Integrating High Speed Treadmill Training into a Traditional Strength & Conditioning Program

Mitch Hauschildt, MA, ATC, CSCS

Prevention, Rehab & Physical Performance Coordinator

Strength & Conditioning Coordinator, Women's Basketball

Missouri State University

Founder, Maximum Training Solutions, LLC

History

- High Speed Treadmill training has become a staple within sports performance enhancement programs over the past 2 decades
  - Most popular within private facilities, but are slowly becoming more accepted with university and professional organizations
  - Most popular for speed and power sports

History

- Originally performed by John Frappier, MS in mid 1980's
  - Frappier trained with Soviet Olympic coaches who were experimenting with "tow training"
  - "Tow Training" was performed by towing athletes behind a vehicle fitted with a handlebar on the rear bumper
  - Frappier saw the high speed treadmill as a safe and useful alternative to the Soviet version of overspeed training

History

- High Speed Treadmill programs are usually the basis of short training programs narrowly focused on speed development by means of technology
- Has led to questions about speed transitions from surface-to-surface, high injury rates, and questions as to how to integrate this technology into a more traditional strength and conditioning program
- History has shown that, just as with all new technologies and programs, treadmill training is most successful when used as a tool within the overall training program for the athlete
  - If the technology and equipment dominates the training for the athlete, the athlete (and ultimately the trainer) will suffer

Sprinting

- Speed = Stride Length + Stride Frequency
- Basic Running Leg Cycle
  - Heel Strike
  - Mid-Stance
  - Toe Off
  - Flight/Recovery
- Goals:
  - Improve time in stance by .005s
  - Improve time in flight by .005s
- Many have theorized that it is very difficult (if not impossible) to improve both parameters simultaneously
- Evidence to refute this with treadmill training

Background

- Advantages of High Speed Treadmill Training include:
  - Increased Stride Length
  - Increased Stride Frequency
  - Improved Sprint Mechanics
  - Improved Metabolic Factors
  - Improved Core Stability

Training Top Speed

- Even though most sports require short bursts of speed and very little top speed, every speed is a percentage of one's top speed
  - Loren Seagrave

Increased Stride Length

- Increased stride length is achieved by increasing speed strength
  - "the ability to exert maximal force during high speed movement" (Essentials of S & C)
  - To increase stride length, one must increase power output
    - Traditionally improved by increasing muscle activity through uphill training or towing
    - Mann & Hagy support this by demonstrating that with the magnification of gait speed, the body showed an increase in muscle activity in the quads, hamstrings, and posterior calf muscles
    - Thus, the greater the speed, the greater the activation of the primary movers and vise versa

Increased Stride Length

- Research supports the use of uphill running to increase muscle activation and power output
  - Caldwell & Swanson demonstrated high speed elevation running increased activity within the Quads, Glutes, Gastroc/Soleus, and Hip Flexors through EMG
  - Similar findings have since been shown on MRI (Sloniger et al.)
  - Gottschall & Kram proved that propulsive forces were improved by as much as 75% while running at 9% elevation
    - Also showed improvements were made with no impact forces
- Greater muscle activity demonstrates an increase of motor unit recruitment within the specific muscles

Increased Stride Length

- Reciprocal Inhibition will cause decreased activation of the hamstrings
  - When one muscle is contracted, the opposing muscle group relaxes
  - The greater the contraction, the greater the relaxation
  - With Quads being recruited at a very high rate, the hamstrings will proportionally "shut down"
  - Minimizes brake forces
  - Must use caution
    - Hamstrings which are trained too much in this manner, lose the motor programs needed to fire in the proper sequence while sprinting on flat ground
    - Can become recurrent hamstring strains if ground based sprinting is not integrated with elevation running

Increased Stride Length

- Initially, improvements are strictly neuromuscular in nature, but research as shown that with continued reinforcement of the heightened neuro activity, long-term muscular changes will occur (after initial 2-5 weeks of training)
- Improved propulsive forces coupled with decrease in impact and braking forces makes sprinting at elevation a very good prospect for sprint training
  - Especially good when compared to tow training
    - Tow training has been shown to dramatically decrease running efficiency by altering hip position

