



Penn State's
Center for Sports Surface Research

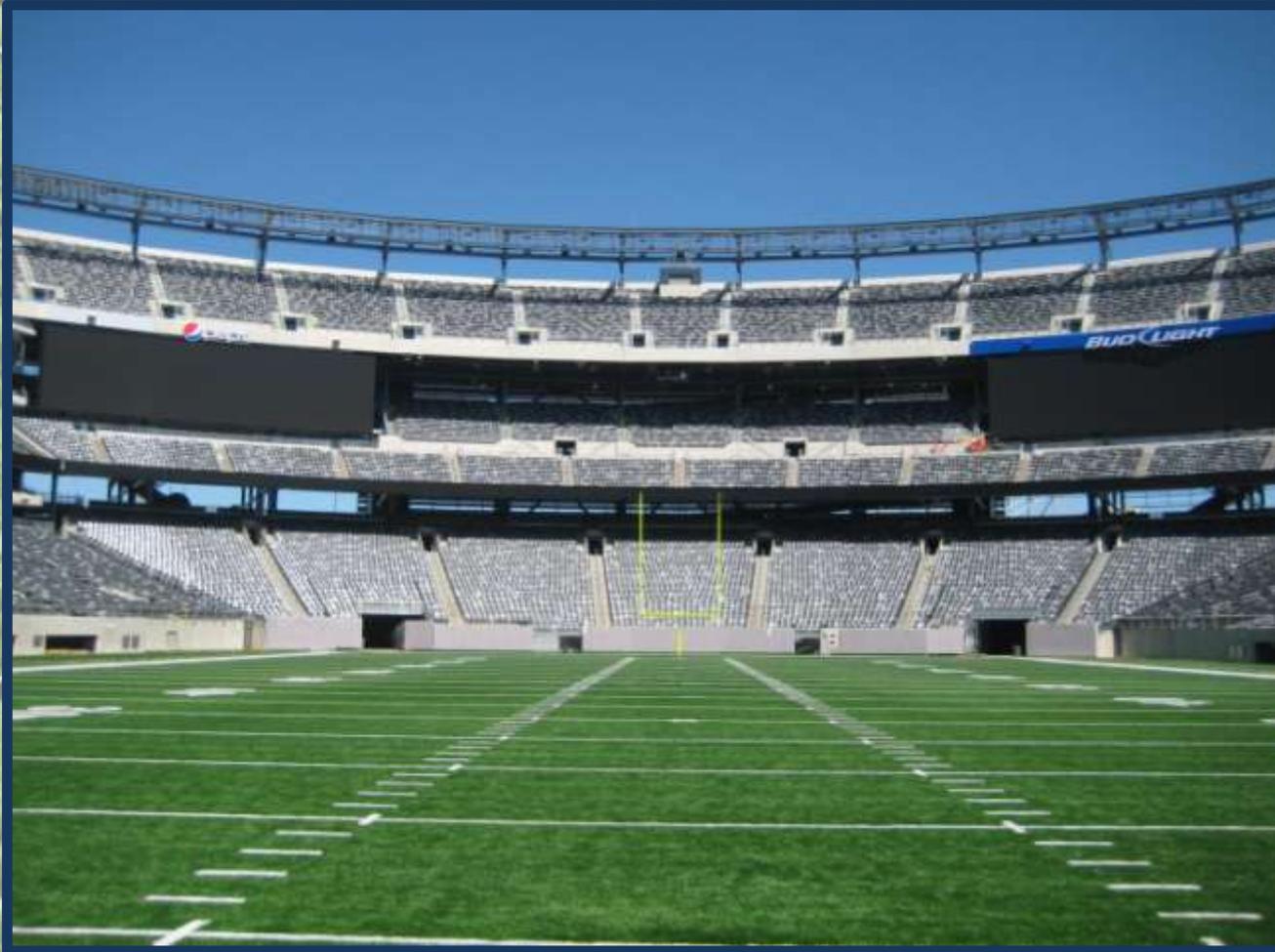
THE **SPORTSTURF**
SCOOP

Surface Temperature of Synthetic Turf

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Surface Temperatures



Surface Temperatures

- High surface temperatures – not a new problem
- 1970's research – traditional, non-infilled Astroturf (Buskirk, et al., 1971; Koon et al., 1971; Kandelin et al., 1976)
 - Surface temperatures up to 50° F higher than natural grass





