Building kayak excellence: from the adolescent to the elite athlete.

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Building an athlete in order to reach his maximum possible performance is a long process which starts from infancy. The history of our interdisciplinary group (medical doctors-trainers) is equally long. It started in the 80s with the cooperation of a medical doctor and a trainer. Over the years, the group has grown involving new trainers, former athletes, athletes and young doctors who share their own specific knowledge in order to individualize and promote the maximal performance of each single athlete, trying to keep them in optimal health and prevent typical injuries caused by overload.

Although kayak is considered as a cyclic and continuous sport, the abilities of development and stimulation are numerous and multilateral. The first motor ability that we try to develop around the age of 9-10, when the child approaches the sport of kayak, is equilibrium. It is expressed in the boat as a dynamic adjustment of the position in space, which is mediated by the central nervous system through somatosensory impulses, the visual and the vestibular system. Winter offers the possibility to train these skills first with ground exercises and then with physical exercises and as well as the contemporary use of minimal weight load (dumbbells). After this stage, fitball exercises are introduced, first without load and then with minimal load or with the use of a medical ball weighting 2 or 3 kilograms. The purpose of using force in conditions of unstable equilibrium is to simulate the moment in which the child, seated on a boat, has to try to exert force in the water with the paddle. The paddling technique is learned and corrected outside the water, using first a basin and next a paddle ergometer. The child is placed in the ergometer which allows the simulation of paddling with the help of a resistance adjusted to the ability of the subject, in front of a mirror which provides the possibility of an optimal feedback to the trainer's supervision. The practical approach to the river is based primarily on the use of high stability river boats which can be used by people without any experience. When the child has mastered the use of the boat and the paddle, we start to introduce: balance exercises on the same boats, exercises that include moving the boat only with the hands, position changes (seated – standing), equipment changes (paddles and/or boats) without leaning on the docks or stepping on the ground, and finally equilibrium exercises on the boat. The methodological errors which are expressed through predictable or unexpected turn overs are not considered failures, but through the visual analysis of the trainer who control the children from a motor boat, the error is pointed out (errors caused by body setting, current confrontation, unexpected waves and obstacles) and suggestions are made to remedy the missing dexterity.

After achieving this goal, the child is introduced to a new, slightly more unstable boat model. The exercises, which stimulate a major development of the equilibrium, are repeated and even at the

cost of many falls in the river, finally a secure position on the boat is achieved in accordance with the age and the experience of the subject. The diversity noted in the time and the method of achieving the predefined objective is mainly the expression of the innate adaptive capacity of each child. The utilization of progressively more unstable equipment provides a training stimulus for these capacities that are different for each single child. The failure or the incapacity to reach a predefined goal is not a sign of an absolute incapacity of the subject to reach the goal, but only a stimulus for the trainer to reprogram the development of the equilibrium. In this phase specialized training for a specific course distance is not pursued. The aim is mainly to develop the technical ability of paddling for a long time, in different conditions of water and current, in order to build the ability of endurance.

Once the child reaches a satisfactory sense of equilibrium, which permits the constant outing on a boat in the river (the river presents some turbulence of the current according to its water level, which in turn constitutes obstacles of different grade depending on the flow), the attention of the team is focused on the physical construction of the athlete, maintaining however, even in the winter months, a minimum of technical training (two outings per week in autumn and spring and one outing per week in winter), which prevents the athlete from losing the technical skills he has already acquired. The winter is also the season which allows the dedication in the physical and muscular building of the young athlete. The major part of the work is concentrated on the aerobic capacity, typical abilities of the early adolescence that are particularly trained with the activity on the boat (when weather permits), running and swimming. We introduced work out repetitions with predefined duration and distance, which start with a duration of about 12 minutes and gradually decrease to 10 minutes, with a concurrent increase in the number of repetitions. This work out is carried out with only the load of the child's body, and through a variation of the recovery time between the different repetitions, it is considered as a preparatory training for the weight load work out.

