Racing Surfaces Testing Laboratory
Orono Maine USA

THE UNIVERSITY OF MAINE

Racetrack Surfaces and Technology Integration

10 YEARS OF THE ORONO BIOMECHANICAL SURFACE TESTER
5 YEARS OF THE RACING SURFACES TESTING LAB

Issues in Catastrophic Injury

- Conformation
- Individual predisposition
- Pre-existing disease
- Shoeing
- Training
- Track surfaces
- Multi-factorial risk

No disease no breakdown….

Tracks did not "cause" the problem, they CAN improve the situation

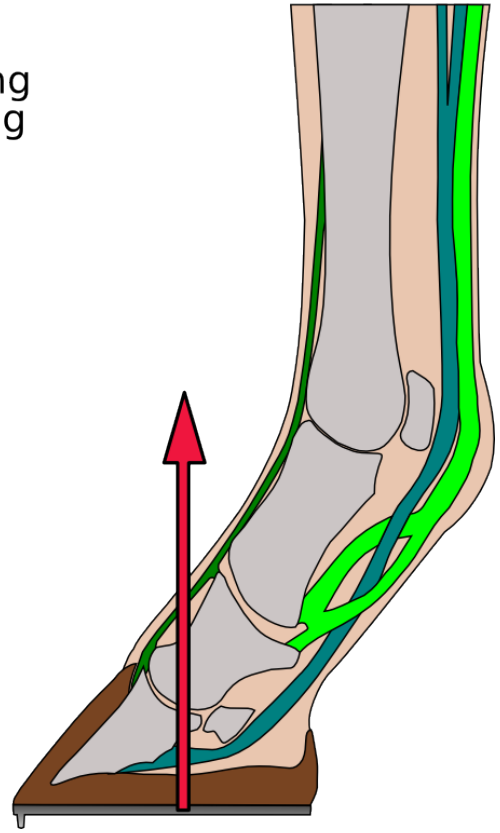
Why do Research on Surfaces?

- Well developed work on biomechanics
- Work on tracks was usually done with a regional focus
- Need standard testing
- Testing based on biomechanics

Surface has different function during phases of gait: Impact/loading

Impact

Vertical Loading of Soil/Shearing



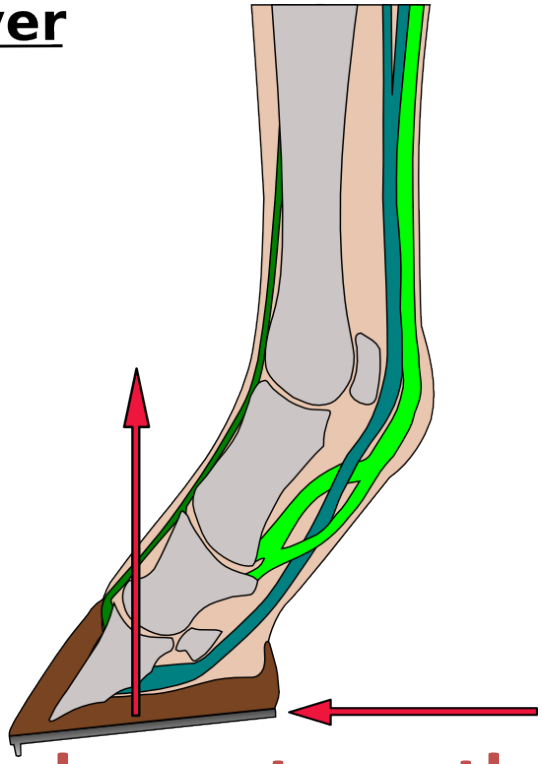
Shear and Normal Load from Hoof

- Lower vertical modulus reduces strain rate and peak loads
- Shear failure reduces horizontal peak accelerations

High peak load fracture….

Surface has different function : Breakover/Propulsion

Break-Over
Unloading with Shear



- Shear strength to support hoof during propulsion

http://cdn.paulickreport.com/wp-content/uploads/2014/05/RideOnCurlin_gallop_28May2014.jpg

Low shear strength, bowed tendons….