Increased Stride Frequency

- Increased Stride Frequency is performed by moving the ground leg through the same range of motion faster than normal
  - Overspeed Training
    - Traditionally performed through assisted running
      - Downhill running or towing
      - Force unnatural mechanics
    - Utilizing a spotting technique on a high speed treadmill forces the athlete to run at speeds which are faster than they are accustomed to
      - Keeps pelvis in neutral position
      - Allows for verbal cues to promote knee drive
      - Keeps athlete in a safe, appropriate environment while forcing the legs to cycle at a higher than normal rate

Increasing Stride Frequency

- Stride Frequency gains are largely due to neuromuscular factors
  - Increasing the rate of firing for the musculature responsible for moving the legs through the running cycle more quickly
    - Primarily the hip flexors as they are most responsible for decreasing the time spent in recovery
    - Especially true of overspeed training performed while running uphill
      - Elevation running necessitates more time spent in stance, thus shortening the recovery phase
      - Shortened recovery time at elevation further encourages the activation of the hip flexors quickly and powerfully
- As with power development, initial gains are seen solely in the nervous system, but later become permanent neuromuscular programs (motor engrams)

Increased Stride Frequency

- Training top speed through overspeed training is important for enhancing sport specific speed

Increased Stride Frequency

- Traditional Means of Overspeed training
  - Downhill running
    - Can be effective if performed with the right athlete and on the right elevation
    - Most athletes develop a very unusual gait while running downhill
    - Athletes tend to heel strike unnaturally, thus increasing braking and impact forces
    - Downhill running also tends to produce a great deal of Delayed Onset Muscle Soreness (DOMS) due to eccentric nature
      - DOMS has been shown to decrease running efficiency and power output
      - Recommendations for dealing with DOMS includes 3-5 days of recovery following the onset
  - Tow Training
    - Research shows a decrease in running kinematics while being towed (Corn & Knudson)
    - Running Mechanics MUST be a priority

Improved Mechanics

- Utilizing a controlled environment is easiest way to promote motor learning
- Treadmill allows for easy motion analysis
  - Eliminates need for video analysis as athlete is cycling in place with the trainer standing very close, cueing them as necessary
- Sprinting at elevation is a self-limiting exercise
  - If the athlete cannot perform the technique properly, they will be unable to perform it at all
  - Elevation forces "Triple Flexion" of lower extremity just prior to toe placement
    - Most explosive position for the lower body because of the stored energy and prestretch placed on the musculotendinous junction of the Glutes, Quads, and Gastro/Soleus (Novacheck)

Improved Mechanics

- Pelvic Position is the most important issue with speed training
  - If an athlete is unable to stabilize the pelvis in a neutral position, they will be unable to be an efficient runner
  - Core Stability, Flexibility, and Neuromuscular education are all factors
    - Many athletes will not have the neuromuscular efficiency to adequately control the pelvis
      - Perform pelvic control exercises to promote control
  - Running while holding will help the athlete find a neutral pelvic position and learn to maintain the position in a dynamic, running environment

Metabolic Factors

- Improving Anaerobic capacity another key to improving the speed and power athlete
- Large number of advantages to training anaerobically on a high speed treadmill
  - Pyne, et. al demonstrated an increase in Oxygen uptake and lactate levels with interval uphill running
  - Roberts and Belliveau theorized that the increase in mechanical work with uphill running is due to the heightened activation of the hip and leg musculature responsible for propelling the body under the load of the hill
  - Several researchers have shown an increase in lactate production with elevation running

Metabolic Factors

- Research supports the notion that an increase in intramuscular lactate will have an effect of fatigue and performance during athletic events
  - Lactate interferes with muscle contractions if not cleared from muscle quickly and efficiency
  - Lactate must be dealt with by the body
    - It may be expelled through the gastro-intestinal system (not desireable)
    - The other option for the body is to shuttle Lactate out of the muscle through a specific lactate shuttle system
      - Restores pH within the muscle and prevents fatigue
      - Shuttle system responds quickly following several workouts and becomes very efficient very quickly

Metabolic Factors

- By progressively overloading the lactate system, the body will improve the efficiency of the shuttle system and reduce fatigue for the athlete
- The athlete's body should be forced to deal with large loads of lactate without expelling it
- The three most accepted means of producing large amounts of lactate include:
  - Interval sprint training, running uphill, and overspeed training
  - All three occur simultaneously with high speed treadmill training
  - Very difficult to reproduce this type of environment any other way