Aerobic training is carried out in pre-teens on average three times a week and is completed, once a certain aerobic capacity is reached, with weight load training which is repeated two or three times a week.

Weight work out is introduced with criteria which are not based on the chronological age, but on the biological age, specifically when after a medical examination the pubic age is determined to be in 2-3 Tanner stage. The differences between sexes do not influence the choice of the duration or the type of the introduced exercises. The exercises are always performed under the supervision of a trainer. Initially they are performed only with a minimal weight, and then, when the trainer judges that the exercise is performed correctly, more weight is introduced. At first, exercises that are carried out with instruments, under standard conditions and protect from abnormal loads, are

preferred. When the child becomes accustomed to these exercises, new exercises are gradually introduced both with and without instruments, paying special attention to the development and strengthening of the muscles, which aid the stabilization of the posture, considered to be a very important fact in canoeing. In the beginning, the introduced work out, usually consists of 3 sets of 8 to 10 repetitions of at least 3 exercises with long recovery time (5-6 minutes) between two consecutive sets. Gradually new exercises are introduced, and the work out consists of 4 sets of 10 repetitions with 5 exercises. After a stable performance is achieved, the recovery time between sets is shortened in order to intensify the training.

Running tests (Cooper tests to evaluate the aerobic capacity) and weight lifting tests in two standard exercises (Bench press and Bench pull up) in order to evaluate the maximal load capacity (1 RM), take place every two months. According to the results, the individual work out load for each child is decided (70-80% of 1 RM). The work out with the weights is performed after an adequate warm up period (10-15 minutes) and it is followed by an equal period of cool down or stretching. The variations of training during the microcycles may concern the type of exercises, the recovery time and the effective load. The variations of the exercises are introduced in order to stimulate the adaptive ability of the organism. The philosophy of the work out even in this age group is based on observation and evaluation of each individual child, by performing tests that appreciate the abilities, the performance, and above all serve in remodeling the training scheme of each child in accordance with his/her performance and the evident deficiencies.

In the next age group (16 years and up), the preparation is reinforced by introducing a 6 time per week training schedule. The training is structured in two months plans, aiming to the development of different abilities, by modulating in different ways work out with weights and on board. Before the winter training period starts, two types of tests are performed: one with weights in order to determine the RM in Bench Press and Bench Push Up and one incremental test in the paddle ergometer in which every 30 seconds the velocity is increased in order to determine the maximal aerobic velocity. Afterwards, the data is analyzed with the program VAMEVAL (Charlet and Sylvain version 3). Usually the tests are repeated every two months so as to adjust the training loads to the athlete's abilities. In the beginning of the season, the weight test is repeated after one month of training, in order to evaluate the improvement usually observed in the first part of the season. In the first block (months of October and November), after a recovery break of fifteen days in the end of the season, training on the boat is introduced three times a week , dedicated to the development or recovery of aerobic capacity with long outings (60-90 minutes), performed at a heart rate between 50 and 60% of the maximum. These outings are dedicated to the correction of any technical imperfection in the athletic movements. The children are followed, on a support boat by the trainer, who uses a camera to film part of the training. The film is reviewed in the end of each

session, with emphasis in the errors and their possible corrections.

The weight exercises, three times a week, are divided in sections with the load at 70% of 1 RM and 90% of 1 RM.

In October a weekly session is introduced at 70% with the following exercises: Bench Press, Seated Row, Lat pull down, Bench pull up, Back extension and hyperextension and Abdominal aiming at building a muscle hypertrophy, especially the muscles needed for canoeing, and also at the development of muscle endurance. Three sets of each exercise are performed. Each set includes 8-10 repetitions with a 3-4 minute recovery interval.

Also, two weekly sessions are performed with the same exercises at the 90% of 1 RM dedicated to the augmentation of the strength. This sessions includes three sets of 3-4 repetitions of each exercise, with full recovery (5 minutes) between two consecutive sets. The weight training sessions are preceded by 10-15 minutes of warming up and followed by at least 10 minutes of stretching.

