Surface Characteristics

Another look at testing and evaluation

Colin Walker,
Mechanical Engineering,
Strathclyde University,
Glasgow

SportSURF Launch Seminar
17th November, 2005

Supported by:

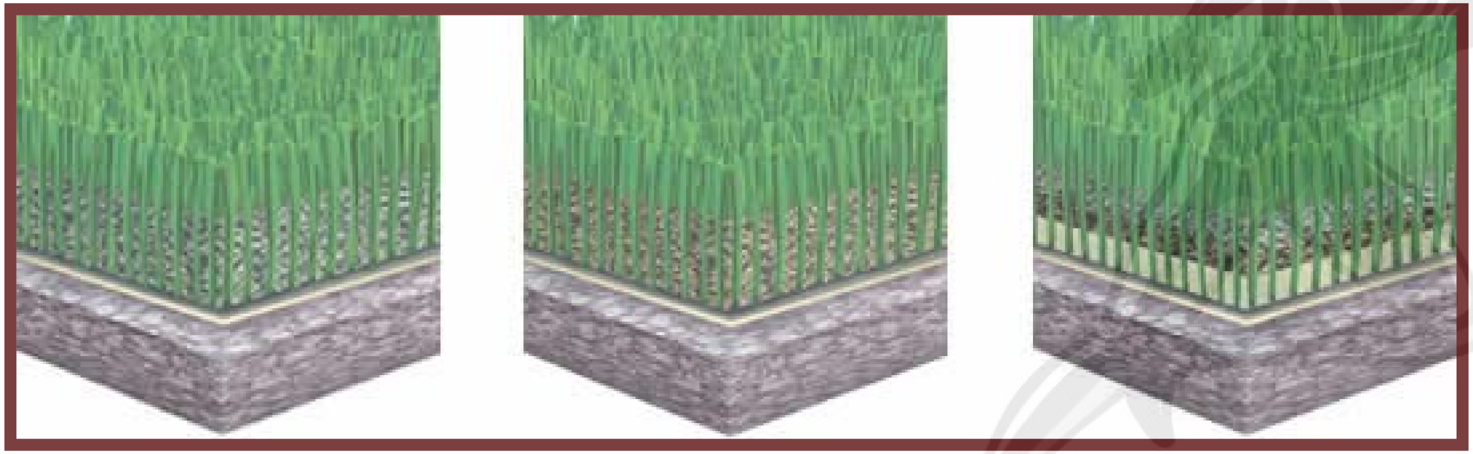
Why Artificial Turf?

- Natural turf regenerates slowly
- Weather may be too cold, too wet or too dry
- Good pitches cannot take more than 1-2 games a week without degradation
- If a high quality pitch is always available, skill levels will go up

Artificial Turf Today - 1

- FIFA and UEFA both have major initiatives in place and detailed specifications
- Hockey has gone over to artificial turf right down to schools level - the game has undergone a revolution
- Rugby has just issued a draft specification

