Applied Biomotor Training Concepts for Track and Field: Combined Events

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The success of many track teams relies on the multi-purpose or multi event (decathlon/heptathlon) athlete who can score in several events. This type of athlete may be the nucleus of the team and is asked to perform in many events within a short period of time. These athletes are usually very skilled in a variety of areas and have outstanding fitness levels. The multi purpose athlete tends to be entered in the speed and power events, as well as being used as potential relay personnel. This versatility creates different demands of training which combined with their competitive nature causes difficulty in training design. There is a tendency to overtrain this type of athlete which makes them more susceptible to injury and fatigue. In addition, if the athlete has different event coaches, problems can occur if the athlete is pulled in too many directions.

To optimize the performance of these athletes it is necessary to design training programs that include a periodized plan, event priorities and flexibility. A philosophy should be developed that will include the needs of the athlete, team and coaches and not place undue pressure or take advantage of the individual. Priorities of the individual should outweigh the needs of the team or coaches.

Competing in multiple events is a specialty in itself. These athletes are potentially decathletes or heptathletes and the philosophy of training should take that into consideration. Training to be a specialist in each event may not be feasible and the coach should realize that there may not be enough time to develop the athlete to their maximum in each event. Some modifications and concessions must be made in regard to this type of athlete.

Maximum athletic performance is predicated on training concepts that are applied in the daily practice sessions over extended periods of time. This cumulative effect of daily training units serves as the building blocks of biomotor development. It is necessary to select the proper training units that will be most beneficial to the athlete with concern in regards to the efficiency and economical principles of training. The application of these principles combined with the proper training plans in periodized process will allow the athlete to achieve optimum athletic performance.

It is the responsibility of the track and field coach to view the track and field athlete in a ***holistic sense*** **of** ***development and place emphasis on all*** **of** ***the physiological systems*** **of** ***the body***. Energy systems must be trained accordingly so as to set the stage for neuro-muscular development in the explosive events as well as preparing athletes for the endurance events.

This paper will deal with several principles that can be used in concert to develop athletes to their maximum. The Theory of Specificity can be subdivided into principles of training which will work hand in hand to provide the athlete with the proper plan for training.

Training Principles

Theory of Specificity

- Units that are precise and explicit to the action desired
- Units of training that expressly develop the required demands of the action

Principles of Specificity

1. Compatibility Principle

- Units of training that work together in harmonious manner
- Units of training that can be mixed without interfering with another unit's action
- Units that are congruous and can be bonded together with greater effect

2. Complementary Principle

- Units of training that can act mutually to make up deficiencies and enhance the performance
- Units that can be combined together to create a sequence of action to complete a skill

3. Commonality Principle

- Units of training that share similar biomechanical properties of activity
- Special exercises that simulate actions that can be transferred into technique
- Units of training that have comparatively equal demands on the system

4. Transference Principle

- The body's ability to accept other training units and use the qualities developed to blend into technique
- Units that convey a property of training from one action to another

Application of these principles must be considered in designing training programs in order to create an economical and efficient development of the physiological systems. The philosophy of design must consider these principles when selecting training units or modules of training which would develop the athlete without duplication of training that is unnecessary or time consuming. Therefore, it is necessary to increase loads in a logical ***progression from simple to complex.*** Generally, the greater the complexity of the motor skill the greater need for dynamic strength development and more demands are made on the energy system's ability to produce force.

Analysis of the training inventory should consist of a comparison of units with the four Principles discussed.

Example

Using multi-throws prior to acceleration development or sprint starts would indicate that these two units would be ***compatible*** as well as ***complimentary*** to the overall system. The two can become bonded in regard to the explosive nature of the multi-throw and are common because of the contact times when applying force. This ex-plosive training modality can use the principle of overload because of the added weight of the shot, which could help make up deficiencies the athlete might have in acceleration development. This all has a ***transference*** effect into the demands of the system. Each training unit must therefore be analyzed and incorporated into the training plan at the proper time and sequence. Obviously, in contrast, one would not lift heavy squats prior to acceleration and block work, because almost none of the principles would be adhered to. The demands of the heavy lifting would take away any form of ***compatibility*** or ***complimentary*** gains.

When selecting training units to introduce into the session it is necessary to define each unit according to the principles mentioned. By utilizing this philosophy training can be blended together to create a smooth transition from unit to unit and enhance the overall plan.

Biomotor Development

Athletic performance is based in the biomotor areas of human development. Training plans that enhance these areas will contribute to the overall development of the athlete. In training design it is necessary to develop the biomotor areas in a logical sequence, as well as, adhering to the Principles of Specificity.