Core Stability

- In addition to land core training, the treadmill can be used as a great way to train the core
- Performing holds within running workouts will force the core musculature to work in proper sequence and stabilize the core
- Higher speeds and elevations will increase the intensity of this training technique and promote core stability

The High Speed Treadmill is a TOOL within your overall training program

Failure to treat it in this manner will have a detrimental effect on your athletes and team

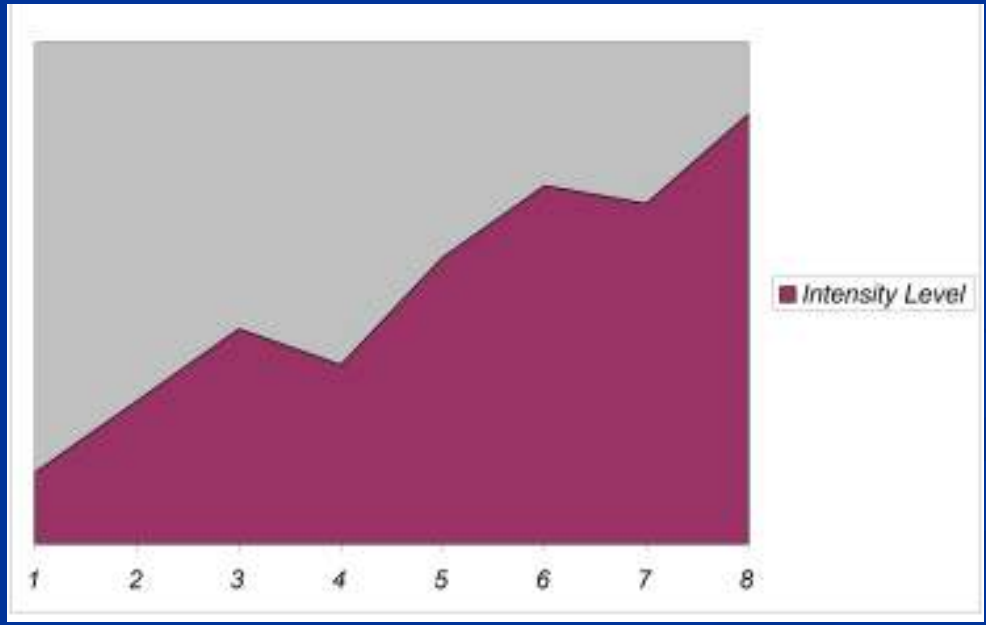
Research suggests that the combination of treadmill and ground based training provides the best results

Yearly Macrocycle

- High Speed Treadmill training should be performed 2-3 cycles per year
  - More than 3 and the athlete will struggle to recover long term because of the intensity of the training
  - Less than 2 and the athlete will not get full advantage of the neuromuscular education that is possible with the treadmill
- Each cycle should be 8-10 weeks in duration
  - Research shows that 6 weeks is required for permanent neuro education to take place
  - Allows for 2-4 weeks of reinforcement of motor patterns following the initial learning phase
- Plan to train on the treadmill in preseason and 1-2 cycles in the offseason
  - At least 4-6 weeks after season has completed
  - Allow 4-6 months between cycles to encourage neuromuscular stimulus

8 Week Mesocycle

- Workout intensities vary throughout the 8-week program
  - Ever changing stimulus keeps body free from plateaus
  - Allows athlete to recover and tolerate increasing intensities both physically and mentally



Weekly Microcycle

- Attempt to split workouts up
  - Workout #1 - Ground Based Speed
  - Workout #2 - Agility
  - Workout #3 – Treadmill
- Total body lift everyday
- Utilize Core Stability exercises daily
- Start with the exercises that are the most demanding on the Neuromuscular system and progress
  - Dynamic Warm-up
  - Speed/Agility
  - Power
  - Strength
  - Core
  - Conditioning
  - Flexibility

Program Overview

- Entry Level Programs (21 options):
  - Developmental
  - Developmental Leg Strength
  - Reduced Speed
  - ***Standard***
  - Advanced
  - Developmental Lineman
  - Standard Lineman
  - Advanced Lineman

Standard Program is appropriate for 60-70% of athletes

- Program which is the basis for all of the other program variations

- System allows for semi-individualization of programs within a group setting
- All have several metabolic components