Surface During Gait

- What the rider feels:

Performance

- *Musculo-skeletal* loading:

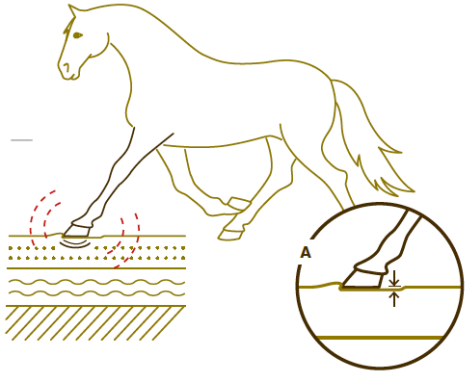
Safety

- **FIVE FUNCTIONAL PROPERTIES:**
  - firmness
  - cushioning
  - responsiveness
  - grip
  - uniformity

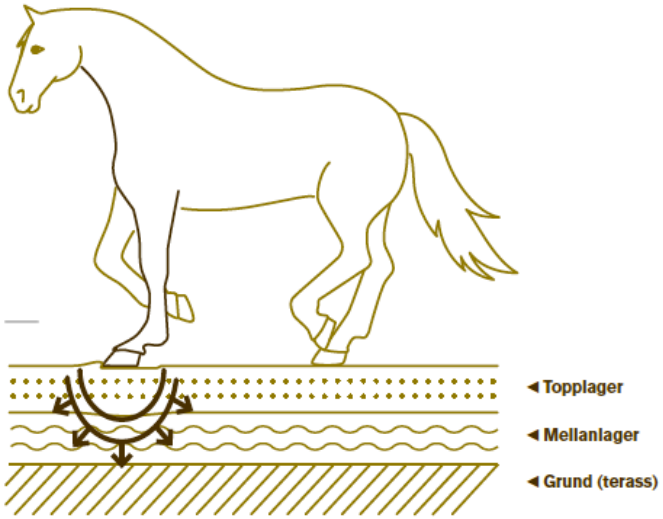
Focus on Safety Horse& Rider

Can we measure these parameters?

Sarah Jane Hobbs, Alison J. Northrop, Christie Mahaffey, Jaime H. Martin, Hilary M. Clayton, Rachel Murray, Lars Roepstorff, Michael "Mick" Peterson Equine Surfaces White Paper, http://www.fei.org/fei/about-fei/publications/fei-books