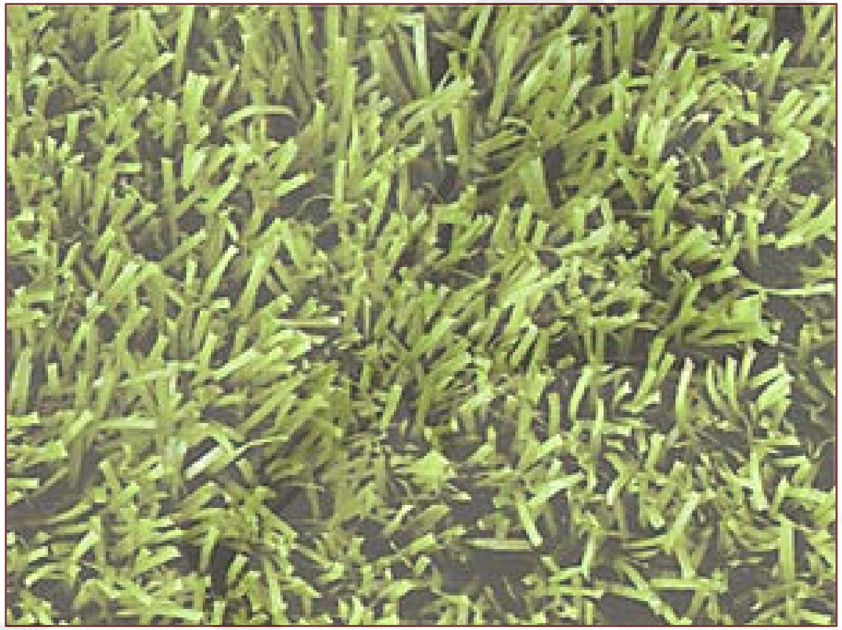
Types of Artificial Turf



Football turf with various infill options

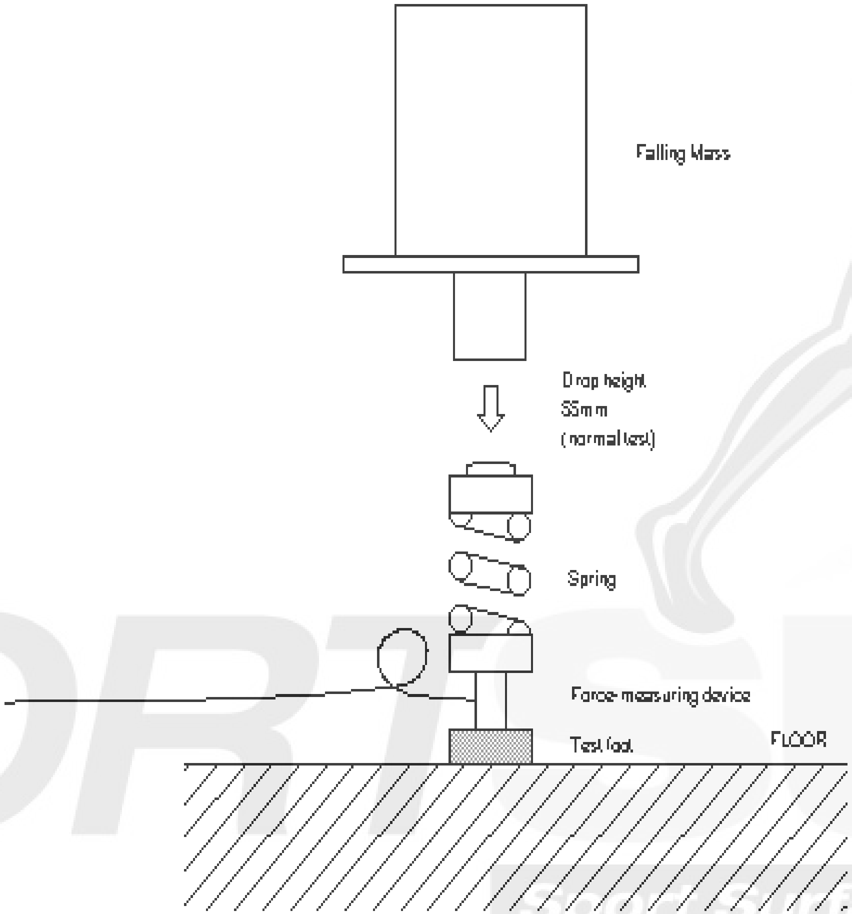
Fibres for Artificial Turf

Fibre tufts



Player's-eye view

Schematic of the Berlin artificial athlete



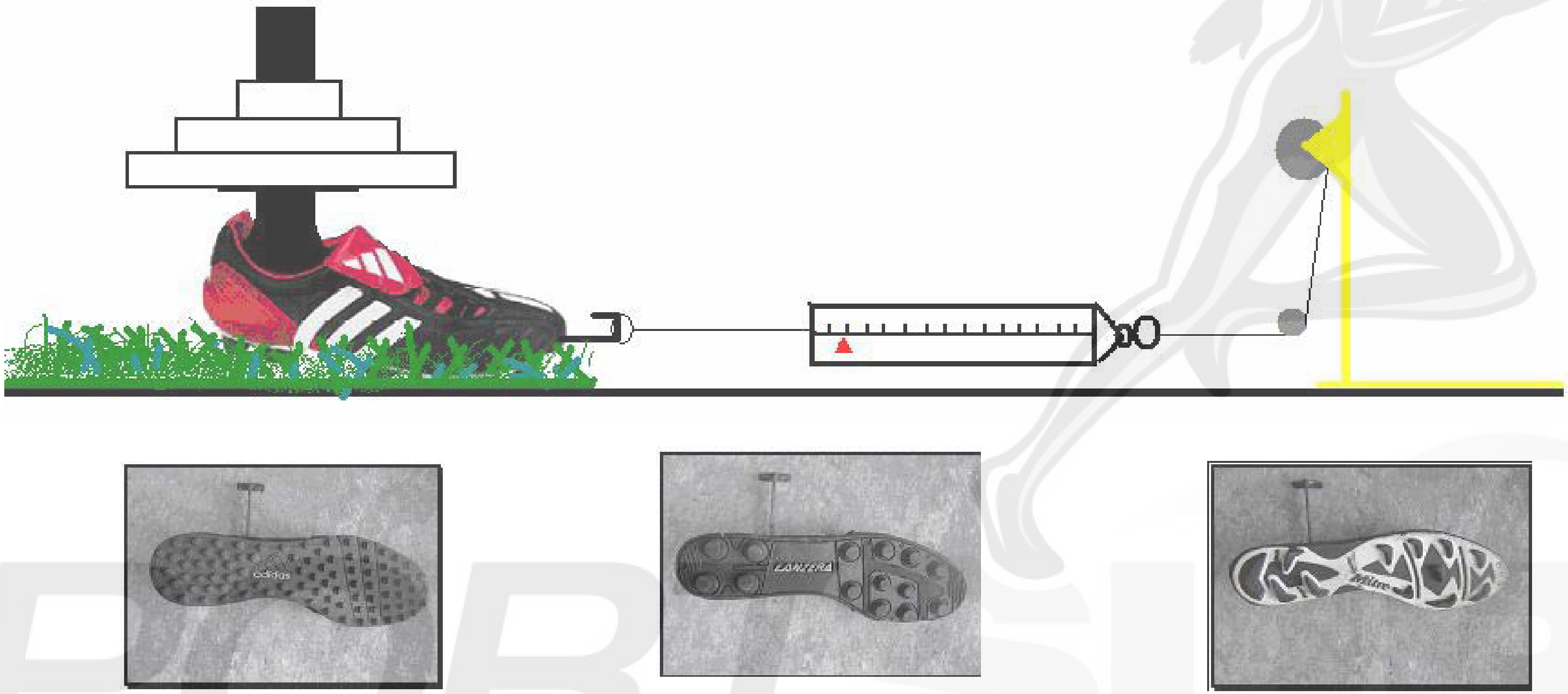
Sliding Resistance Test