Program Overview

- Metabolic Components
  - Standard Metabolic
    - Appropriate intensity loads for majority of the athletes in the program
  - ↑ LA
    - Variation of the standard program for the athlete with a poor anaerobic capacity
    - Consists of increased volume
      - Longer runs and a greater number of them
      - Most runs are several seconds longer (especially the holds)
      - Increased number of run/hold/runs
  - Low Metabolic
    - A variation of the standard program for the athlete with a very good anaerobic capacity and/or very low metabolic need for their activity
    - Decreased volume of runs
    - Greater focus on neuromuscular development to increase speed and a decreased focus on conditioning
      - Shorter runs, higher speeds, decreased number of runs
    - Great program for athletes preparing for a tryout/combine

Ground Based Speed

- Medium intensity workout to focus on speed training – Traditional speed training workout
  - Initiate speed workout with Drills, followed by a sprinting workout
  - Should be technique period
  - Ground based workouts will allow hamstrings to fire in proper sequence while sprinting
  - Opportunity to work on acceleration phase of sprinting and starts

Speed Drills

- A Skip
  - Skipping is basic motor development activity
  - Dynamic, ballistic movement that carries over well to sprinting

Speed Drills

- High Knee Drill
  - Increased knee drive and upper leg speed

Speed Drills

- Leg Cycles
  - Develops Proper leg motion for running

Speed Workout

- Technique can also be enhanced through sport specific runs
  - Form Runs (75%) x 30-50 yds
  - Accelerations x 30-50 yds
  - Ins-n-outs x 40 yds
  - Acceleration running drills (i.e. wall run)
- Sport specific sprints should be incorporated to fit the athlete's needs
  - Include multiple start positions replicate the sport

Agility Workout

- Perform Dynamic Warm-up, followed by agility workout
- Don't get caught up in specific drills for agility, rather teach planting/cutting movements in a variety of environments, focusing on quality over quantity
- Key points are to decelerate body under control (shouldn't slap feet), get past object, plant off of inside foot, and make a sharp corner
- Encourage athlete to keep weight over inside foot and accelerate off of it as they leave the corner
- Keep hip, knee, and ankle in a neutral position throughout
- Add transitory exercise (i.e. add a ball) once the athlete perfects the movement skill in a controlled environment

Treadmill Workout

- Perform Dynamic Warm-up
- Follow warm-up with basic running drills
  - A Skip
  - High Knees
  - Butt Kicks
  - Leg Cycles
- Initiate Treadmill workout

Treadmill Pretest

- Treadmill Pretest serves as both an evaluation tool and initial treadmill training session
  - Usually performed at the end of week 1 of training
  - If there isn't a good evaluation tool, you will never be able to properly prescribe specific, individualized training
- Pretest is based on several factors:
  - Treadmill Training History
  - Body style, sport, and position played
  - Speed
  - Metabolic test results

Treadmill Pretest

- All athletes initiate the program at the same speed and elevation (7.5 mph; 0% elevation)
- From that point, athletes are progressed in a similar manner until they cannot finish a run without a spot
  - This does not always coincide with ground based speeds due to elevation changes
    - One athlete may be much faster than their teammate in a 40-yd dash, but show very little difference in ability to climb a hill at high speeds
    - This is a product of strength, speed, and power (speed strength)

Treadmill Pretest

- Once the athlete has reached a run necessitating a spot (i.e. 10 mph; 22% elevation), they are classified into a program based on their speed (Reduced Speed)

# Runs	Incline	Speed	Time	Complete
2	0	7.5	:20	
1	15	7.5	:20	
1	25	8.7	(hold) :15	
1	25	10.0	(hold) :15	
1	15	10.0	:12	
1	20	10.0	:10	
(Move to Developmental Program)				
1	22	10.0	:10	
(Move to Reduced Speed Program)				
1	25	10.5	:10	
(Move to Standard Program)				
2	25	9.5	:08/:08/:08 (run/hold/run)	
(Advanced Program)				
Developmental Program (Leg Strength?)				
1	17.5	10.0	:08	
1	17.5	9.0	:08/:08/:08 (run/hold/run)	
Reduced Speed Program				
1	22	8.7	:08/:08/:08 (run/hold/run)	
Standard Program				
2	22	9.5	:08/:08/:08 (run/hold/run)	