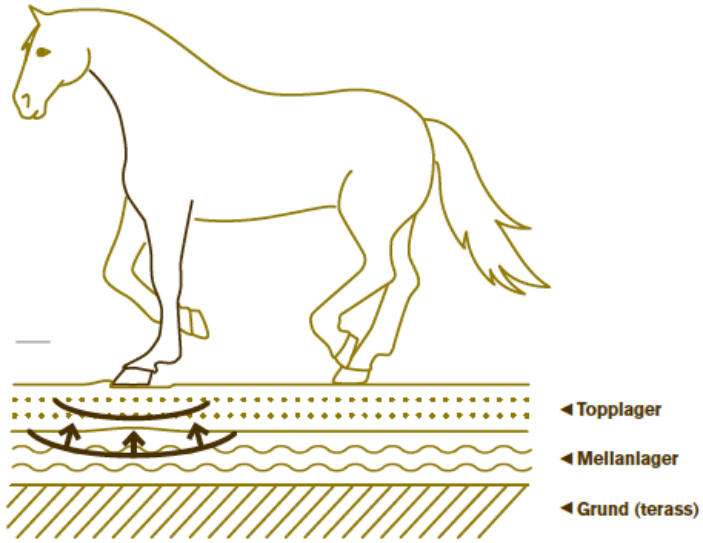


Surface firmness

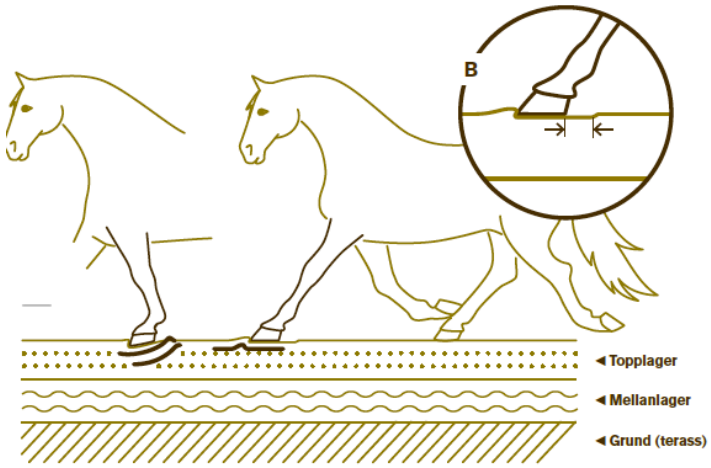

◄ Topplager
◄ Mellanlager
◄ Grund (terass)

Cushioning


2012-02-25 17:31:18 -0762.0[ms] 000000015 HiSpec 1 color Fastec 848x500 @ 500fps 1994µs



Responsiveness



Grip

Equine Surfaces White Paper

Cons Uniformity fection

Surface During Gait

- We need to understand the surface in terms of operational parameters.
- FIVE FUNCTIONAL PROPERTIES:
  - firmness,
  - cushioning,
  - responsiveness,
  - grip
  - uniformity

How do we measure these parameters?

Sarah Jane Hobbs, Alison J. Northrop, Christie Mahaffey, Jaime H. Martin, Hilary M. Clayton, Rachel Murray, Lars Roepstorff, Michael "Mick" Peterson Equine Surfaces White Paper, http://www.fei.org/fei/about-fei/publications/fei-books

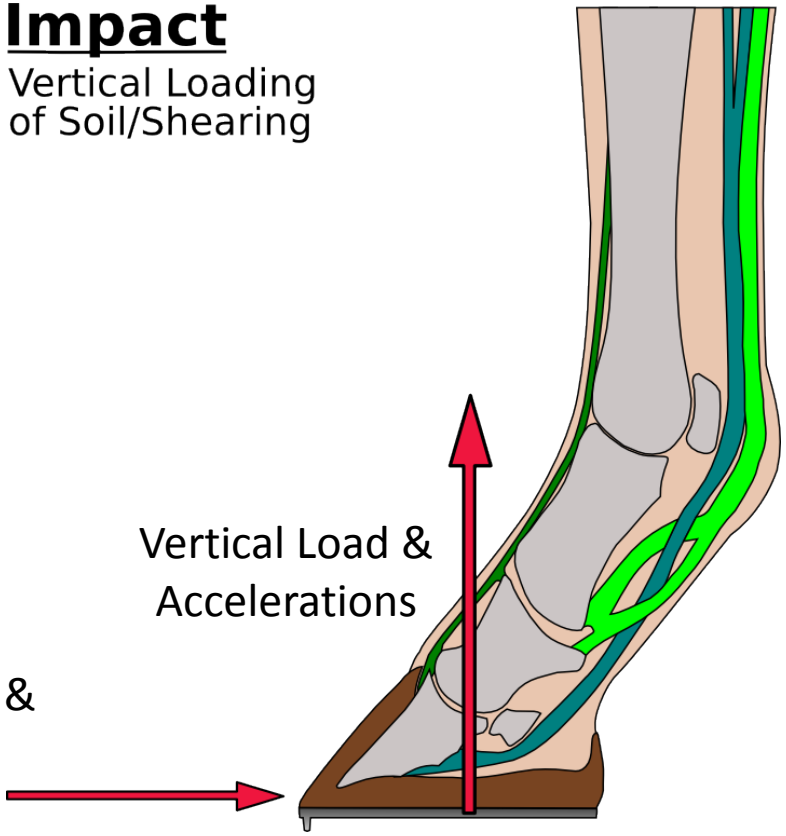
We Learn What Matters from the Horse….