Work Capacity/Endurance

The athlete's ability to sustain work must be developed before more intense and technical units can be applied. This biomotor quality has two main components:

1. **Increase Cardiovascular Endurance/ Aerobic** Power. When cardiovascular endurance is enhanced the athlete is more efficient in using the energy systems during activity and provides an avenue for recovery. A good general base of aerobic fitness is necessary to create a progressive overload in intensity and will help the athlete to recover more efficiently. Increased capillary efficiency will help to supply the muscles with the needed nutrients transported by the blood for exercise resulting in an anticipated quicker recovery .The faster the athletes recover the sooner an additional overload can be applied.

   In developing aerobic power for the combined events athletes it should be noted that there is a procedure that can more specifically related to technical training. Training for aerobic fitness should be designed around extensive interval training. This endurance mo-ality requires the athletes to train at 60 to 70 percent of maximum with short bouts of exercise done in technical and biomechanical form with short rest duration.

Example

4x4x100 grass strides at 60% with 30 second recovery after each repetition and 1.5 minutes between sets. This type of activity will elicit the proper response to the training stress and cause an increase in aerobic power with minimal amount of technical change. ***(Commonality Principle)***

- Volume and distance of the run be- comes the main consideration for overload
- Recovery periods, intensity and technique will remain fairly constant.

2. **Maintain Dynamic Activities for the Duration of the Event.** Endurance in the explosive events is related to the duration of the dynamic strength demanded by the activity before neuromuscular fatigue sets in. Technical units would closely duplicate the perfect biomechanical model and maintain proper form with minimal deviations. The athlete who has trained to buffer the system against this fatigue would accomplish greater work capacity and thus increase performance levels.

Example

A jumps circuit training session would develop dynamic strength during an extended period of time. In-place-jumps at each station with the athlete executing sprint drills (A's, B's, etc.) between stations. A session might include the following

- 25 x Rocket Jumps
- A's for 50 meters
- 25 x Tuck Jumps
- B's for 50 meters
- 25 x Lunge Jumps
- Side Slide for 50 meters
- 25 x selected med ball exercise
- Jog 50 meters
- Repeat circuit from beginning to add volume and intensity

Flexibility

Flexibility exercises are added to the training parameters to increase range of motion, as well as increasing bone, ligament and tendon stability. Flexibility should be of major emphasis in the early stages of training in both static and dynamic stretch exercises.

Athletes who have developed this area will then be able to increase their mobility and coordination.

1. **Static Stretching** involves long duration contractions that increase tension on the tissue to extend its ***suppleness*** and prepares it for prevention of injury .Static stretching in the muscle can also help to reduce soreness and help restore muscles that have been fatigued during training bouts. Static stretching in the tendons sets the stage for ***storage* of *elastic energy in the connective tissue.*** Because of the high stress of explosive activity, the need for connective tissue elasticity is of utmost importance.
2. **Dynamic or Ballistic Stretching** helps to illicit the ***stretch reflex mechanism*** in the muscle and effects the magnitude of the ***Golgi Tendon Apparatus response***. This type of stretching will illicit an alarm stage in the movement and will overload the system to a point of greater tolerance for ballistic or dynamic explosives. In addition an inhibitory effect on the Golgi Tendon Organ effect can be elicited causing a greater potential for ***elastic energy***. Obviously, care must be taken when administering this type of activity as a higher possibility of injury exists as the movements become more intense.

Coordination

To develop mobility and coordination requires a combination of the proper:

1. ***Vestibular, Visual and Kinestic Cues*** with
2. ***Bone, Connective Tissue, Muscle Stability*** and ***Elasticity***

A weakness in either of these qualities will affect the degree of *coordination* that can be achieved. Therefore, ***flexibility, dynamic strength*** and ***balance*** become ***complimentary to the development of the coordination qualities of the athlete.***

It should be noted here that ***coordination, agility and mobility*** are directly related to static and dynamic temporal movements within the proper spatial position. Motor units must be fired in a logical sequence so as to produce the most effective force that can be applied with proper technique. The biomechanical principle of ***summation of forces*** relates to the athlete's ability to ***switch motor units "on and off"*** in recruitment which results in the desired temporal pattern of movement in the proper spatial plane.

Strength

Strength can be defined as the ability to apply force ***(F=Mass x Acceleration)***. Once the stage is set through the proper development of ***work capacity, flexibility and coordination,*** the application of *strength* principles can be effectively utilized. Once the athlete has exhibited proficiency in those three areas, applied ***strength*** principles can be introduced. As ***strength*** increases, the ability to apply force is enhanced which is the precursor to *speed.* Specifically ***strength*** training is one component that can be used to develop all of the biomotor areas mentioned. With the proper plan the athlete can be trained with a variety of exercises that will transfer into performance.

