

Developing, Testing, and Selecting Natural Turf and Artificial Turf for Athletic Fields

**Third Seminar on Practical Turf Management,
Hong Kong**

John Sorochan, Ph.D.
University of Tennessee
July 20th, 2013

Outline

- **Synthetic Turf 101**
- **Synthetic Turf Maintenance**
- **Testing Synthetic Turf Surfaces**
- **Purchasing Synthetic Turf**

SYNTHETIC TURF

101





Infill Popularity



Photo: J.T. Brosnan

Infill Popularity



Photo: J.T. Brosnan



Photo by A. Boggs

Manufacturing Terms 術語

1. **Fibers**
2. **Extrusion**
3. **Primary Backings**
4. **Fabrication**
5. **Secondary Backings**
6. **Pad Systems**
7. **Testing**

SPECIFICATIONS

- Fiber weight:
 - The amount of fiber tufted into one square yard
- Stitch gauge:
 - Distance between rows of tufts
- Pile height:
 - Amount of exposed fiber from the surface of the backing

SPECIFICATIONS

- Tuft spacing:
 - Stitch rate
- Infill:
 - 100% crumb rubber
 - Sand/crumb rubber mix
 - Alternate infills
- Color:
 - Anything on the color wheel is available
- Seams:
 - Sewn, Glued, or Velcro

FIBERS

There are three components that are used to manufacture synthetic turf:

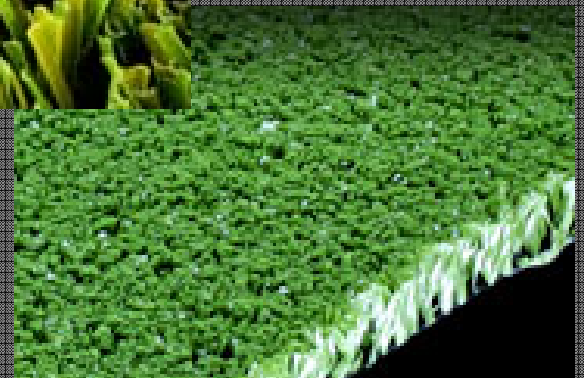
1. Nylon



2. Polyethylene



3. Polypropylene

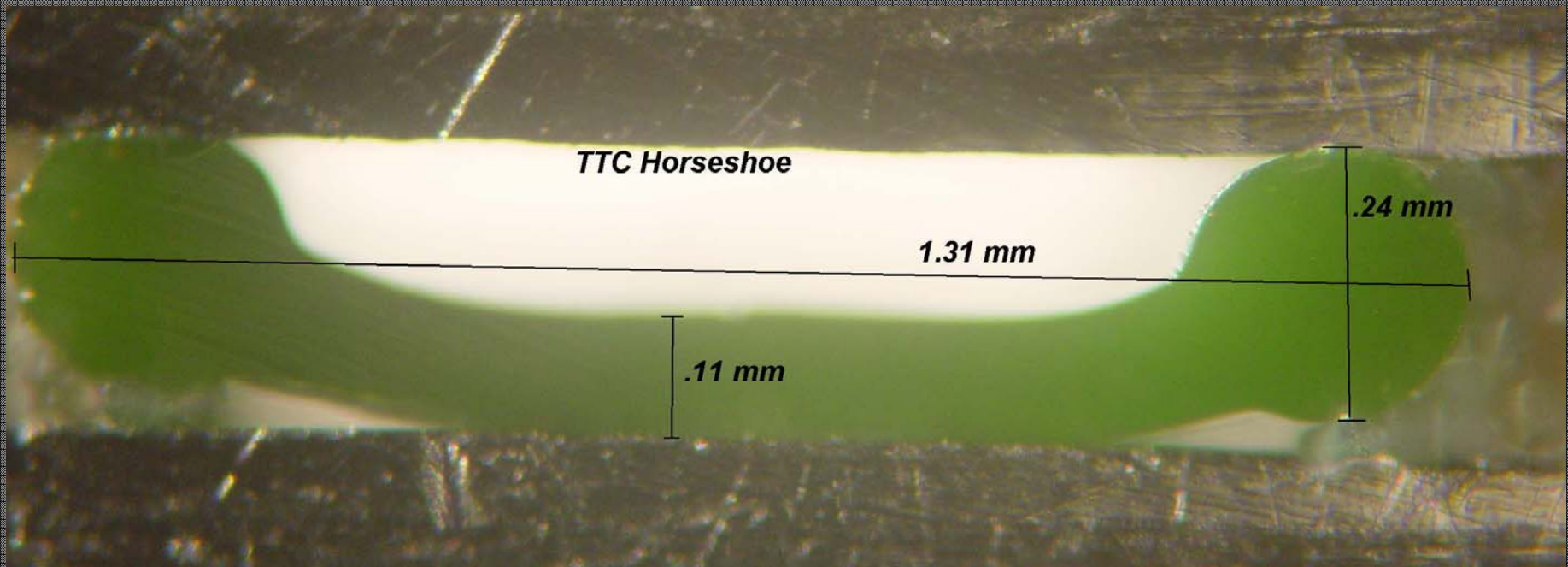
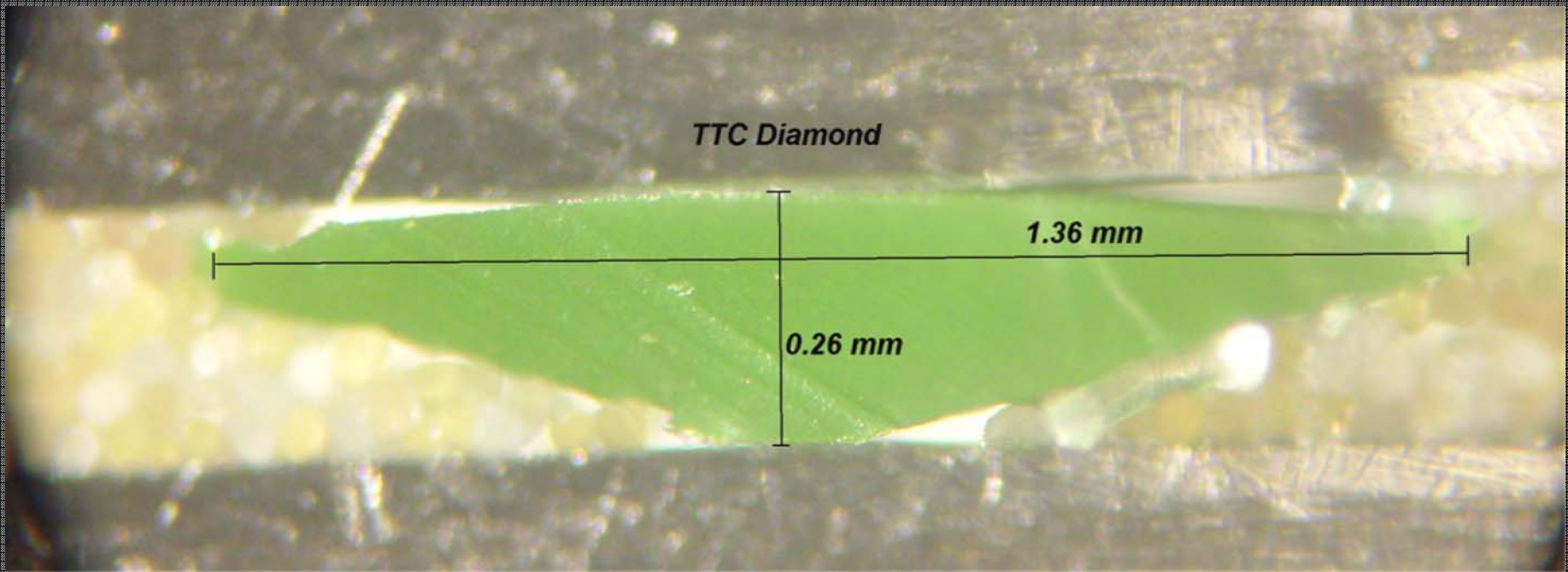


Synthetic Systems

- Knitted Nylon System
 - Original AstroTurf
 - Preferred surface for field hockey
 - Abrasive
- Pure Grass System
 - 100% nylon
 - Installed without infill (typically)
 - Installed over shock pad/foam layer
 - Can use some sand infill if desired
 - Shorter pile length (1 – 1 ½")