Rotational resistance

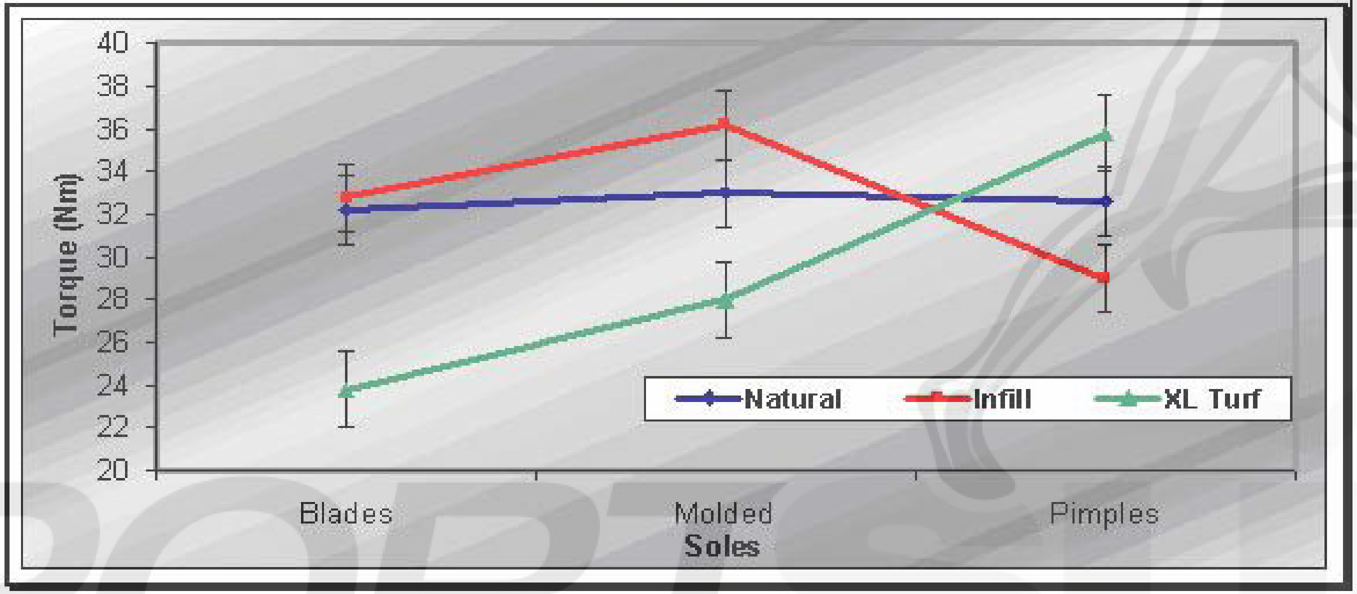
Rotational resistance apparatus

Traction Resistance

(F Vachon, XL Generation)



Rotational Resistance



Current Challenges

- Testing (lack of basic science input)
- We do not really know how injury arises
- What is the best mix of properties?

So what is the Problem?