Using the overload principle of training we find that to increase the amount of force that can be generated, the athlete must overload the system by using various weight loads during exercise. Track and field athletes strive to improve performance by adding these loads to the body mass and try to accelerate the mass through a regiment of movements. In order for the coach to increase the capacity of the system, the overload principle must be applied by adding various amount of mass to the system. Increasing the volume, intensity and monitoring the density, or rest vs. work ratio, the coach can design a program that will enhance performance. Systematically, the coach can expand on the force formula by adding additional mass during the training unit and monitor the amount of stress that can be controlled.

Increased **F** *= (Body Mass + Implement Mass) x Acceleration*

By adding mass to the body via implements, such as medicine balls, shot puts, dumbbells and barbells with weight, one can overload the system in a variety of ways. Using this principle of over-load, the coach may select loads that are ***complimentary*** in regard to ***strength*** development. When developing ***power*** we find that technique requires force in the horizontal and vertical directions and should be addressed in the training program. Therefore, multi-throws exercises will combine both the vertical and horizontal components and create ***commonality*** to sprint and jump events.

Caution should be taken as too great of a load can create a breakdown in neuromuscular stabilization and cause the athlete to be susceptible to injury or premature fatigue.

The physiological contractile properties' of muscle tissue consists of two basic actions necessary to generate force production in athletic movement:

1. ***Concentric Strength*** refers to a muscular contraction in which the muscle actually shortens. This kind of strength is predominant in ***Isotonic*** exercises in the weight room.

   Example: A biceps curl where the muscle fibers slide past one another and the bone lever function is completed.

2. ***Eccentric Strength*** refers to muscular contraction in which the muscle lengthens, stretches the elastic component of the muscle tendon unit and allows it to contribute to force production. This kind of strength is predominate in plyometric forms of training and works in concert with the ***Tendon Reflex-lnverse Myotatic Reflex***. This combination of elastic and chemical energy produces a very powerful and forceful action. Studies have shown that ***"when a concentric muscle contraction is preceded by a stretching eccentric phase, the force, power and work produced are greater than for a contraction without a pre stretch."*** (Bosco) Therefore, dynamic movements prior to event execution are more beneficial than performed from static positions.

   Example: A series of in place jumps prior to the sprint start would elicit a pre loaded eccentric contraction and prepare the athlete to produce additional force to the block pad upon execution.

Types of Strength

1. ***Absolute Strength.*** One must begin with Absolute Strength which could be defined as the greatest amount of force that can be exerted at anyone time regardless of the athlete's weight. Absolute strength could be tested in the laboratory to determine the ultimate contractile possibilities for any muscle group. This also must include the factor of contractile ability without causing injury to bone, ligament, tendon or muscle. It is the goal of the training program to strive for Absolute Strength, but one must realize that without electro stimulus that athletes cannot volitionally reach this plateau.
2. ***Maximum Strength*** is the amount of force that can be exerted volitionally. This maximum, unique to each individual, may not be developed in relationship to the absolute ability of the athlete. The training program must be designed to close the gap between Absolute and Maximum Strength in order to reach optimum performance.
3. ***Relative Strength*** is specific to the athlete's mass and the ability to apply force. If the athlete is hindered by excessive body fat, then the relative strength of the individual decreases. Lean muscle mass is necessary for optimum performance in the areas of the sprints, jumps and hurdles. One athlete may be able to lift heavier loads than another due to the mass of the body, but it may not be relative to the performance desired.
4. ***Dynamic*** *vs.* ***Static Movements.*** During athletic activity, athletes rely on antagonistic movements and concentric/eccentric contractions to transfer into motor/skill performance. Timing becomes of utmost importance in reaching the ***Transference Principle***. The body has to be taught to turn the switches "on and off" during certain movements in the proper biomechanical sequence. If certain muscle groups are elicited out of order one loses the summation of forces that are desired and maximum optimum performance suffers. If the timing is off and the spatial positions are not reached in the proper sequence, then performance suffers and coordination and mobility are not used to their maximum.
5. ***Power*** is the ability of an athlete to overcome resistances by a high speed of contraction. Once the athlete is proficient in the dynamic and static movements it is possible to develop power. Power is the ***combination* of *dynamic and static activity*** in the proper sequence to be able to mechanically be efficient in movement. The greater the temporal patterning through spatial positions, the greater the power that can be developed.
6. ***Strength Endurance*** is the athlete's tolerance level against fatigue in strength performances of longer duration. The athlete's work capacity in this area is extremely important to buffer the neuromuscular fatigue level which directly effects biomechanical efficiency.
7. ***Special Strength*** can be defined as the type of strength required to perform the component parts of technique. ***The Principle* of *Complimentary Overload*** is introduced in this training plan to provide strength that is directly related to the

event. Essentially, the athlete strengthens the body according to the demands of the activity. An example of this type of strength would be to provide the plyometric units that would correspond to the contact times needed for the event.

> **Example:** A shot putter would need special strength activities with longer contact times, such as box jumps, as opposed to speed bounding for a sprinter.