Synthetic Systems

- Infill Systems
 - Synthetic fibers with crumb rubber and/or sand infill
- Monofilament Polyethylene Systems
 - Highly durable, individual monofilament blades
 - Tufted into a backing material
 - More natural appearance
 - Resilience determined by fiber shape
 - Currently being researched (i.e. flat vs. horse shoe)
 - Components used in resin (impact molecular chain)
 - Fibrillation



Synthetic Systems

- Slit Film System
 - Thin sheet of fiber that is extruded and slit sporadically throughout the system
 - Intended to blossom (fibrillate as the system ages/gets worn (accordion like)
 - Older system that is durable, but does not have the look and feel of the monofilament systems
- Textured thatch root zone
 - Increase resilience of fiber
 - Reduce crumb rubber migration
 - Reduce amount of infill
 - Minimizes root zone compaction over time (being researched)







Unanswered Questions

- Maintenance effects
- Performance vs. Natural Grass
 - Injury
 - Playability
- Cost



Synthetic Turf Maintenance

Not Maintenance Free

- Brushing every week instead of mowing
- Grooming a couple times per year instead of aeration
- Irrigation to cool surface during hot sunny days
- Spraying fabric softener to reduce static
- Spraying wetting agents and occasional Roundup
- Every few years topdressing some new infill

Manufacturers recommendations for frequency of maintenance actions

(courtesy: Prestige/Tarkett)

SERVICE	Weekly	Monthly	Annual	As Needed
Brushing	X			
Refurbish penalty point	X			
Change penalty point				X
Clean		X	X	
Aeration			X	
Check bonding joints			X	
Chemical weeding			X	
Check sporting qualities				X

Maintenance Issues

- Sun (UV) and heat exposure
- Snow removal
- Vandalism / Fireworks
- Seam separation
- Infill migration
- Static control
- Fiber layover
- Compaction
- Cleanliness / Infection control
- Paint / Paint removal

“Guidelines for Synthetic Turf Performance”

Synthetic Turf Council

- Conclusion
 - Future developments
 - “It is noted that proper maintenance is essential for the performance and quality of any synthetic turf system”

www.SyntheticTurfCouncil.org

Necessary Equipment

STMA Advisory Bulletin 2

- Grooming / Spiking equipment
- Sprayer w/ 100 gallon tank
- Topdresser
- Utility vehicle
- Turf Sweeper / Blowers / Vacuum
- Hand tools

Compaction

- Certain fields have shown increases in hardness
 - May lead to
 - Increased concussion incidence
 - Greater wear on players' bodies
 - Poor ball bounce
 - Decreased drainage
 - Decreased footing

Brush or Groomer

- Brush only:
 - blades erect
 - frequent
 - Promotes “fuzz”
- Groomer:
 - “fluffs” rubber
 - fibrillates blades
 - some smoothing
 - sanitizing help





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Adjustable tines



Weed Control



Photo: J.A. Borger

Static Electricity

- Initial year
- After grooming
- Hydrophobic over time
- Treatment:
 - Fabric softener w/ water
 - Wetting agents



Hydrophobicity



Photo: J.A. Borger

Management issues...

- Bio-hazards
 - Vomit, blood, spit, tobacco, etc
 - localize
 - wet / dry vacuum, disinfect, flush/disinfect, replace rubber
 - Sweat, routine practice liquids
 - infection potential
 - Regular disinfectant?
 - flush with rain / irrigation



Vomit?

Food/Drink?

Blood?

Tobacco?

Gum?

Saliva?

Hair?

Animal debris?

Tape/mouth pieces?

Other?

Photo by A. Boggs

Cleaning



Photo: J.A. Borger

Disinfectant ?