- Turf properties change the game
- New patterns of injury
- Players do not take the time to adapt
- Incorrect footwear selection may lead to injury
- Game may change and new skills are needed

Other Problems

- While the testing is rigorous, it is not related directly to performance or injury potential
- There is a lack of basic scientific input to relate real players to real surfaces
- How do players react to changes in surface?
- How should we test pitches to reflect how players move?

Our Response

(Bioengineering & Mechanical at Strathclyde)

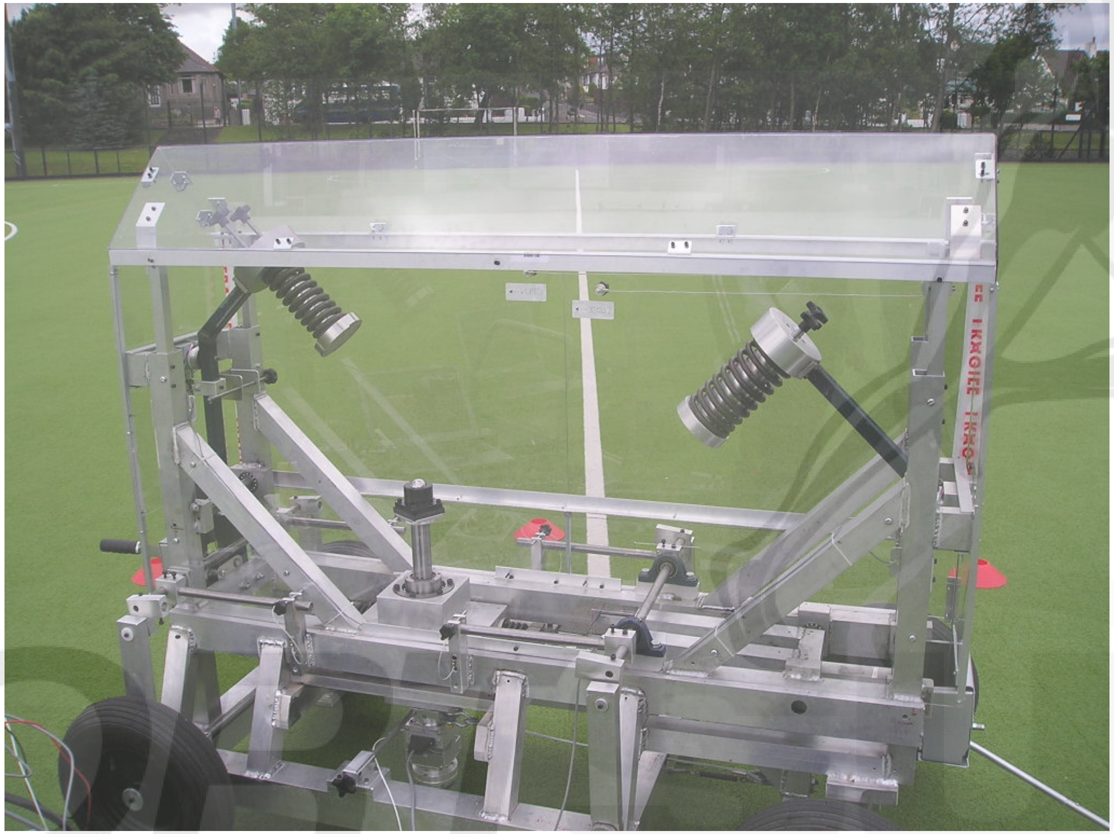
- Existing test methods look at one parameter at a time (friction, torque, compliance)
- When a player turns, he combines all of these aspects of the pitch – ie he impacts, stops and turns as a single movement.
- Pitch testing should reflect this reality (or be able to show that the effects can be combined in a linear fashion)