Prior literature showing what is important was limited

Initial Funding from AQHA Racing, Started in 2001

Impact

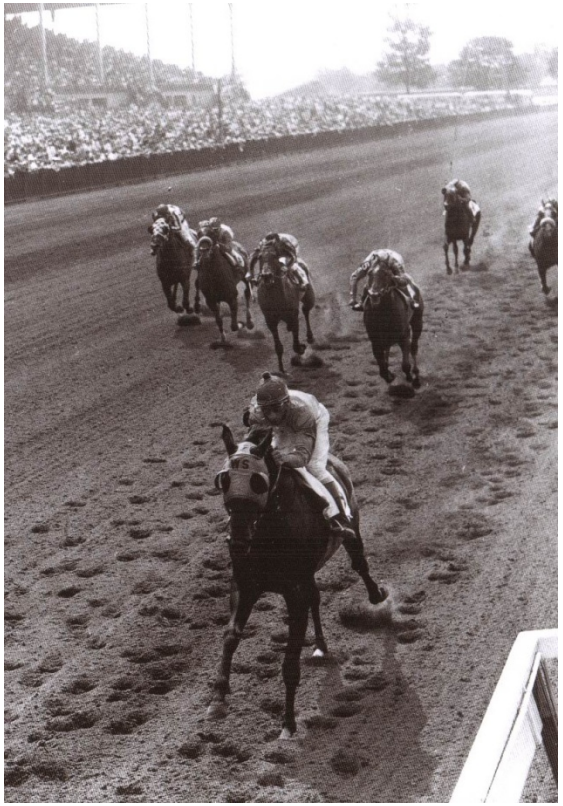
Vertical Loading of Soil/Shearing



Need to Load Like Surface a Horse

Track Materials – Synthetic and Natural

- Non-linear
  The more the material is loaded the higher the modulus (stiffness)
- Strain rate dependent
  - Synthetic shows creep deformation
  - Dirt and turf shows dynamic response controlled by moisture content
- Measurement tool length scale consistent with hoof



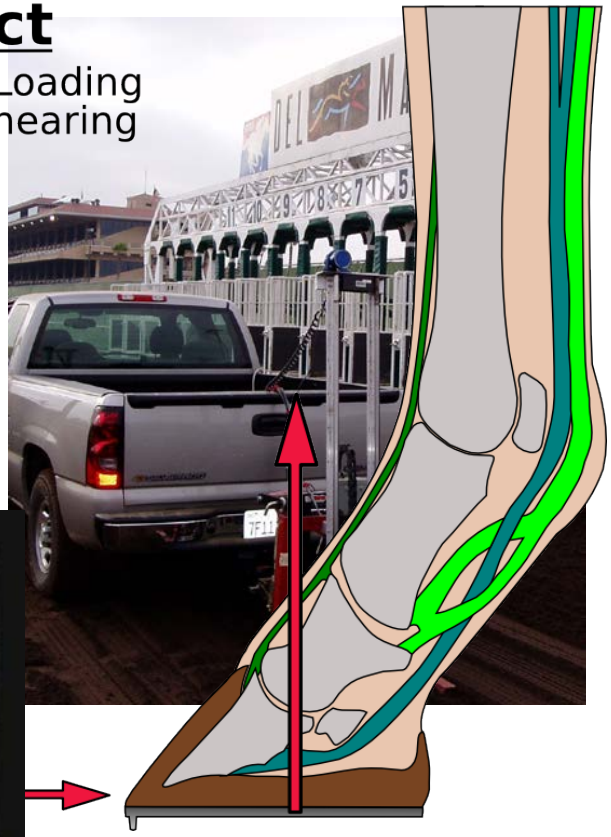
If You Race Small Portable Horses You Can Use a Small Portable Tool