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Children less able to adapt to changes in temperature



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High Surface Temperatures

- How does high surface temperature affect field users? (Astroturf) (Buskirk et al., 1971)
 - Heat sensors in shoes
 - Heat transfer from surface to sole
 - Greater chance of heat related health issues
 - Discomfort, dehydration, heat stroke



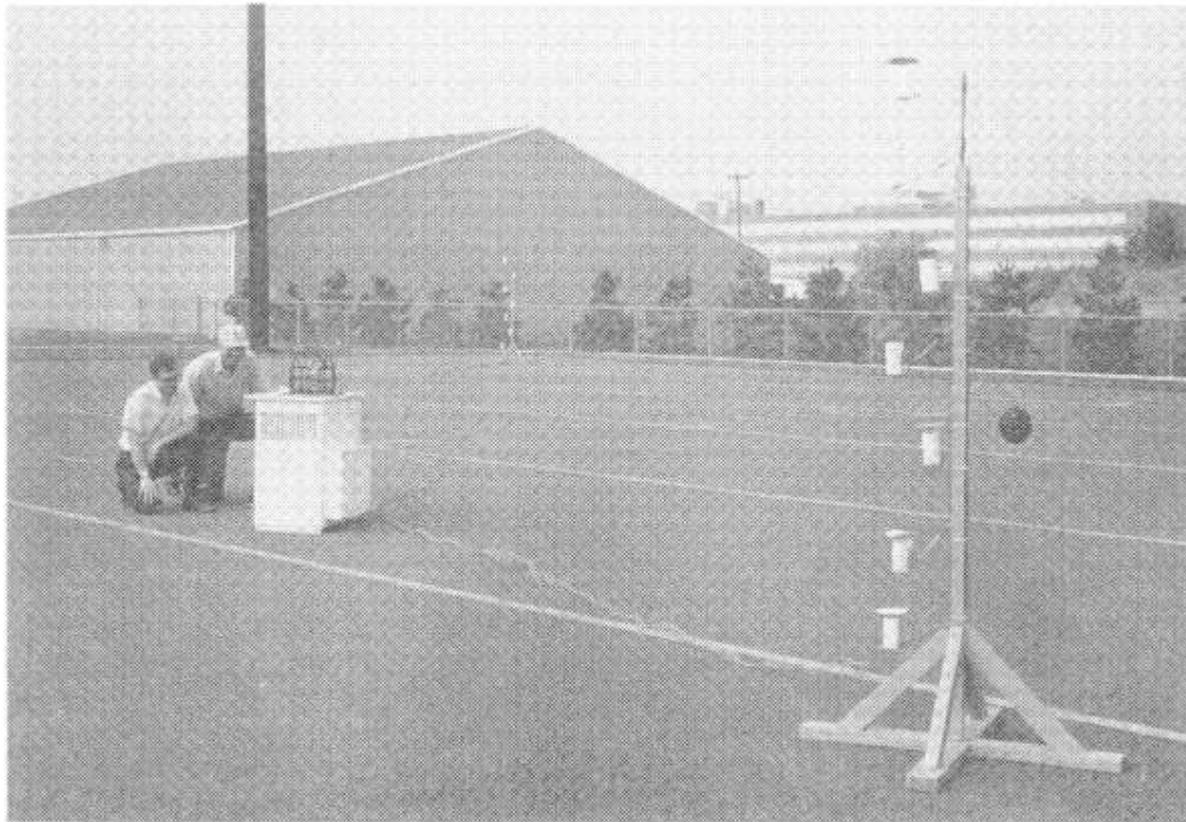


Fig. 3-2. Thermocouple trees with black globe placed on artificial turf. Instrument in center is pyroheliometer. (From Buskirk et al., 1971.)



When do surfaces get hot?

- **Sunny/Clear**
- **Low humidity**
- **No clouds**
- **Noon – 3:00 PM**



When do surfaces cool down?

Cloud Cover



High Humidity/Haze



How hot can synthetic turf get?

- Highest temperature published in research paper: 200° F (93° C) on 98° F (37° C) day in Provo, UT (Williams and Pulley, 2002)
- Central PA: 175° F (79° C) (McNitt et al., 2008; McNitt and Petrunak, 2010) (<http://ssrc.psu.edu/infill/infill.cfm>)



How does this compare to natural grass?