From November we plan two weekly sessions at 70% and one weekly session at 90% RM.

During December and January only one weekly outing on the boat remains, due to very low temperatures (often below zero). These outings have a minimum duration of 90 minutes in the part of the river between the city and the Ticino-Po confluence and back (about 18 kilometers). In the first part which has a duration of 35 minutes, the current has the same direction as the boat. In the remaining time the athletes paddle against the current, therefore having to face both the cold and the difficulty of the route. The weight sessions remain three times a week, but there are now two sessions at 90% and only one at 70% of RM, as always, integrated with gymnastics and stretching.

Two weekly training sessions with the paddle ergometer are also introduced. They are composed of at least 6-8 repetitions of 8 minutes, with a two minute recovery time. The exercise is performed at a heart rate equal to the 70% of the maximal heart rate. In order to prevent the exercise from being carried out very mildly, every 1’30” the athlete is asked a maximal power for 30”.

From February until the end of March, the work out settings are modified, starting the specific preparation that precedes the pre-competition period. The weight work out sessions remain always three per week, but they are modified with the introduction of a session of weights in contrast. ●The other two sessions remain unmodified: the one with weights at 90% and the other at 70%.

Depending on the weather conditions, the number of boat training sessions vary. In case of good weather, three sessions are introduced, which can be even replaced by working out at the ergometer. In any case, all the sessions are performed with repetitions (10-12) with a duration of 4 minutes and a recovery time of 1‘-1’30”. The work out on the boat can be executed at a predefined distance (the races are of 200, 500 and 1000 meters), but the choice of our group is to use the time of work out. This happens because the use of distances, even when measured with GPS, is susceptible to the interference of many variables such as the current. This makes the effort different if the current is in

favor of the direction of the boat or against it and also depends on the distance of the boat from the river bank or even the level of the river.

The total quantity of training is decreased, while the intensity is increased. The control test used from this point until the end of the season, is no longer the incremental test that reveals the maximal aerobic velocity intersected by the heart rate, but a four minute maximal effort test, followed after 30 minutes by another two minute maximal effort test. The tests that use the approximate travel times of an 1000 meter course and a 500 meter course are performed at the paddle ergometer Riverrunner, that allows to control various parameters: the power generated (maximum and minimum) and how the athlete exerts the power (right and left paddle) for the whole duration of the test. It is afterwards possible to calculate different parameters that provide us with further information:

The fatigue index is expressed as a number by the formula: $FI = \frac{\text{Max power - Min power}}{\text{Max power}} \times 100$

and the power expressed in kilograms of weight.

The fatigue index provides an indication of the endurance of the athlete and permits the modification and programming of the training, in order to correct the marked declines evident in relation with time of exercise in which they occurred. The corrections can be achieved either using reduced weight session at 70% before the outing on the boat (before fatigue) or with the use of boat work out repetitions specifically at the time that the decline in force occurred.

The maximal effort tests at the paddle ergometer are performed every two months during the tapering week.

The weight tests are performed regularly until the summer season.

With the pre-competition phase, which begins in April, the work out on the boat increases and reaches up to six times a week. The total amount of work out is decreased with a further intensification of the introduced exercises, which are usually of a 4 minute duration at the first half of the week and a 2 minute duration in the second half. The goal is to achieve the increase of the aerobic potency and for this reason we alternate, between exercises with the classic duration of four and two minutes, and exercises with a duration of four (or two) minutes, replaced by repetitions (4-6) with a duration of 1 minute. As the training days go by, the recovery time between the repetitions is reduced, while it remains always long between the sets. From April, exercises which intend to develop the buffer system of the muscles, appear in the training plan: numerous repetitions of very short duration, short recovery time between two consecutive repetitions and total recovery between the sets. For this purpose, we introduce exercises that variate from a minimum of 15 seconds to a maximum of 1 minute, with a total workout duration equal to the duration of recovery and a five minutes interval between the sets. This type of work out is introduced only in the day of the week

before the day off, and after 3 weeks of adaptation, it is also introduced in the middle of the week.