Orono Biomechanical Surface Tester

Prototype Testing 2004

- Biomechanical Hoof Tester
  - Started discussion in 1998
  - Comparison of more than 60 tracks, 8 Synthetic Tracks, 5 turf tracks
- During racing (40 min, 24 locations)
- Simultaneously measure shear and hardness

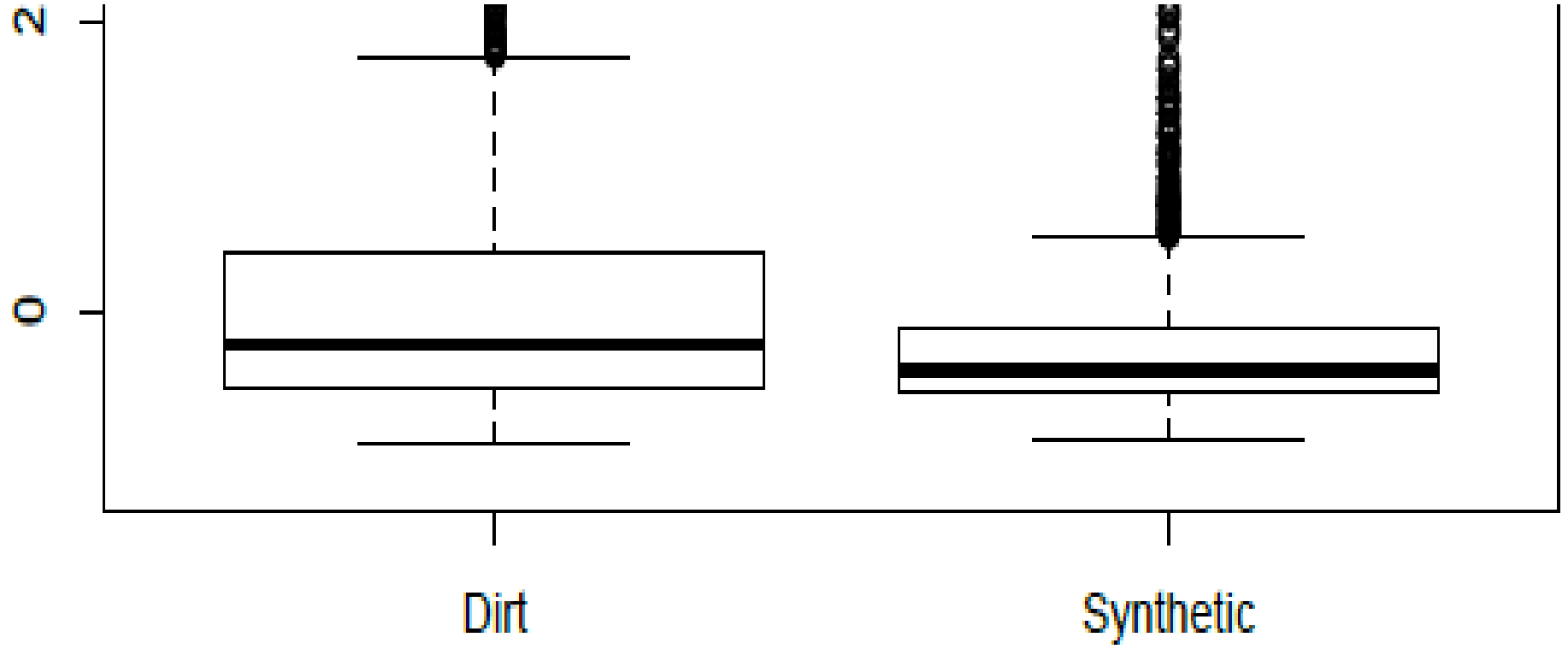
Impact
Vertical Loading of Soil/Shearing