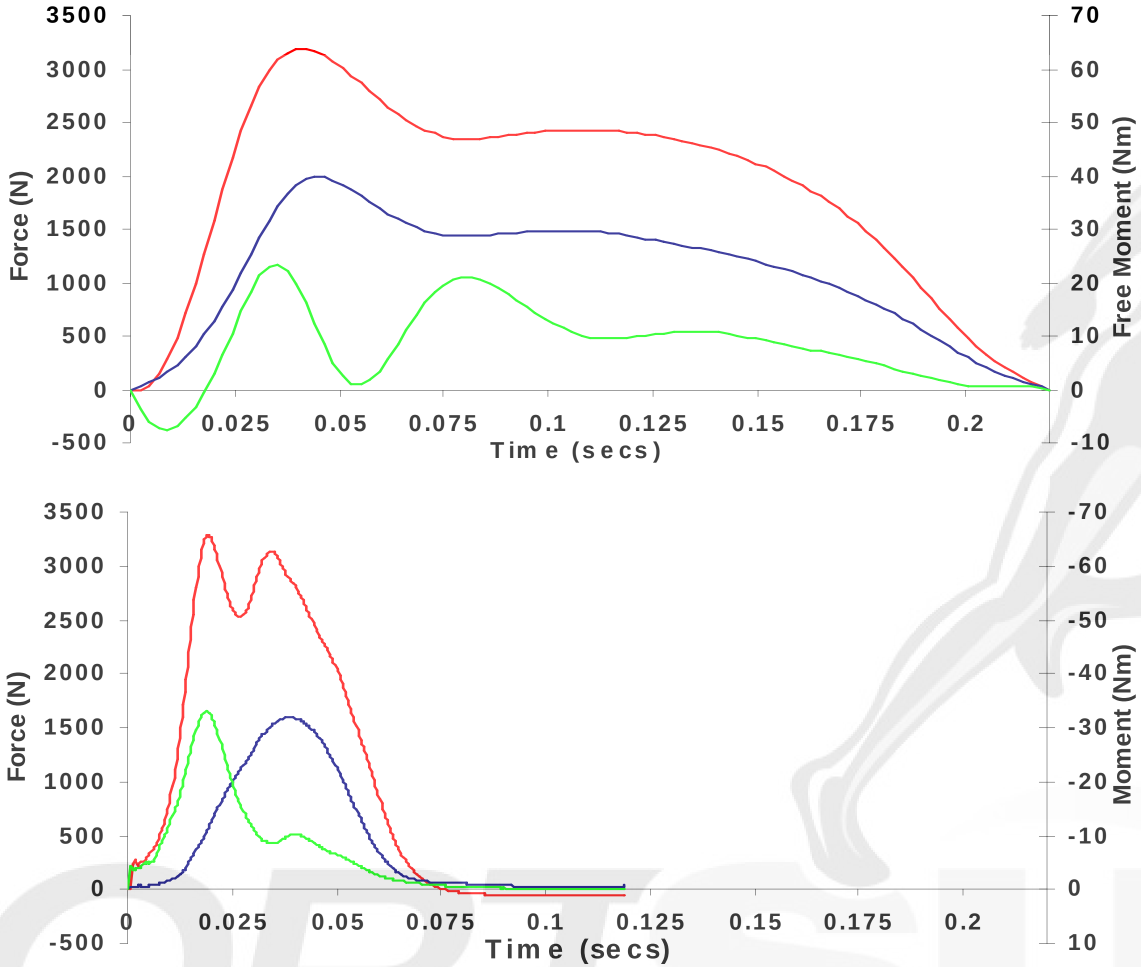
New Test Regime - System Design

- The basic concept uses a test foot which may be loaded and twisted at the same time, like the foot of a player who is running and turning
- In reality, we use two pendulums which impact on the foot to give the two motions
- The torque and friction forces may be varied independently by varying the torque arm

Integrated Pitch Tester

Tester Primed for Action





Ground loadings during human sports movement (a) and rig testing of a 3G surface (b)

RESULTS:

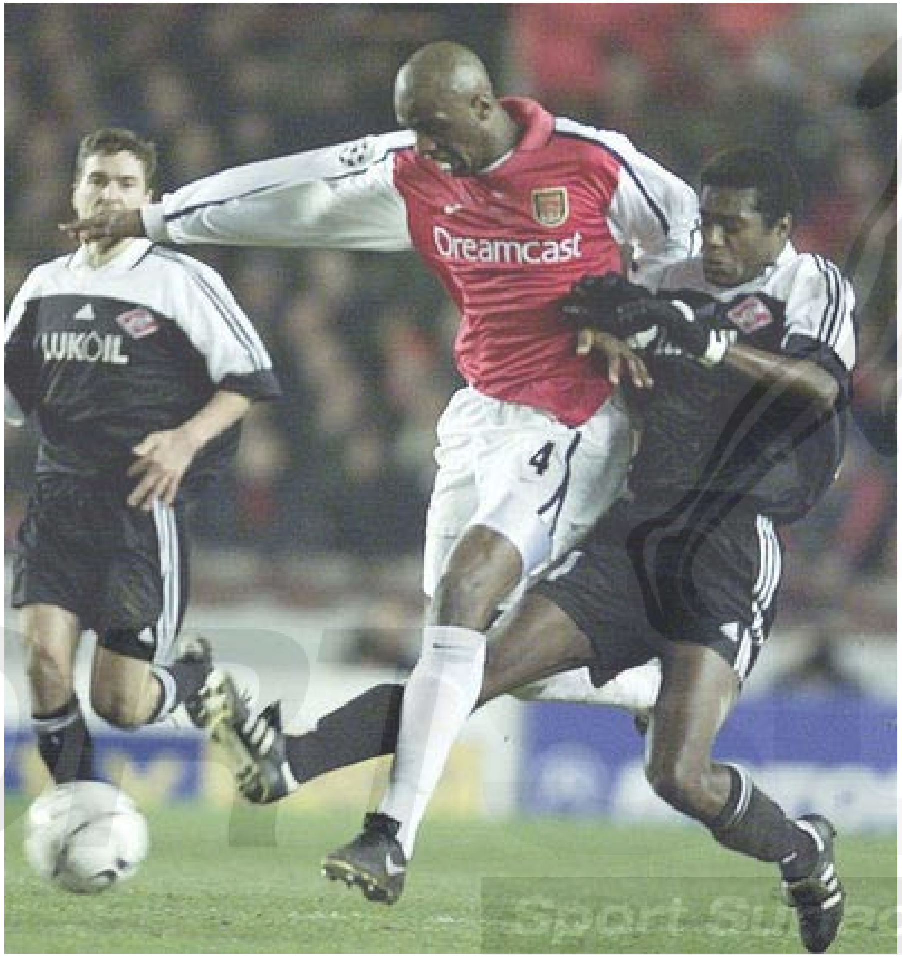
- Dynamic 3-D testing produced similar loading magnitudes to a player/ground interaction.
- Shear and torque values were much greater during the dynamic 3-D testing compared to the combined shear and torque loading with a static vertical load
- Greater normal (vertical) loads decreased the traction coefficients
- Traction coefficients and peak torques were slightly lower on 3G turf than natural grass during dynamic 3-D testing
- The variability of the results reflected the different areas of the pitch tested