The weight exercises are omitted, except for specific cases of deficiency of the maximal strength or the endurance, until the first part of the competitive season (late June). The competitive season for the junior categories demonstrate two peaks of concentrated races, the first one finishes in mid-July and the second occupies the whole September. For this reason, we reintroduce a weekly weight work-out at 90% from the beginning of July, and being aided by the end of the school year, we propose to the more motivated or talented children the increase of the training sessions to a number of 10 per week (with double daily training four times a week). It is suggested that the children rest two afternoons per week (Wednesday and Saturday), while Sunday is considered a day of rest or recuperating lost training sessions due to personal reasons or bad weather. In this phase, we tend to correct the deficiencies noted in the first phase of the competitive season and in the comparison of the four and two minute maximal tests. The work out on board reflects what was described above, but the addition of the new 200 meter distance, forced us this year to explore new methods of training and testing. The 200 meter race lasts between 33 and 38 seconds and it is performed under anaerobic conditions. Each single moment is important, because any error becomes difficult to correct. Exercises of lactic acid type are mainly proposed, paying always close attention to both the paddling technique and the initial phase in which the boat is launched. In order to adapt the muscles to endure stress, we have proposed exercises with the brake (a rubber tube with a diameter of 2,5 cm which slides under the keel of the boat and offers a large resistance to the advancement of the boat). The training sessions, dedicated to the work-out with the brake, consist of four sets of repetitions (with the duration described above), which are followed by one set without the brake, in order to memorize the strength, the potency and mainly the speed of the execution, in a neuromuscular level.

The passage to the superior category forces us to study different strategies, according to the abilities and the different specializations chosen by our athletes. Currently in our society we are training elite athletes in wild water (canoeing) (races of 2 and 20 minutes), in flat water (canoeing) (races of 35 seconds, 1’45”, 3’45”) and in the canoe marathon (above 2 hours). The research is focused on the development of training strategies which, while maintaining the individual specificity, allow the trainers to follow the whole group at the same time. The elite athletes, even from the winter phase of preparation, are obliged to train 10 times a week. These athletes are examined weekly by a physician, in order to avoid local overloads, which may cause contractures or small muscular problems, that may affect the training sessions or become worse from the training itself.

October and November are dedicated to the recovery and augmentation of the maximal strength and muscle hypertrophy. Four weekly training sessions with weights are proposed: two sessions at

90% and two at 70%.

In addition to the classic Bench Press, Seated Row, Lat pull down, Bench pull up, Back extension and hyperextension and Abdominal, complementary exercises for minor group muscles are introduced, leaving the choice among the various groups to the individual athlete's judgment. As always, the training sessions are preceded by warming up and followed by cooling down–stretching exercises. During this period, the on board training aims to the development of aerobic capacity and the strength exerted in every single paddle. Therefore, long work outs with a duration of 60-90 minutes are introduced with time variations, which are a function of the training week in the middle of the training cycle. The purpose of these work outs is to maintain the boat speed using a low number of predefined paddles per minute. In speed races of 1000 meters, an expert kayak athlete starts with 110 paddles per minute, then in the middle part of the race, he maintains a frequency of 100 paddles per minute and in the final part, he reaches 120 paddles per minute. In this phase of the preparation, we try to keep the usual speed with 60 paddles per minute. The smooth movement of the boat with a small number of paddles depends exclusively on the force exerted in the water. Therefore, we try to work on every single paddle, in order to train the athlete to always exert the maximal possible force in the water. We use this type of training because, when the athletes train in the river, it is not possible to use a course with a fixed precise distance. Every month, with the procedures described above, the athletes undergo tests of maximal strength (1 RM) on Bench Press and Bench Press Up, incremental tests at the computerized paddle ergometer Riverruner, in order to evaluate the maximal aerobic velocity and maximal strength test in four and two minutes of paddling. The evaluation of the incremental tests by the program VAMEVAL (Charlet and Sylvain version 3) allows the trainer and the athlete to calculate the heart rate of reference, which will be used during the training both at the river and the ergometer. The evaluation of the maximal test in predefined times allows us to control, apart from the parameters mentioned before, the values of heart rate with personalized indications of correction during the training. The tests are performed during the week of rest in the middle of the monthly cycle