Now the Method has Expanded Beyond Racing

A Decade of OBST Data: **Grip**

6000 tests, 80 Racing & Training Surfaces

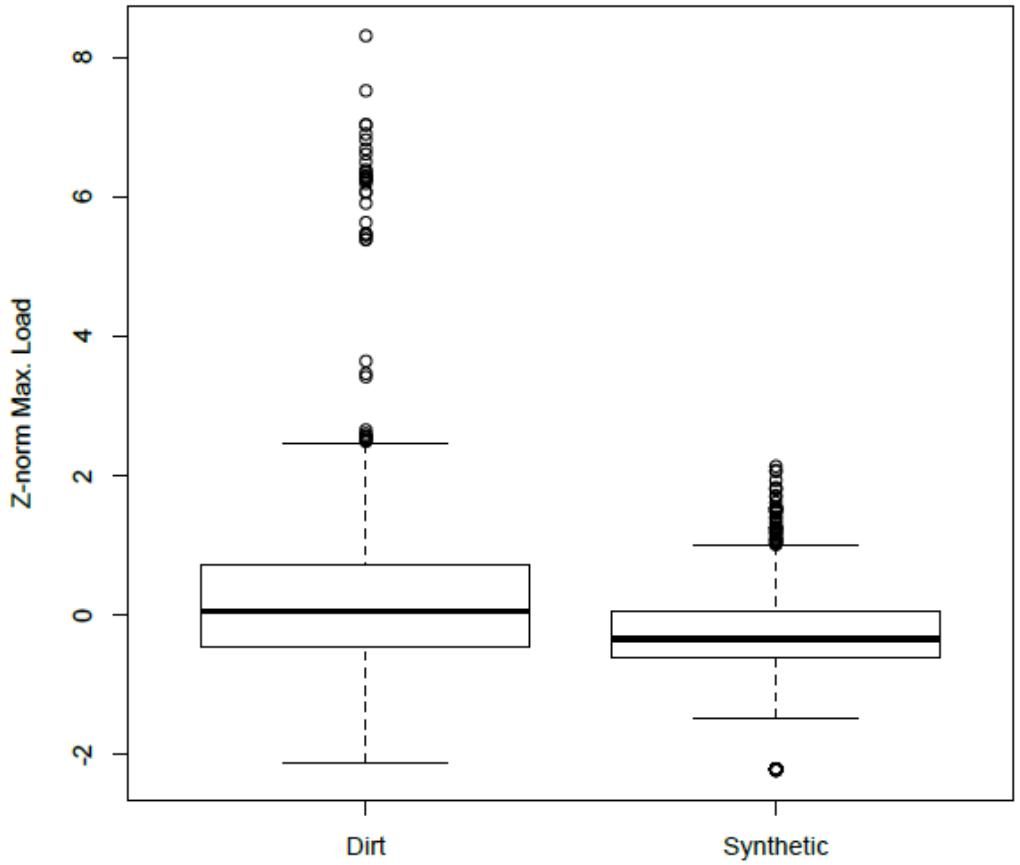


Range of slide data on dirt is MUCH larger than on synthetic

Some dirt has less slide (higher Grip) than synthetic

A Decade of OBST Data: **Cushioning**

6000 tests, 80 Racing & Training Surfaces



Even Cushioning of dirt overlaps synthetic data