Athlete-Pitch Interaction

- We <u>can</u> test the physical properties of pitches
- But - How does this match with the way that players perform?
- Can we use players to tell us what pitches should be like?

Player/pitch interaction

More interaction



Athlete with markers, knee goniometer and data logger

Athlete at the end of a trial in the biomechanics lab.

Programme 1

- Players from football, rugby and hockey
- 3 artificial pitches built in a lab.
- Players ran, turned, stopped etc
- Their movements were recorded

Programme 2

- The ground reaction force was measured
- Changes in kinematics were correlated with changes in pitch properties.
- Tests repeated outdoors on grass and artificial turf, wet and dry

Results 1

- Players adopt a personal running style, independent of the surface
- For most tests, the differences between all of the pitches was minimal
- <u>But</u>, in situations where injury may arise, the stiffness/friction properties come into play

Results 2

- When a player turns, the detailed mechanics depend on the balance between the friction and the compliance of the surface.
- Players who opt for maximal stability – ie long studs – may injure their knees or ankles.

How do Injuries Arise?

- We do not really know
- Overuse injuries arise from running on hard surfaces (not from long distances per se)
- Acute injuries arise from a combination of speed, surface, shoes, fatigue and preparation (ie it is multifactorial)
- <u>But</u> pitch design and sound advice can help

Adapted, by permission, from W.B. Leadbetter, 1992, "Cell-matrix response in tendon injury," Clinical Sports Medicine 11:533-578.

Typical overuse injury (hypothetical)