Photo by A. Boggs

Cleanliness

- “Cleat Cleaners” at every entrance
- Chewing gum, sunflower seeds, tobacco, sport drinks
 - Stringent policy of no food or drink allowed on surface. Post signs
 - Crumbs/sugar + bacteria = hazard
 - Gum: ice, then cut out

Cleaning



Photo: A.S. McNitt



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Sweep Debris





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Cleaning



Photo: J.T. Brosnan

Cleanliness



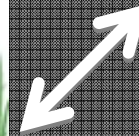
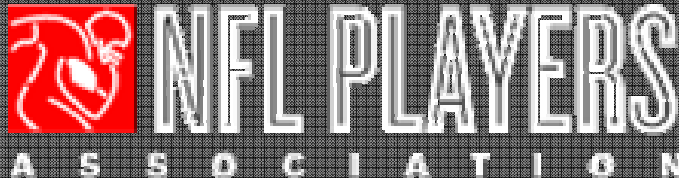
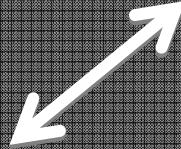
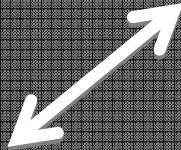
Sometimes there is no other way

Sports Turf Research focusing on Improving Player Performance & Safety

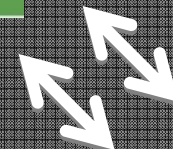
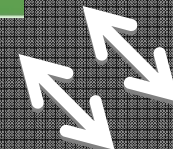
**J.C. Sorochan, Ph.D. & J.T. Brosnan,
Ph.D.**

**Directors for the
Center for Athletic Field Safety (CAFS)**





Grounds
Managers



Comparing Sports Turf Surfaces

- **72 Plots (150 ft²)**
 - **12 Synthetic**
 - **6 Natural Turfgrass (Sand Based)**
 - Bermudagrass
 - Kentucky Bluegrass : Perennial Ryegrass Mixture
 - **6 Natural Turfgrass (Soil Based)**
 - Bermudagrass
 - Kentucky Bluegrass : Perennial Ryegrass Mixture
- **10 year commitment**



Traction



Traction

Enable players to make
necessary movements

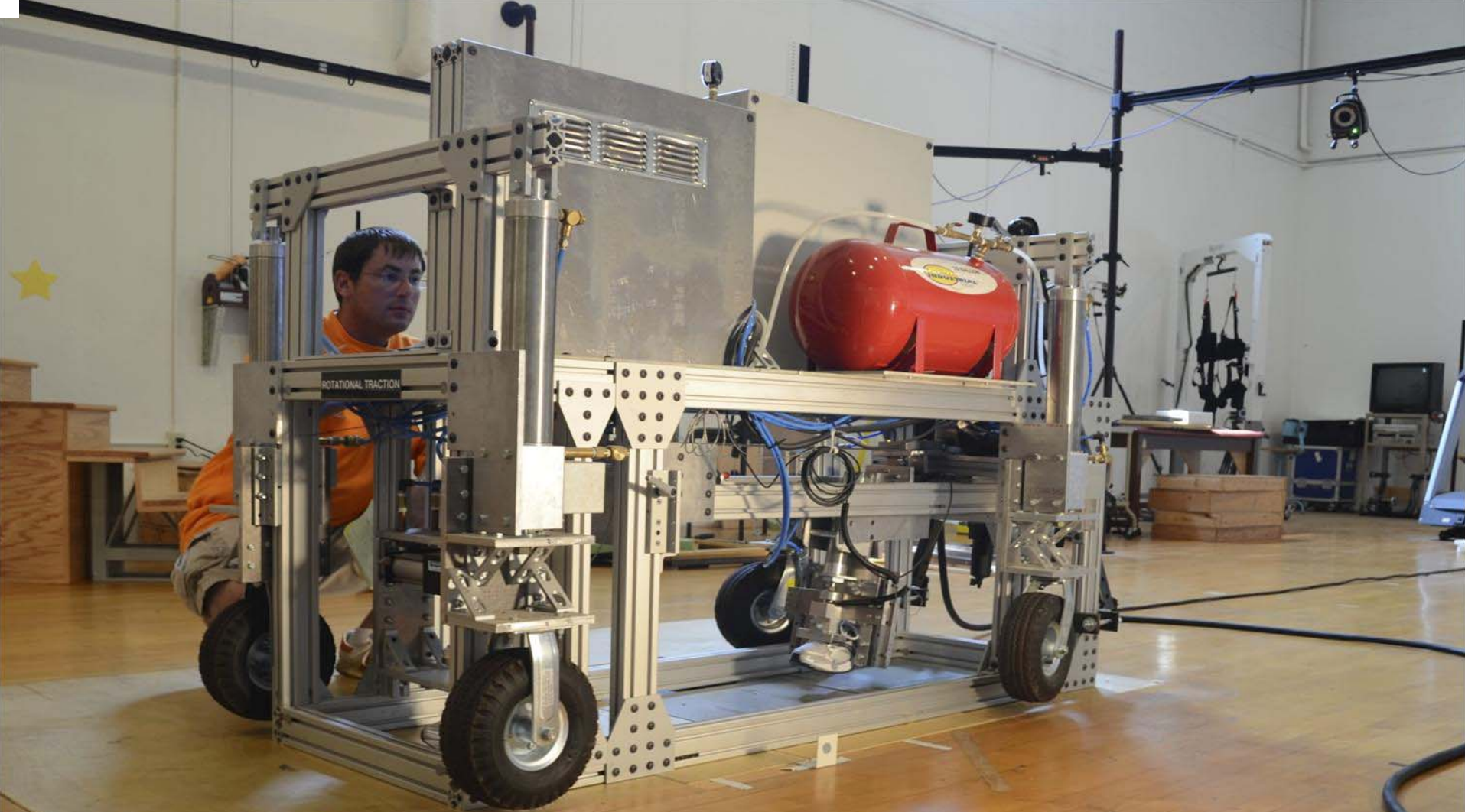
(Bell et al.,
1985)