- **Over 100° F (38° C) - very rare on natural grass**
 - Commonly 75° to 95° F (25° to 35° C) on hot day
 - Less than air temperature
- **Generally, synthetic turf 35° to 55° F (20° to 30° C) hotter than natural grass**



Why do synthetic surfaces get hot?

- **Crumb rubber infill?**
 - 1970's research on Astro turf (**Buskirk, et al., 1971; Koon et al., 1971; Kandelin et al., 1976**)
 - **Traditional Astro turf vs. Infilled synthetic turf**
 - **McNitt et al., 2008; McNitt and Petrunak, 2010**
(<http://ssrc.psu.edu/infill/infill.cfm>)



Why do synthetic surfaces get hot?

- **Black crumb rubber infill?**
 - Black crumb rubber painted white (Devitt, et al., 2007)
 - Very minor surface temperature reduction



What does this tell us?

- **Fibers** are a major contributor to high surface temperatures



Why don't natural grass "fibers" produce heat?

- Grass leaves transpire
 - Release water vapor
 - Evaporation causes cooling



Attempts to reduce surface temperature



Watering

- Watering reduces surface temperature for a short period of time
- **Williams and Pulley, 2002**
 - Watering for 30 minutes dropped temperature from 174° F (79° C) to 85° F (29° C)
 - After 5 minutes: 120° F (49° C)
 - After 20 minutes: 164° F (73° C)



Watering

- **McNitt et al., 2008**
 - Temperatures rebounded 20 minutes after watering
 - Temperatures remained 10 degrees cooler than non-watered for 3 hours
 - ****Astroturf – cooler for longer time (pad close to surface, stayed wet longer)**



Attempts to reduce surface temperature

- **Calcined clay**
 - Similar to kitty litter
 - Used on baseball infields
 - Traps and holds water



- **McNitt et al., 2008**
 - Infill: 20% calcined clay, 80% crumb rubber
 - No effect on surface temperature



Attempts to reduce surface temperature

- **1:1 mixture of rubber and larger calcined clay particles**



Is Calcined Clay Stable ?

Calcined clay broke down, lost cooling effect



Attempts to reduce surface temperature

- **Water early morning, then cover with tarp**
 - Reduce evaporation prior to use
- **McNitt et al., 2008**
 - No effect on surface temperature