8. ***Specific Strength*** would directly relate to the demands of the technical execution of the event. The *Theory* of *Specificity* with all of its component principles merging together to produce the ***specific strength*** that is required to execute the event to its maximum. An athlete who performs an event with the lack of ***specialized strength*** will have a breakdown in performance.

> **Example:** The long jumper needs to have ***special strength*** in penultimate and take off strides during the jump. A lack of strength would cause too much amortization in the joint and result in a longer contact time with a minimum amount of force application.

Training units must be incorporated to fit the demands of the event, insuring that the technique does not suffer biomechanically because of a lack of strength. This type of strength directly relates to the ***Transference Principle*** and is specific to the success in the event.

Kinds of Strength

Certain kinds of strength are imperative in the overall development of the strength component. Basic kinds of strength fall into the following categories:

1. ***Isometric Strength*** is applied when no change in the length of the muscle occurs when executing a muscular contraction. This would relate to stabilization in a joint angle for instance. The joint can be stabilized by using this kind of strength training in the program to create an angle that is prepared to contract the forces that result during application.

> **Example:** This *specialized strength* can be beneficial in counteracting the amortization in the joint upon impact in the take-off leg in a long jump. In this kind of strength the inner forces equal the other forces and stabilization occurs.

2. ***Isotonic or Dynamic Constant Resistance*** is a muscular contraction in which the muscle exerts a constant tension. This is the traditional kind of strength that most athletes and coaches include in their training programs. This kind of strength occurs when the inner forces are greater than the outer forces and movement occurs. The overload principle can be applied in a logical progression and

strength gains can be noticed periodically. This type of activity can enhance maximum strength and create a progressively stronger individual. This type of training can begin to close the "gap" between ***Absolute*** and ***Maximum*** strength.

3. ***Isokinetic Strength*** refers to a muscular con- traction performed at constant angular limb velocity. The movement is controlled and progressively becomes greater or less during its execution. This kind of training will enable the athlete to develop strength throughout the full range of motion. It is necessary to have the proper equipment that can elicit this response.

    Example: Negative Isokinetics can occur during an Olympic Lift, for example when the initial inertia of the weights are overcome and due to acceleration, the implements actually become lighter.

Speed

Speed of movement in the proper sequence over a duration of time is the ultimate object in optimum performance. As strength levels increase and all other biomotor areas have been developed, speed becomes a resultant of the training that has been applied. As the systems are trained, all principles must be adhered to in order for efficient and economical speed development to occur. If the athlete cannot maintain proper neuromuscular coordination due to physiological energy system fatigue, then the effectiveness of speed is reduced. Development of the biomotor abilities of ***Work Capacity, Flexibility, Coordination*** and ***Strength*** are necessary in order to insure that the athlete will be able to maintain speed in all of the events contested.

> **Example:** Biomechanical studies of elite sprinters indicate that, as neuromuscular fatigue increases technique changes. The sprinter who lacks the dynamic strength during the last stages of the 200 meters will decelerate due to technical inefficiency.

It should be noted here that speed and acceleration progressions should be developed prior to speed endurance. Speed would be the precursor to speed endurance and would relate to the ***compatibility, transference*** and ***complimentary principles of training***.

Transitional Control

1. In the decathlon/heptathlon competition there is a sequencing of events that require different energy systems demands.
2. Biomechanical commonalities exist in several events; however, they sometimes do not follow each other in the schedule.
3. Psychological factors from event to event. Evaluation and preparation of each event.
4. Nutrition and environmental effects of the events.
5. Training in sequential order.

Periodization

1. Periodization plans should be designed to protect the athlete from overtaining.
2. Determine the events the athlete will compete in advance.
3. Consider the competition and if the points are not needed let them miss an event or two.
4. Limit them in some meets to only 2 or 3 attempts.
5. Scheduling of Multi event competitions.

Conclusion

Optimum performance in track and field events is achieved effectively by applying the proper theories and principles of training in a logical progression in all areas of biomotor development. The training plan must include those factors in a form of periodization that allows the athlete ample recovery and restoration, as well as a "bleeding and blending" effect of the units that are selected. The track and field coach must apply these principles specific to the athlete's training age, ability and level of fitness. An emphasis in one area over another, or the lack of congruity between training units, will only lead to sub maximum performance and possibly injury.

References

Bosco, Carmel (1993) Track Technique Spring # 123 Mountain View CA

Fleck, Stephen (1987) Designing Resistance Training Programs, Human Kinetics Books, Champaign IL

Harre, Dietrich (1982) Principles of Sports Training, Sportverlag, Berlin

Mann, Ralph (1994) Elite Sprint Biomechanical Analysis Seminar, Orlando FL

USATF Level II Coaching Curriculum, Provo UT

USOC Elite Coaches Workshop in Physiology Curriculum, Colorado Springs CO