# Football Is A Game of Inches

An Inside Look at Speed and Power Development

David Sandler, MS, CSCS*D
www.strengthpro.com

## The Lecture Overview

- Generating Speed and Power
- Reaction Time
- Impact Forces – Giving and Taking
- Quality vs Quantity
- Developing Propulsive Force
- First Step – Getting Off the Line
- Acceleration – The Difference Between Good and Great
- The Future of Football – Is It Time To Change Combine Testing?

Sport is over in less then 2 tenths of a second. By the time you actively blink your eye and refocus, you are beaten. Then you are playing catch up. The best athletes in the world make the transition from thought to execution subconsciously which is really conscious reaction-action movements that are so well planned, they seem automatic.

David Sandler, 2007

## Speed

- Physics of Speed
  - Calculating speed
  - Looking at numbers
  - Is time on a 40 that important?
- What You Already Know
  - Starts, mechanics, arm and leg action
  - Sprint drills to improve running performance
- What You Should Know But Can't See
  - Acceleration, Ground Contact Time and Propulsive Force

## What is Speed

- Speed versus Velocity
- Distance over a period of time defines average velocity/speed
- Calculated by Stop Watch or Light Timing System
- Is Time to cover the distance more important than how the distance is covered?
- How does 40yds relate to football

## Typical Ways To Improve Speed

- Work on Starts
- Work on Body Mechanics
- Work on Transitions

- All great methods to improve "Time to Cover a Specific Distance"
- Inherent problem with this training ONLY
  - does not address football specific needs

## Important Components of Being Fast

- Acceleration FROM EVERY POSITION not just the starting 40yd dash position
  - ➢Acceleration = Velocity / Time
  - ➢Acceleration = Force / Mass
    - ➢Force = mass x velocity / time
    - ➢This second equation gives a clearer picture of what needs to happen to improve acceleration

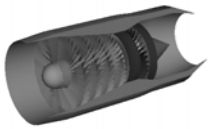
➢Increase Force and Decrease Body Weight to Improve Acceleration

## Important Components of Being Fast

- Ground Contact Time
  - –The longer the time that the feet are in contact with the ground, the greater force produced
    - Impulse is the ability to PRODUCE FORCE for a period of Time
      - –Net Force applied over time (F x T = I)
      - –Change in Linear Momentum
- The longer the time the feet are in contact with the ground, the slower leg turnover occurs

## Important Components of Being Fast

- Propulsive Force
  - –Thrust and Newton's Third Law
    - Every action has equal and opposite action
  - –Directing Force: The Airplane Analogy
    - Lift, weight, thrust and drag
  - –Human Muscle Power
    - Rapid Motor Recruitment



## Airplane Analogy

- Lift Comparison
  - – Force we exert into the ground
- Weight Comparison
  - – Lighter bodyweight, moves "easier"
- Thrust Comparison
  - – Horizontal force created by contacting the ground
- Drag Comparison
  - – Reducing resistance created by ourselves and by others

## Power

- Physics of Power
  - – Calculating Power
  - – Looking at numbers
  - – Is height of vertical jump that important?
- What You Already Know
  - – Body mechanics, arm and leg action
  - – Plyometric drills to improve SSC
- What You Should Know But Can't See
  - – Acceleration, Inertia, Eccentric Loading Time and Magnitude, and Propulsive Force

## Typical Ways to Improve Power

- Plyometrics
- Explosive Lifts
  - – Olympic Lifts and variations
- Increase Strength
- Increase Speed

- All great methods of improving power but MAY not address specific needs of football

## Components of Being Powerful

- Acceleration and Propulsive Force
- Inertia (scientific principle not quantifiable)
  - Resistance to Change (can been seen when viewed properly)
  - What does this have to do with Power?
    - Power is the ability to convert an Eccentric Load into a Concentric Action (activating the SSC) as rapidly as possible
    - Resistance to stretch and or time to handle load will ultimately slow this pattern down.