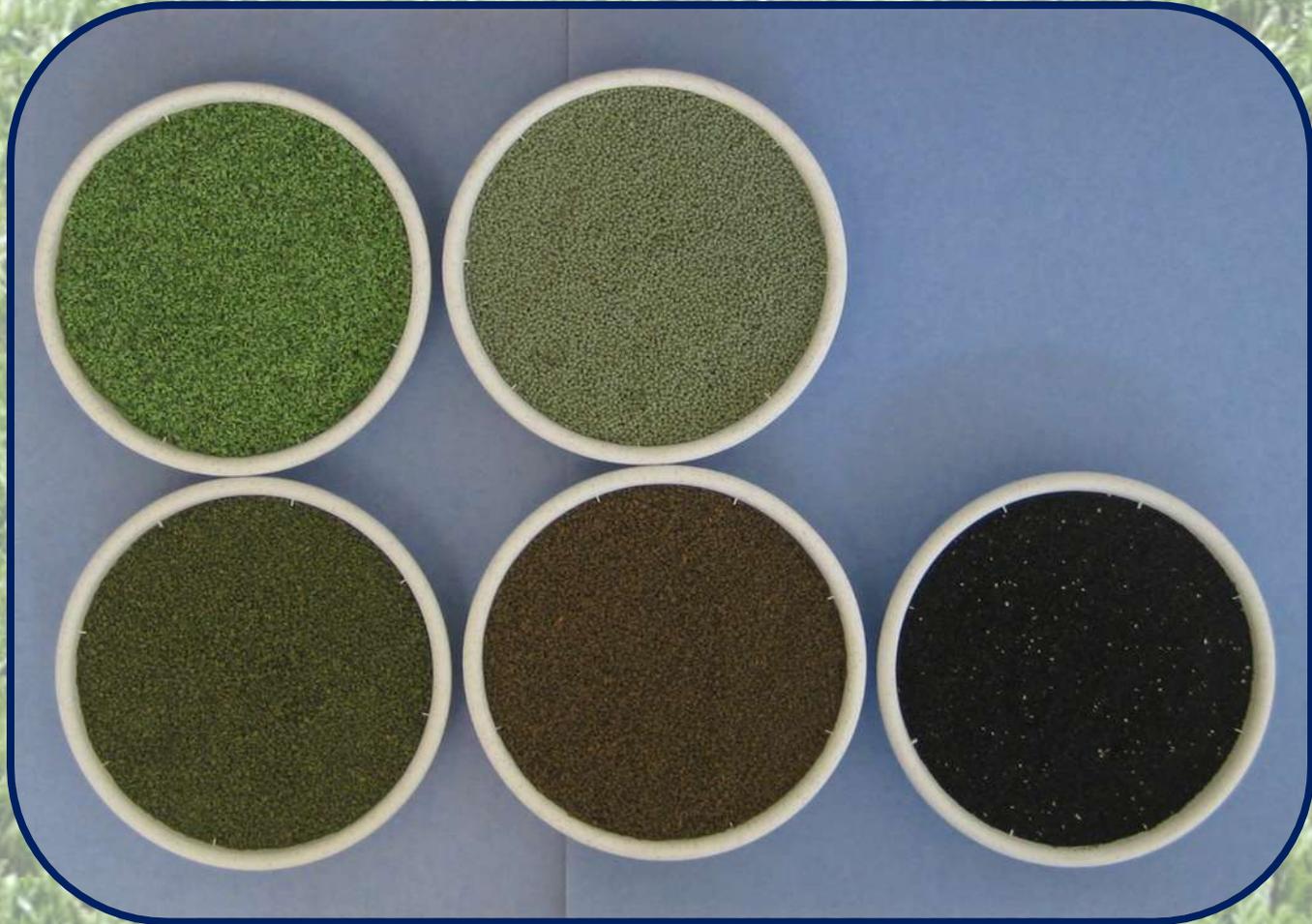
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Penn State Heat Studies



Penn State Heat Studies



Infill Materials

Surface temperatures of various infill after 1 hour under heat lamp

Infill	Surface Temperature (F)
Black Rubber	156.0 a[†]
Tan Rubber	153.4 a
Green Rubber	147.9 b
Ecofill	141.6 c
TPE	136.4 d

[†]Temperatures that do not share the same letter are significantly (statistically) different



Fibers Only

Surface temperatures of various fibers after 1 hour under heat lamp

Fiber Color	Surface Temperature (F)
Silver	149.4 a†
Black	144.3 b
Green (FieldTurf Duraspine Pro)	140.5 bc
Gold	139.8 bc
Green (FieldTurf Revolution)	138.6 c
Green (Astrofect)	137.9 c
White	128.7 d

All fibers were FieldTurf Duraspine Pro unless otherwise noted

†Temperatures that do not share the same letter are significantly (statistically) different



Synthetic Turf Systems

Surface temperatures of various fiber-infill combinations after 3 hours under heat lamp.

Fiber Color	Infill	Surface Temperature (F)
Gold	Black Rubber	171.1 a [†]
White	Black Rubber	170.4 ab
Silver	Black Rubber	169.2 ab
Black	Black Rubber	169.2 ab
Green	Ecofill	167.3 abc
Green (FieldTurf Revolution)	Black Rubber	165.6 abcd
Green	Black Rubber	165.5 abcd

All fibers were FieldTurf Duraspine Pro unless otherwise noted

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Green	Ecofill	167.3 abc
Green (FieldTurf Revolution)	Black Rubber	165.6 abcd
Green	Black Rubber	165.5 abcd
Green	Green Rubber	163.8 bcde
Green	Tan Rubber	161.1 cde
Green	TPE	160.5 de
Green (AstroFlect)	Black Rubber	158.9 e