Metabolic Factors

- Final component of the training program
  - Prescribes both exercise volume and recovery heart rate during workouts
  - Utilize Metabolic Testing unit to get accurate numbers (i.e. iMett)
- Running volumes are based upon ratio of Anaerobic Threshold (AT) Heart Rate to Max Heart Rate achieved during metabolic test
- The lower the ratio, the more volume required to adequately condition the athlete
  - A low ratio indicates a poor Anaerobic Capacity
    - Poor Anaerobic Capacity will mean quick fatigue and poor lactate tolerance for the athlete
  - A high ratio will indicate good Anaerobic Capacity
    - Athlete can focus less on lactatic acid tolerance and more on speed, strength, power, etc.
    - Recommended volumes for these athletes are less

Metabolic Factors

- Heart Rate (HR) recovery is based upon the ratio of AT to 2 min. recovery HR
  - A low ratio indicates good recovery for the athlete
    - This athlete has good recovery and will tolerate reduced recovery times
  - A high ratio indicates poor recovery
    - This athlete will not tolerate short recovery times and will probably expel lactate and their lunch when pushed
    - Their body cannot adequately shuttle lactate quickly out of their muscle tissue

Metabolic Test			
Anaerobic Threshold		**Recovery**	
A.T. HR		2 min. Recovery HR	
Max HR		A.T. HR	0
A.T./Max %	#DIV/0!	Recovery/A.T. %	#DIV/0!
Program		**Program**	
Less than 88%	↑ LA	Speed Only (Low Met. need)	75%
88% to 94%	Standard	Less than 85% (High Met. Need)	82%
94% and up	Low Metabolic	85% to 92% (High Met. Need)	80%
		92% and up (High Met. Need)	77%
**If A.T. is above 94% & Sport has high Met. need, continue with Standard Met Program			
		HR Recovery	

Performing the Pretest

- Example: John Doe
  - AT HR: 170
  - Max HR: 195
  - AT/Max Ratio: 87.2% (poor rating)
  - Athlete's ratio is below 88% and should be put into the appropriate program to increase LA tolerance (↑LA)
- The athlete's volume portion of their training is set
- Recovery
  - 2 min recovery: 148
  - AT HR: 170
  - Recovery/AT ratio: 87.1% (average)
  - Multiply 170 (AT HR) by 80% (Average category): 136
- John should recover to 136 bpm between treadmill runs

Performing the Pretest

- John Doe
  - 15% elev.; 10 mph; 12 sec. (performed well)
  - 20% elev.; 10 mph; 10 sec. (performed well)
  - 22% elev.; 10 mph; 10 sec. (performed well)
  - 25% elev.; 10.5 mph; 10 sec. (needed spot)
  - John is categorized as "Standard Speed" by the pretest
  - Move to the "Standard Program" down the page to finish the workout
    - 22% elev.; 9.5 mph; run/hold/run to finish
- John's Program – Standard Speed/↑ LA and recover to 136 BPM between runs

Sample Workout

Workout #5 Date: _____

# Runs	Incline	Speed			Time	Complete
1	20	9.0	9.5	10.0	:10	
Box Runs 12" Box 1 X 20						
2	22.5	9.5	10.0	10.5	:08	
Box Runs 18" Box 2 X 20 (Super Set with Above)						
2	25	9.5	10.0	10.5	:08	
3	27.5	9.5	10.0	10.5	:04/:04/:04 *(run/hold/run)*	
2	25	10.5	11.0	11.5	*(hold)* :08	
2	25	10.0	10.5	11.0	:06	

Speedwork					
		Male	Female		
1	0	13.0	12.0	:08	
1	0	14.0	13.0	:08	
1	0	15.0	14.0	:08	
1	0	16.0	15.0	*(hold)* :08	

Program Overview

- Intensity is the measurement for difficulty for the athlete
  - Difficult to quantify due to all of the factors involved
    - Speed, % elevation, run times
  - Athletes need variations in volumes, elevations, and speeds to achieve different training goals, but it takes experience to learn what combinations will be of greater intensity

Wrap Up

- Always utilize a quality evaluation tool to determine the proper training for your athlete
- Have patience when working and developing a program
  - Mistakes are oftentimes a good thing in the overall picture
- Consider a "start up" program to help you get going with a new treadmill training setup
  - Be weary of those trying to lock you into to long term deals as you will soon learn what works best for you in your facility with your athletes
  - Make sure it is easily customizable to fit your needs

Questions?

Mitch Hauschildt, MA, ATC, CSCS

mhauschildt@missouristate.edu

www.maximumtrainingsolutions.com