## Components of Being Powerful

- Eccentric Loading Time and Magnitude
  - In Plyos, time in contact with ground/hands is know as amortization time
    - Long amortization time decreases transfer of energy to the concentric
  - Magnitude refers to "how great" the load is, hence depth jumps and other "shock level" plyos are used to increase this
    - Increasing magnitude improves power only if it can be handled properly

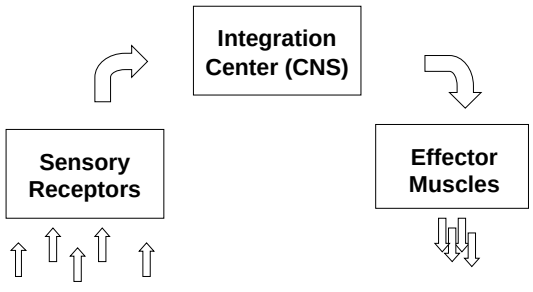
## Reaction Time

- Neurological Processing Pathway
  - From thought to execution
- Generally thought of as automatic reflex activity
  - Extensor thrust reflex, flexor reflex, and crossed extensor reflex
  - Problem – this only answers the first part of the equation (sense and act) but does not clarify how the movement will occur
- Interpreting a Stimulus
  - All senses contribute

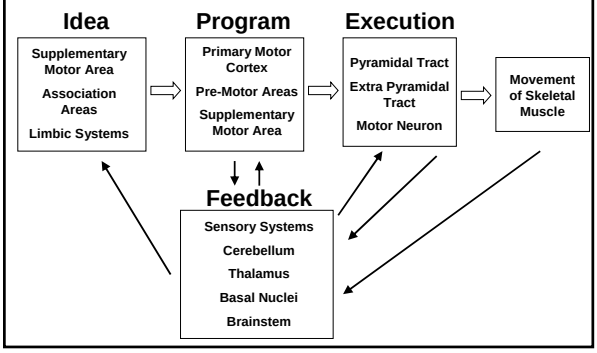
## Reaction Time

- Purpose of reaction training is to stimulate motor recruitment speed and to try to make movement "automatic"
- Reaction With a Correct Action is Most Important
  - Process the Information
  - Send the Correct Sequence
  - Execute The Proper Movement
- More complex then just reacting and more important to design and implement USEFUL exercises
  - Cerebral Cortex
    - Initiates voluntary movement
    - Complex tasks – movement
  - Basal Ganglia
    - Thalamus; homeostasis
    - Balance, equilibrium, coordination
  - Cerebellum
    - Feedback center
    - Timing and intensity of muscle movement

## Reaction is a Planned Movement




## From Thought to Execution:
### The Integration Center



## Impact: Giving and Receiving

- Generally thought of as being tackled or tackling in football
- Deeper look examines joint structure and vulnerability as well as ability for muscle to develop force and withstand stretch
- Using Newton's Law (F=ma) we can calculate force of impact in a perfectly inelastic situation – NOT REAL LIFE
  - Although many have "taken a shot" by accident, in most cases, much of force is dissipated immediately upon impact
- Key to receiving force is to dissipate it
- Key to giving force is to concentrate it.

## Impact Kinetics

- Increase Kinetic Energy
  - $KE = \frac{1}{2}mv^2$
- Increase velocity and Kinetic Energy increases by a factor of 2.
- It is rare to get a full speed open field blind tackle so training velocity has limitations
  - Increase acceleration from a close position, contact velocity increases and so does Impact

## Quality vs Quantity

- Quantifying movement, force, speed and power are important for comparing, categorizing, and marking improvement.
- Quantifying alone does not help to improve a skill or answer the question as to where the "problem lies"
- Qualitative examination is imperative to reveal weakness and design a training system to address those issues.
- Statistical relevance generalizes but may not distinguish the small differences that impact the game of football – centimeters and milliseconds makes a difference in play success or failure.

## Identifying Problems

- Video analysis with time coding and slow speed playback can distinguish many flaws
- Using timing devices, force plates and accelerometers can help to determine specific aspects of performance
- Develop tests/screens that look for specific components that make up a skill, not just the completed exercise
- Examine components that will help to IMPROVE PERFORMANCE FOR FOOTBALL

## Take A Deeper Look

- You've all heard the saying "Don't train sport athletes to be good at weightlifting or powerlifting movements
- So now everybody has switched to "functional exercises", plyometrics, speed, etc.
- So now we are training our athletes to jump higher, run faster, and rotate more explosively
  - I guess High Jumpers and Sprinters make better football players then Powerlifters or Olympic Lifters
- **Have We Really Solved The Problem??**

## What Makes A Football Player

- While people tend to put a lot of stock in vertical jump, 40 yard dash time, and pro-agility, arguably, the best football players ever, have never been the best at one aspect such as jumping, speed, etc.
- Furthermore, after combines, the Pros rarely do those same tests again
- Football is not just about speed, power and strength
- So the question should be "What can we do AS STRENGTH COACHES to help improve skill"

## Planning A Training Strategy

- Difficult for HS coaches and/or programs with limited facilities and coaches
- Generally speaking, every athlete needs speed, power, strength, etc. but further analysis will show that every athlete needs the components of that make up these aspects more
  - The approach should look at including more drills that address specifics such as eccentric loading, reaction with specific action, and maintaining sport useable position.