During December and January, the training with weights retains the same form, but the execution is modified. The simple repetitions become pyramidal (5 repetition at 75%, 4 repetitions at 80%, 3 repetitions at 85%, 2 at 90%, 1 at 95%) or take the form of double pyramid (5 repetition at 75%, 4 repetitions at 80%, 3 repetitions at 85%, 2 at 90%, 1 at 95%, 2 at 90%, 3 at 85%, 4 at 80% and 5 at 75%) or some work outs may take an eccentric form. We choose the modification of the proposed training in order to achieve different neuromuscular stimulation, which may provide a surplus of adaptation, since we are dealing with athletes who have underwent the winter preparation for several years. Working out on board, given the adverse weather conditions, is limited to only one weekly session and it is performed jointly with younger athletes on the same course with

programmed stretches. The choice of training in group for advanced athletes or athletes of younger age is not only dictated for security and assistance reasons, but also from the fact that in a group, the passage of boats create waves, trails (favorable) and contrary trails. This fact promotes the sense of balance and furthermore provides the stimulus to paddle harder in order to perform small sprints so as to evade contrary trails and enter favorable trails, saving energy.

All the other training sessions are performed at the ergometer with repetitions of 8 minutes with different gaits and predefined sprint time: for each single athlete, thanks to the tests conducted monthly, we can indicate the optimal heart rate (with an approximation of 1-3% usually equal to 5-7 beats per minute) and also the recovery time that should be maintained between two consecutive repetitions.

At the end of February, the period of general reconstruction reaches its end, and the pre-competitive period which has a duration of two months, begins. The weight training sessions are modified, maintaining one session at 90%, two at 70% and one with weights in contrast (8 sets of 5 repetitions at 85% + 10 repetitions at 50%), aiming to improve the neuromuscular reactivity and both the potency and speed of execution.

The specific training, as soon as the weather conditions permit, is performed on board and it is modified according to the specialization of the athlete. For the river marathon athletes, a substantial percentage of aerobic work-out remains, during which sprint and speed changes become more frequent. The training plans remain at 8 repetitions of 8 minutes with sprint, which start from one minute and gradually reach up to two minutes. The recovery time is shortened from 1' 30" to 1 minute. The wild water athletes seek both the training of the aerobic capacity (8 repetitions of 8 minutes with 1 minute recovery time) and the aerobic potency (4 sets of 4 repetitions of 4 minutes with recovery time of 1 minute between the repetitions and 5 minutes between sets). The speed athletes spend their training time with repetitions of 4 minutes and 2 minutes (distance of races) constantly shortening the recovery time between the sets.

This is also the period of experiments: the suggestions of the international literature (in the last year "Dietary nitrate supplementation reduce the O2 cost of low-intensity exercise and enhances tolerance to high-intensity exercise in humans" and "Acute L-arginine supplementation reduce the O2 cost of moderate-intensity exercise and enhances tolerance to high-intensity exercise tolerance") are tested in the pre-competition phase, in order to verify the actual benefit, but above all to evaluate the lack of side effects, even the minimal ones, before the actual racing period begins. These experiments are not useful to seek shortcuts to success- only the well organized and well performed training leads to victory- , but to prevent the potential damage that the overload and the repeated stress may provoke, maintaining the "human machine" in the best possible balance.