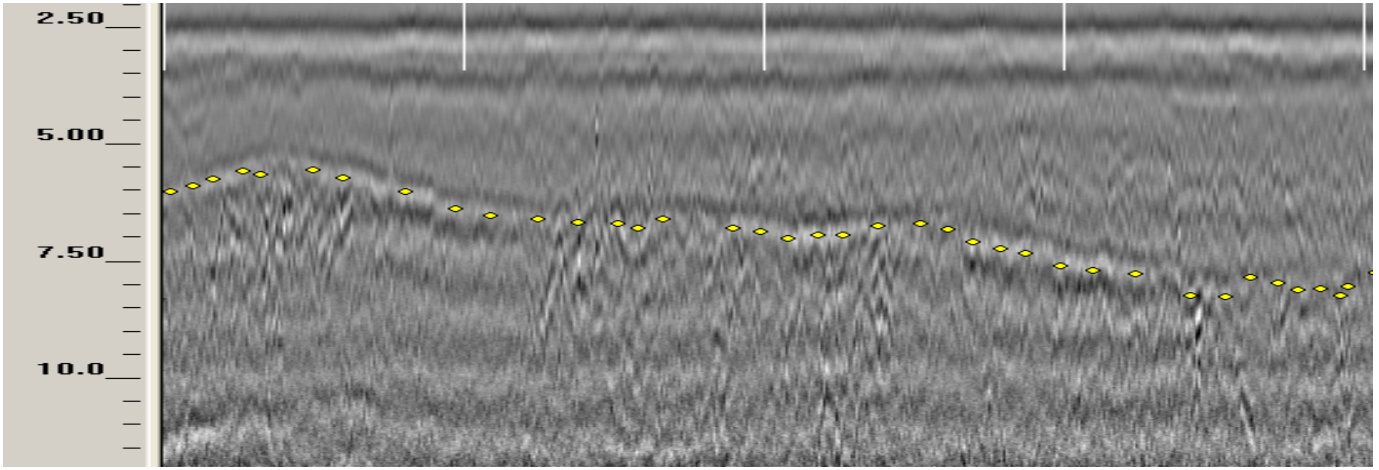
Dirt is much more variable

The Important Conclusion: dirt is more variable than a synthetic track

More tools:

Ground Penetrating Radar

- Detect variation in the base and depth of cushion: Holes in the base, Separation of materials, Loss of fines – drainage, cushion depth
- Identify issues before a problem arises.



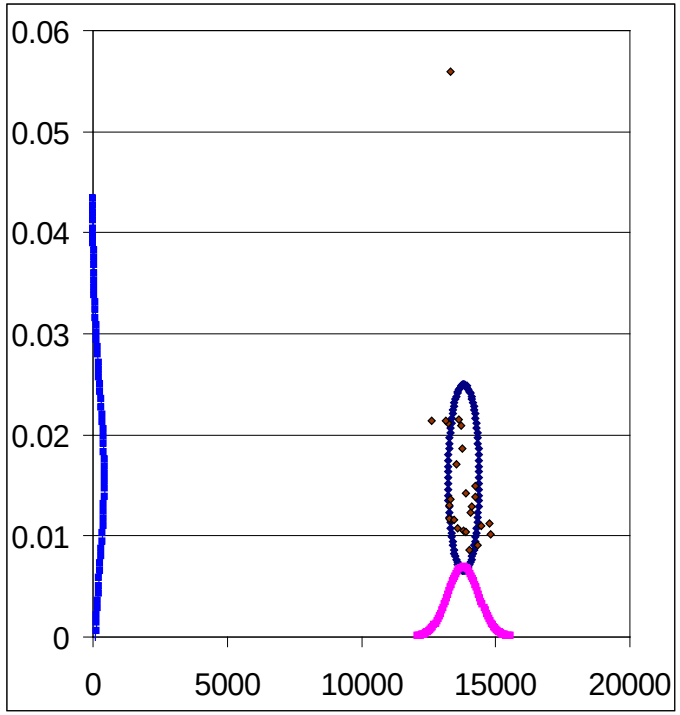

N38°12'17"
N38°12'15"
N38°12'13"
W 85°46'21"