## What is Football Specific

- There is no such thing as Sport Specific other then the sport itself.
- If you want to be a better football player, you need to catch balls, work on separation, run better routes, establish proper position for blocking, etc.
- Do not try to create drills that are for football, rather look at the skill and decide what needs to be improved upon…then, practice the sport

## First Step Training

- Reaction to the First "Correct" Movement Position
- Drill Purpose:
  - Improve ability to tell feet where to go and when to go
  - Proper body position
    - Hips down, head up, chest up, tight torso, relaxed upper body, and weight on balls of feet
- Types of Drills:
  - Ladders, Agilities with Reaction, Reaction Equipment

## First Step Drill Considerations

- Challenge step sequence when using ladders
  - Your athletes will "get good" quickly because the step sequences become learned and "rung" distance is standard
  - Use ladder combo drills so that athlete has to enter or leave the ladder in proper position
  - Speed is only one part, if your athlete cannot stop, change direction, restart, and SEE WHAT IS GOING ON, then why do the drill

## First Step Drill Considerations

- Agility drills need reaction and body position component
  - Cones are markers for direction change – focus on the transition between footwork patterns
  - Athlete's head should be looking up SO HE CAN SEE WHAT IS GOING ON!
- Reaction Balls or tools are to get the body to react and move
  - emphasis should be on body position, not whether or not the athlete can actually catch the ball
  - Reaction stimuli should be audible and visual as sport need requires

## Acceleration/Propulsion Training

- Driving Force To Move The Body
- Most Important in Football:
  - First 5 to 10 yards
    - If your athlete cannot move fast in the first few steps, you are out of the play, and while "closing speed" looks impressive on field, your athlete should not have gotten beaten in the first place
- Drill Purpose:
  - Increase force of drive (thrust), overcome inertia, and decrease drag
- Types of Drills
  - Short acceleration sprints, agilities, long jump and variation, single leg squat, lunge and jump exercises

## Acceleration Drills

- Football is about “getting there quick”
- Form, technique, etc. is important but not at the cost of losing valuable acceleration
  - Work on acceleration, build in technique
- 5 to 10 yards all out, all the time, then break it down
  - Don’t fatigue athlete and confuse conditioning with increasing overall movement acceleration
- Accelerate from different positions
  - Lateral start, standing start, kneeling start, etc.

## Acceleration Training

- As you become more explosive, and drive out harder, body position will need to be corrected
- Try doing acceleration training first, then fix mechanics rather then mechanics first
  - You may not be in “proper position” on the field
  - Concentrate on only one thing at a time
- As a coach, try to only fix one variable at a time

## Eccentric Load Training

- Rapid and/or Large Pre-Loading of Movement
- Separately Trained From Power
- Drill Purpose:
  - Increase ability to load eccentrically WHILE MAINTAINING PROPER BODY POSITION
- Types of Drills:
  - Drop landings, speed loading, deceleration training

## Eccentric Loading Exercise

- Deceleration component in agility, ladder, plyometric, and sprint drills
  - Stop suddenly and completely maintaining balance and body position
- Land on balls of feet
  - Just work on perfect landings on the balls of the feet, keeping tension on achilles
- Rapid loading quick feet/hands plyometrics
  - Keep drills short, fast and minimize GCT

## Speed Training

- Covering Distance in Shortest Time Period
- Acceleration vs top speed vs speed maintenance
- Drill Purpose:
  - Improve break-away and closing speed
  - Improve 40 yard time
- Types of Drills:
  - Sprints, ballistic strength, rotational speed

## Speed Drills

- Sprint distance about 20-40 yards
  - Work on “jog to sprint”
  - Work on 10 ⇨ 20, 10 ⇨ 30, 20 ⇨ 40
- Ballistic strength exercise (6 reps max)
  - Speed squats, speed bench press, etc.
  - Reduce time to complete reps
- Rotational speed exercises
  - Med ball and tube work

## Power Training

- Converting Stored (Built Up) Energy to Concentric Force Production
- Drill Purpose:
  - Improve ability to transfer force rapidly
  - Make athlete more explosive
- Types of Drills:
  - Fast feet jumps, general plyos, resisted sprints, resisted jumps, explosive lifts

## Power Exercises

- Focus on decreasing time
- Focus on rapid transition from eccentric to concentric (rapid SSC activation)
- Keep resistance light so that bar/body travels rapidly
- 3 to 5 rep sets with enough time to recover completely