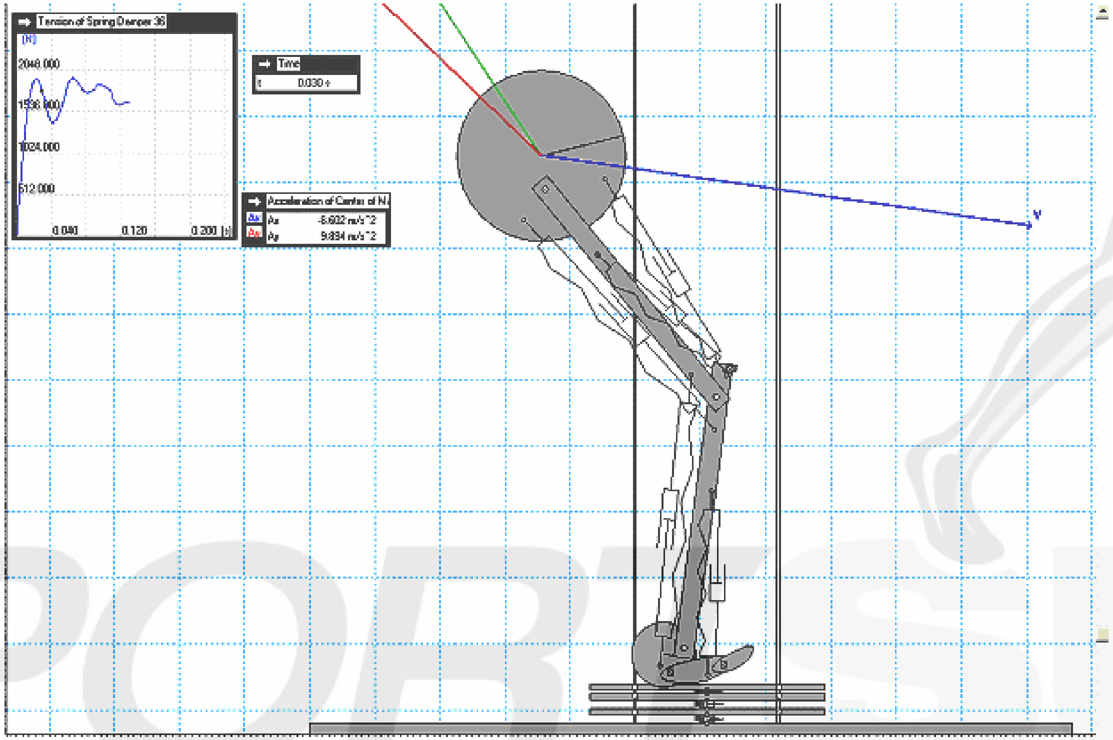
Muscle Forces 1

- We need to understand the interplay of muscle forces during activity
- It is hypothesised that the interaction of active and antagonist muscles leads to injury
- We need to understand the forces in muscles during activity

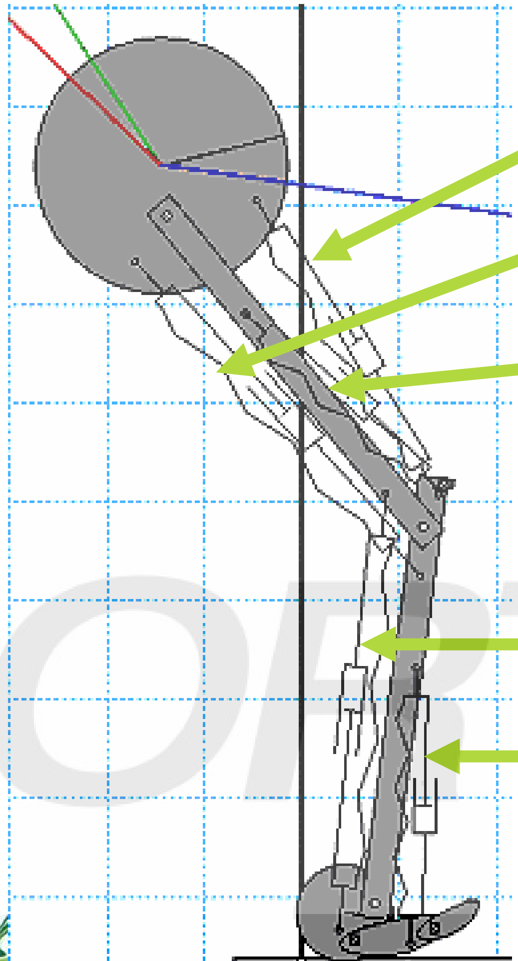
Muscle Forces 2

- It is not easy to measure muscle forces in real time
- Our approach was to develop a model of the active leg with all of the main muscle groups represented
- Muscles were modelled as spring/damper units