The beginning of the racing season changes totally the training of the various specialties. Only one

session of weight training per week, at 90% of RM is left and all the other training sessions are performed on board. Only the exercises dedicated to the improvement of the buffer system of the muscles remain the same for all. The exercises are introduced twice a week and they consist of 6-8 sets of 15-30-45-60-45-30-15 seconds of work-out with a recovery time equal to the work-out time and total recovery (5 minutes) between the sets. During the weeks which are far from the races, these exercises are introduced partially with the brake (4-6 sets), leaving the last two weeks free so that the neuromuscular system "memorizes" a higher execution velocity, and therefore a higher number of paddles per minute. One weekly training session for the aerobic capacity is also retained for all the specialties. This session has a duration of 80-90 minutes, which is performed in group and it is characterized by continuous stressing and sprint. The other exercises are modified according to the specialties: for the speed athletes, the aerobic potency remains the main goal, and therefore the weekly training plan includes 4 and 2 minute exercises, mixed systems (1 time 4 minutes, followed by 4 times 1 minute, recovery time 1 minute between each exercise and 4 minutes between sets, executed 4 times or alternatively a work out with a duration of 4'-3'-2'-1' with a recovery time of 1 minute, executed 6 times with recovery time between sets of 3 minutes).
Both wild water and marathon athletes perform the 2 minute exercises, but as an alternative to the longer aerobic potency work-out, we propose a set of 8 repetitions with a duration of 8 minutes followed by sprint of 30" or 45" every 1' 30".

When approaching the river marathon races, we also insert specific training for portages. The river marathon race is characterized by the intermission of the course by parts, in which the athlete has to run carrying his boat. For this reason, training time is dedicated to the speed of disembarking on the peer and embarking again. Therefore, considering the competitive commitments and knowing the length of the portage (different from race to race), we simulate the arrival point, the route followed at the race and the re-embarkation. It is amazing to watch the balance abilities of these Canadian canoe athletes, who have already been trained for some years. They paddle on their knee (higher center of gravity and greater instability) on boats, characterized by a minimal surface in contact with the water. They arrive at the peer paddling, hop on the peer, run for 100-200 meters with the boat on their shoulders and practically without stop, they hop on the boat again.

The competitive season consists, in a national level, of two phases of important activity: the first one lasts until July and the second is within September. For the athletes with international activity, the races continue throughout July, followed by the world championships usually in the end of August. Therefore, emerges the problem of scheduling the races in order to avoid exhaustion in the end of June, which may render the athlete unable to perform optimally in the international activities. The duration of training sessions is thus drastically reduced, but their number remains steady. The settings given to the sprinters and the wild water sprint races aim to the development of the race and

therefore, we propose a training plan that distinguishes the various phases of the race starting with repetitions (12-15) of an intensity equal to the one of the first 100 meters, with total recovery between two consecutive tries. The distance –and therefore, for us the time- is gradually elongated to 50 meters at each training session, always maintaining the pace of the race and complete recovery between the various tries. In this way we reach the week before the races, when we only propose in each session 3-4 courses of 1000 meters or 6-8 of 500 meters. In the last two weeks, we also add to the end of each session, 8-10 launching tries so as to stimulate also the neurosensory responsiveness in cases of relative fatigue. Throughout this period, we try to align the training and the related exhaustion with the racing commitments, in order to bring the athlete to the most important races in better conditions. In case the athlete does not participate in international races, we propose at the beginning of July a week off and after that, we resume the training in view of the autumn commitments. The training schedule of the second phase is similar to one of the last two months, however we try to train in a special way the weaknesses that were revealed during the selection races. This training method permitted many athletes, who took their first steps in canoeing in our river, to reach an international level (participation in world championships, world cups, Olympic Games) in all specialties, and now, taking into account the last months, it gives us a new satisfaction in marathon races: the participation in two different races (C1 and C2) within two consecutive days, both in the World Cup and the European Championship.

Probably, we were lucky enough to train exceptional athletes, but I believe that a part of this success can be really attributed to the team work of these years and in the passage –and I dare say the transfer- of each person's knowledge to the other.

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