## Strength Training

- Increasing The Total Numbers of Muscle Fibers Involved in Producing Usable Force
- Exercise Purpose:
  - Improve overall muscle strength, muscle balance,
  - Reduce joint instability and injury potential (Pre-hab)
- Types of Exercise:
  - Multi-joint, ENTIRE body, FULL ROM
  - Solid base exercise that require core strength

## Strength Exercises

- Major Push – Pull movements
- 5 to 8 rep sets with long rest
- Ground based as often as possible
- 4 to 6 week cycle before switching (to power, endurance, speed, etc.)
- Clean up technique
- Activate core (abs, low back, etc.) and learn posture control
- Pulls, drags, carries, and “big strength” exercises

## Impact Training

- Increasing Kinetic Energy or Dissipating Force Rapidly
- Training Purpose:
  - Increase KE – full ROM, follow through and finish strong
  - Dissipate Force – “swallow” impact by forcing body position
- Ways To Train:
  - Increase KE – compensatory acceleration, release moves, “run drills out” (finish full speed)
  - Dissipate Force – drop step loading, “balanced-mobility” training

## Impact Exercises

- Increasing Impact Power
  - Band and chain training
  - Release moves allowing follow through
  - 5 yard full sprint finishes on drills (ladders, agilities, etc.)
- Dissipation of Force
  - Drop load landings
  - Reverse lunges
  - Dynamic movement to static hold

## Balance Training

- It easy to show that an athlete has weaknesses, but do those "weaknesses" really have anything to do with football
- Football is dynamic, recruiting muscle fiber for stationary activity can be done in strength training
  - If you have enough strength, you can "right yourself" with strength
- Balance in football means TRANSITION from one movement to another while maintaining balance
  - Lateral accelerations into forward, forward into lateral, lateral to backward, backward to lateral, forward to back, back to forward, and combinations of those

## Testing for Purpose

- You can "test to test" or "test for purpose"
- Testing for numbers is good for keeping your job and ranking players
- Testing for purpose means to develop a battery of tests that truly determine valuable information that you can use to BETTER YOUR PROGRAM
  - Remember, only you can take a good look at what you do and decide how to make it better

## Types of Tests That Provide Good Information

- Tests that can reveal individual parts of a complete skill
- Tests that can assess a "valuable" piece of information for football
  - Acceleration (lateral and linear)
  - Contact time, eccentric loading mechanics
  - Movement transition
  - Tolerance
- Use of tools that can provide accurate info
  - Electronic timing
  - Video – regular slow motion playback is fine
  - Strain gauges and accelerometers provided it is not too complicated

## Re-Think Your Strategy

- Don't train to test (unless you have to)
  - Train to be faster and smarter
- Improve passive strength
  - Eccentric loading
- Improve neuromuscular mechanics
  - Use training tools (ladders, balls, etc.) to work transitions
- Trouble shoot from the field to weight room
  - What is athlete's weakness and what can you do to help

## When to Incorporate Specific Training Stimuli

- Good dynamic warm-up
- "New" Training Stimuli
  - More complex skills or new skills next for about 10-15minutes (don't over do-it)
- Follow with support exercises for increasing speed or power
  - Don't use "heavy – shock" drills on advanced action training stimuli days
- Then hit your strength exercises
- Good cool-down

## Example Training Stimuli Program

- Dynamic warm-up
- 4 sets of 3 different specific footwork drills
  - Emphasize body mechanics and movement patterns, not just finish drill
- 4 sets of 3 agility drills
  - Emphasize transitions and body position
- 4 sets of eccentric loading drills
  - Emphasize proper loading technique and body position
- 3 sets of 2 fast plyo drills
  - No depth jumps or shock drills on eccentric load strengthening days
- Strength workout to finish

## Football Specific

- Is accelerating specific to football?
- Is eccentric loading specific football?
- Are movement transitions specific to football?
- Are 40s, pro-agilitys, or 225lb rep tests football specific?
- Catching, tackling, drops, routes, and separation, and throwing are football specific

## Football in the Future

- Bring science to the football field and cross reference with “weight room” activities
- Become more in tune with football motor skills and performance variables that relate to it
- Tools will become easier to use, give more valuable information and help diagnose more correctly to provide better prescription

## Summary

- Training should not be about developing gimmicky exercises
- Don’t over think, but think it through
- Don’t over correct, coach one skill at a time
- Focus on improving mechanics through drills and exercises that will improve on field performance and not just “in the gym” performance