Traction



(Middour, 1992; Nigg and Yeadon, 1987; Wannop et al., 2010)



Assessing Traction

Tennessee Athletic Field Tester

- Simulates footstrike
- Measures the vertical and horizontal forces



Tennessee Athletic Field Tester

- Athlete weight
 - 45 lbs – 315 lbs
- Running
 - 1 m/s
- Contact distance
 - 230 mm



TAFT – Tennessee Athletic Field Tester



TAFT – Tennessee Athletic Field Tester



TAFT – Tennessee Athletic Field Tester



TAFT – Tennessee Athletic Field Tester



Cleat Type



VS



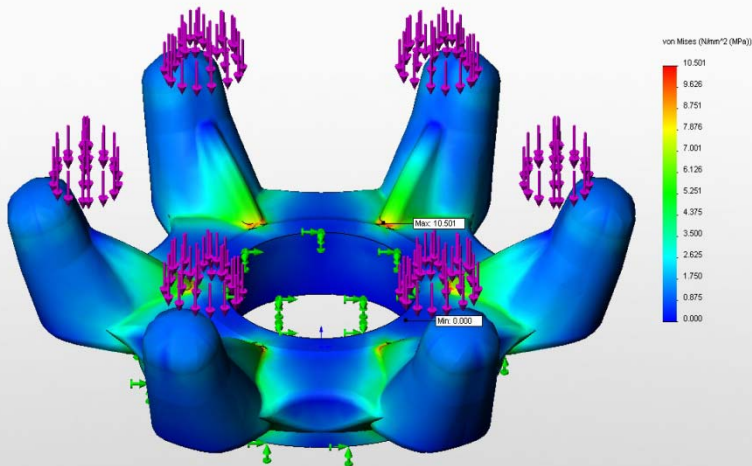
Kirk et al. (2006) – Proc of Int. Sports Eng. Assc.

Cleat Type

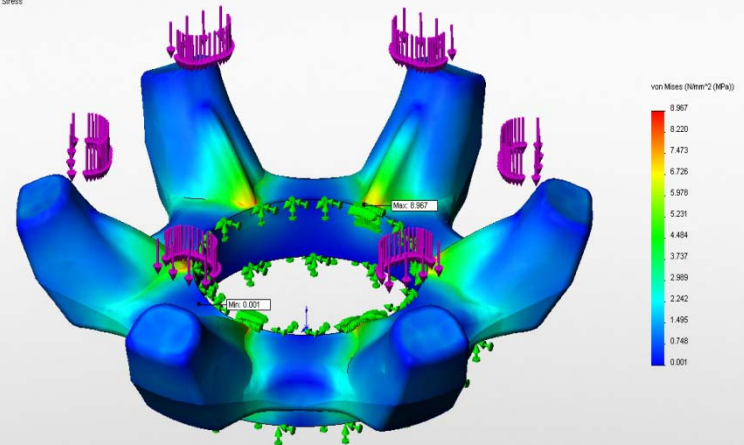
Cleat development for athlete safety and optimal traction

