: "Die Periodisierung des sportlichen Trainings," Sportverlag Berlin.
5. Roth, W., Schwanitz, P., Pas, P.: "Untersuchung zur Gestaltung differenter Kraft-Zeit-Verläufe," in: 'Medizin und Sport,' 2/1987.

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 (%)
<ul style="list-style-type: none"> - Development of technical rowing skills in 1x 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 - Development of partial general strength endurance 	<ul style="list-style-type: none"> - Technical training in 1x 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) - Beginning of build-up of general strength endurance training - General aerobic and co-ordinative training 	<ul style="list-style-type: none"> - Application of training methods for beginners. Combining individual and crew training (1x 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: 	70
		<ul style="list-style-type: none"> - Start exercises, speed changes (ratings) 	2
		<ul style="list-style-type: none"> - Strength training in group and during circuits 	18
		<ul style="list-style-type: none"> - Jogging, games and callisthenics 	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 (%)
<ul style="list-style-type: none"> - Complex general training - Further stabilisation of rowing technique and crew adaptation - Further build-up of aerobic capacity - Build-up of lactic and alactic capacities - Development of general strength and strength endurance - Improving general athletic training as bases for specific performances 	<ul style="list-style-type: none"> - Specialising in sweep oar rowing or sculling in different boat categories - Long distance training of 20 to 25 km depending on boat category, variability - Third stage of preparation: Start training, speed of movements - Training of lactic mobilisation: 500 m, 1000 m - 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 	<ul style="list-style-type: none"> - Specialisation in rowing technique according to talent, ability, prospective and individual performance in 1x and 2- - Long distance training, HR of 144 to 160, lactate of 2 mM, rating 18-20, keeping boat speed as constant as possible attention to stroke efficiency 	60
		<ul style="list-style-type: none"> - Start exercises and ten stroke pieces during long-distance training 	3
		<ul style="list-style-type: none"> - Work on feeling for boat speed; 500, 1000 and 2000 m 	3
		<ul style="list-style-type: none"> - Second stage of preparation (winter): Weight training at 80 to 100% of Fmax 	15
		<ul style="list-style-type: none"> - Strength endurance programme, 10 to 12 aerobic exercises at 4 mM lactate, circuit with 1500 repetitions - 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 (%)
<ul style="list-style-type: none"> - 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 	<ul style="list-style-type: none"> - 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, 10 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 	<ul style="list-style-type: none"> - Subjective and objective criteria of harmony, behaviour of boat and ability to perform - Training in 1x, 2- and 8+, training in groups, sparring - Long distance 20-25 km, heart rate, 2 mM lactate, rating of 20, time controls 	60
		<ul style="list-style-type: none"> - Distance pieces, aerobically with 4 mM - Incorporation of start- and speed pieces in endurance training, removing lactate 	3
		<ul style="list-style-type: none"> - 4 to 5 weeks of cycle' of maximal strength training 	3
		<ul style="list-style-type: none"> - Strength endurance programme with 1,500 reps 	15
		<ul style="list-style-type: none"> - Jogging, games, callisthenics 	19
Fourth Training Season: Achieving and Stabilising Performance at the International Level			
Training Objective	Central Issues of Training	Training Means and Methods	Time Ratio (%)
<ul style="list-style-type: none"> - 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 	<ul style="list-style-type: none"> - 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 	<ul style="list-style-type: none"> - 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 	60
		<ul style="list-style-type: none"> - Starts, series of short pieces, 10 x 10 strokes, etc. - Fmax is not over-emphasised, 70-100% 	3
		<ul style="list-style-type: none"> - Stabilising aerobic character of strength endurance at the 4 mM La level, circuit training 	15
		<ul style="list-style-type: none"> - Jogging, games, callisthenics, skiing, swimming 	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).