All fibers were FieldTurf Duraspine Pro unless otherwise noted

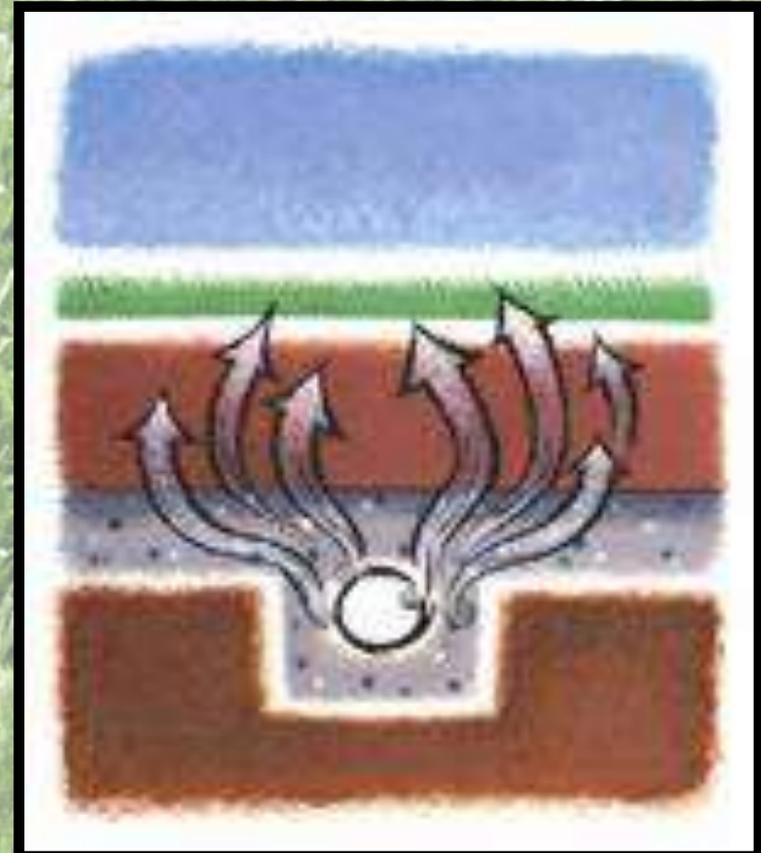
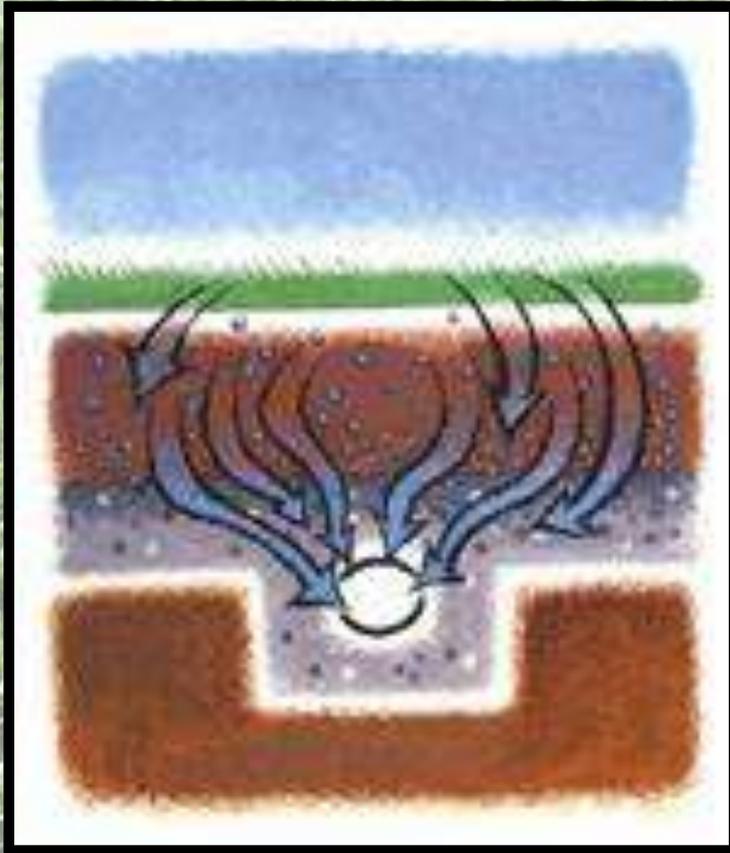
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SubAir system



SubAir system



What Can Be Done Now?

- **Practice time – mornings and evenings**
 - **BYU guideline: no use above 120° F (49° C)**
- **Athletic trainer involvement**
 - **Monitor conditions**
 - **Monitor players**
 - **Communications with coaches**



Future Research

- **Penn State's Center for Sports Surface Research**
 - Infill ?
 - Fibers ?



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Website: <http://ssrc.psu.edu>



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