- Computer model of expected cleat Dynamics
- Field research with Tennessee Athletic Field Testers (TAFT)
- Human subject testing

Model name: AP2013 BVI Field Cleat Top ROUND
Study name: Simulation/press Study
Plot type: Static nodal stress Stress
Deformation scale: 30.7035



Model name: AP2013 BVI Field Cleat Top
Study name: Simulation/press Study
Plot type: Static nodal stress Stress
Deformation scale: 45.4613



Shoe companies now focusing on traction



Human Test Subjects for Performance and Safety



Human Test Subjects for Performance and Safety



Temperature Study



HEAT

Preliminary study @ BYU from 2002:

Artificial Turf averaged 39-degrees higher than sand based grass field and 8 degrees hotter than asphalt, with hottest reading @ **86** degrees higher than grass field.

Heat stress, blisters and dehydration

Factor in scheduling?

Environmental monitors?

Training staff on site?



Atmospheric Data

Air temperature ($^{\circ}\text{C}$)

Relative humidity (%)

Precipitation (mm)

Solar radiation (W/m^2)



Experimental Surfaces

1 – Monofilament A

2 - Puregrass

3 – Monofilament B

4 – Monofilament C

5 – Monofilament D

6 – Slit Film A

7 – Monofilament E

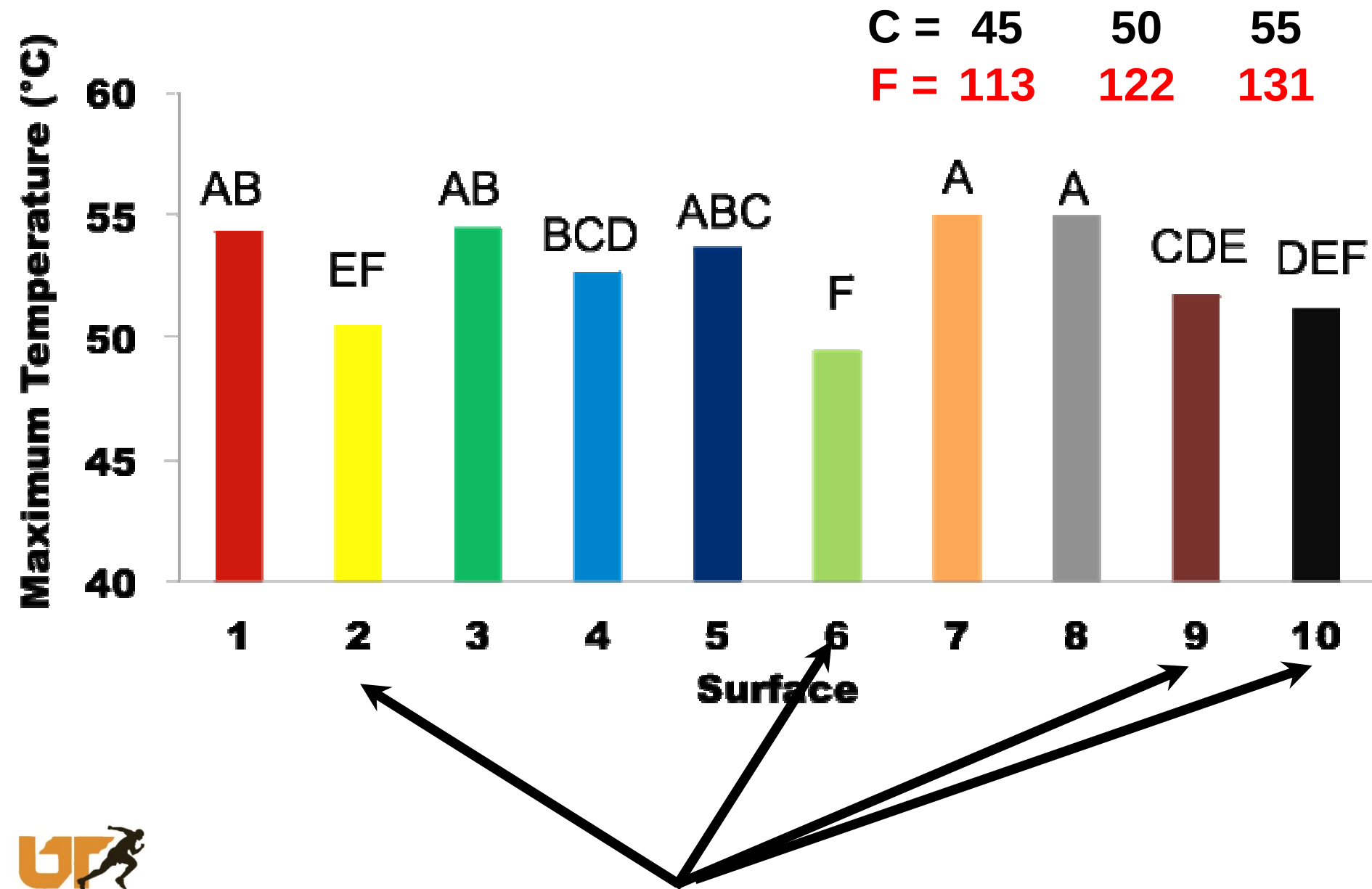
8 – Monofilament F

9 – Slit Film B

10 – Slit Film C



Maximum Temperature



Purchasing Synthetic Turf

Considerations for Synthetic Turf

- Ability for “excessive scheduling”
 - land use issues
- Quality surface in poor weather
 - takes pressure off grass fields
 - little risk of “disastrous” game
- Perceived “lower maintenance cost”
 - must define standard in order to calculate
 - factor for end life / disposal

Cost comparison; Multi-use soccer field

NYC Dept of P&R, Operations, Dec.15, 2006

		Synthetic	Natural grass
Installation costs	Per field	\$1.365M	\$690K
	Expected life	10 yrs	5 yrs
	Install. cost/yr.	\$136,500	\$138,00
Annual maintenance costs	Materials	\$0	\$750
	Mowing equipt	\$0	\$107
	Fld mtnce equipt	\$31	\$59