Dynamic Leg Model
Just after Impact



Muscle Groups



Rectus femoris

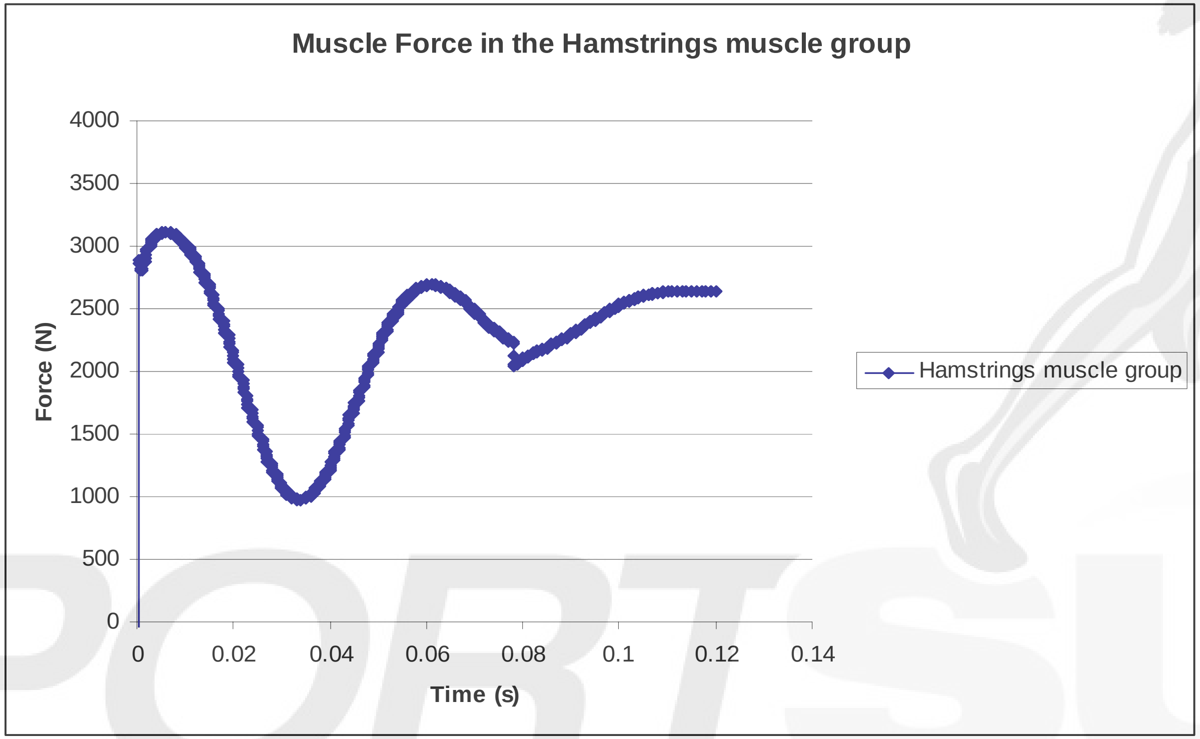
Hamstrings

Vasti

Gastrocnemius

Tibialis anterior

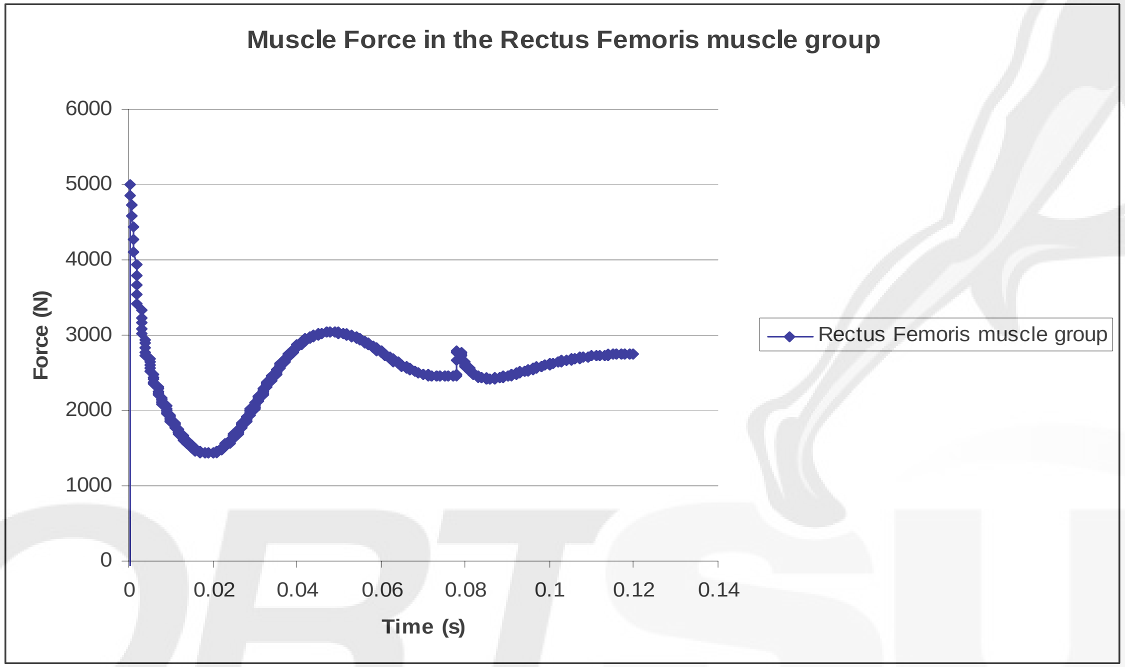
Predicted Muscle Group Forces - Hamstrings



Force - Newtons

Time - seconds

Predicted Muscle Group Forces – Rectus Femoris



Force - Newtons

Time - - seconds

Conclusions 1

- A new design of integrated pitch tester has been demonstrated which can deliver a realistic assessment of pitch performance
- We have shown the importance of friction as a property of turf that, along with the compliance, defines the kinetics of motion during a turn

Conclusions 2

- The detailed muscle group forces have been predicted from a dynamic leg model
- We now have the basis for defining the injury potential of pitches and shoe/pitch combinations.