	Mowing labor	\$0	\$826
	Fld mtnce staff	\$1,239	\$10,864
	Staff Supervision	\$255	\$2,133
	Ttl. Mtnce	\$1,525	\$14,739
Total year		\$138,025	\$152,739

Factor replacement...

		Synthetic	Natural Grass
Total Cost/Field/Year (5 years)	Install/ Maintenance	\$138,025	\$152,739
Replace after 5 years	Install	N/A	\$100,000
Replace after 10 years	Install	\$800,000	\$100,000
9 additional yrs of maintenance costs	Maintenance	\$13,725	\$132,651
Total cost/Field/Year (10 years)	Install/ Maintenance	\$218,025	\$103,739

Current Purchasing Estimates

New construction / natural turf conversion

- \$8 – \$10 / ft²
- Includes:
 - base system
 - Synthetic turf
 - anchoring system
 - Infill

Current Purchasing Estimates

Replacement of existing synthetic turf

- \$4.50 - \$6.50 / ft²
- Includes:
 - Disposal of old system
 - costs can vary with disposal
 - New synthetic turf
 - Anchoring
 - Infill
 - New versus reusing old infill

Sustainability

- Athena Institute (Canada)
 - “Estimating the Required Global Warming Offsets to Achieve a Carbon Neutral Synthetic Field Turf System Installation.” Meil, Bushi 2006
 - Estimate the greenhouse gases emitted during the life cycle of the synthetic turf system as opposed to a natural grass surface
 - Determine the number of trees to be planted to achieve a 10-year carbon neutral synthetic turf installation

- Synthetic Field
 - Production of components
 - Use and maintenance
 - Disposal phase (recycling)
 - Transportation
- Natural Grass Field
 - Grass seed production
 - Organic plant matter production
 - Transportation
 - Carbon sequestration
 - Maintenance

Conclusion

- Natural grass field has total Greenhouse Gas Emissions of -16.9T of carbon dioxide (sequesters carbon)
- Synthetic Turf field has total Greenhouse Gas Emissions of +55.6T of carbon dioxide
- Greenhouse gas emissions of the synthetic field can be offset in 10 years by planting 1,861 coniferous trees



Thank You!



<http://www.turf.tennessee.edu>