A Decade of Testing: Variability

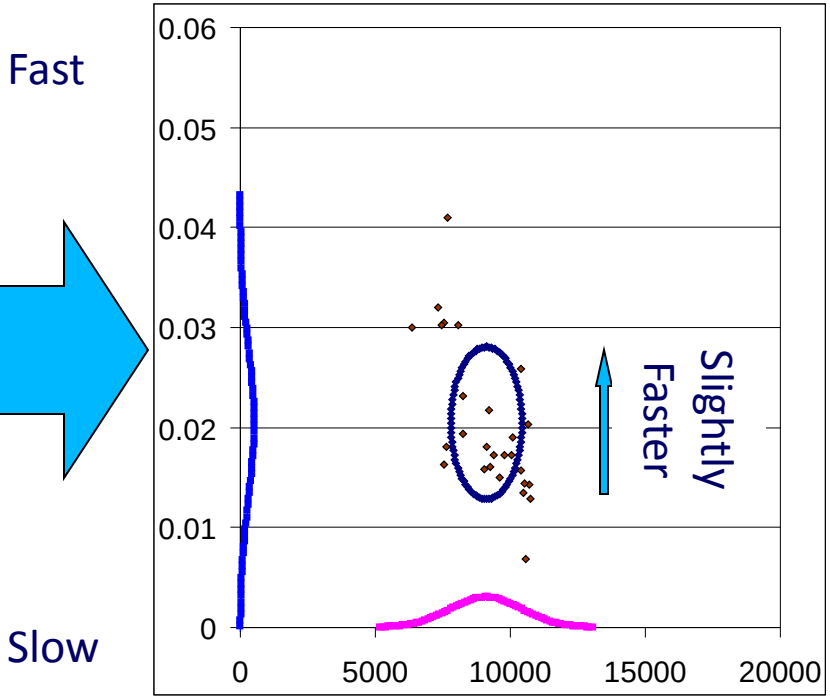
What factors need to be controlled….

- Synthetic Tracks
  - Spatial
    - Compaction (Cultivator vs. harrow)
    - Grading
    - Segregation of material
  - Temporal
    - Degradation of wax and fiber
    - Loss of rubber
    - Weather and temperature
- Dirt & Turf Tracks
  - Spatial
    - **WATER**
    - Grading
    - Compaction (tracks with a pad)
    - Segregation of material
  - Temporal
    - **WATER**
    - Material composition/loss

Maintenance Matters: Rip, Till a Racetrack?



Softer & More Variable



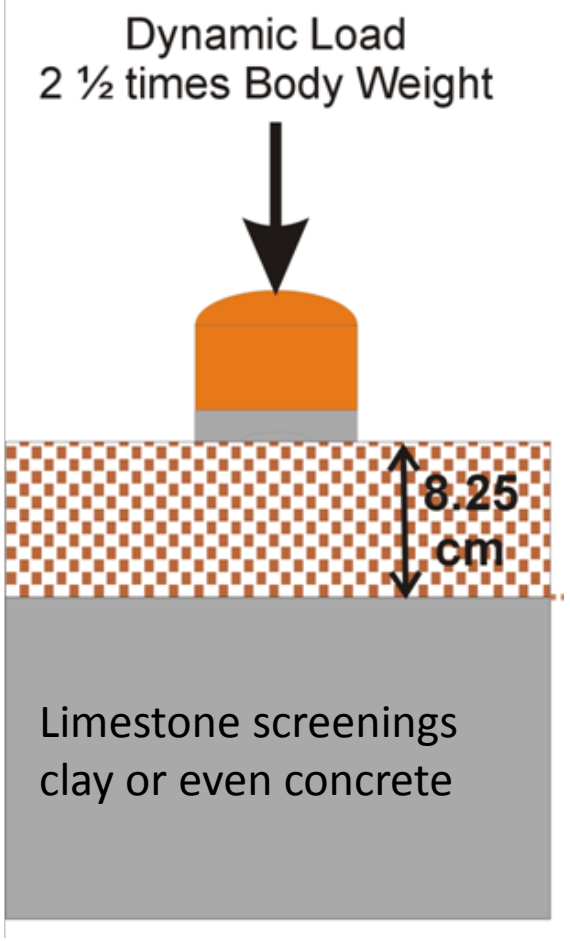
The OBST correlates to actions on track

Effect of track maintenance on mechanical properties of a dirt racetrack: a preliminary study, Peterson and McIlwraith, Equine Veterinary Journal, 40 (6) p 602-605

Not simple!!!!

Three Different Dirt Track "Designs"

- Hoof contacts surface of track during impact.
- During breakover the hoof penetrates the cushion.
- Shear and penetration strength must be sufficient to avoid toe contact with base



Cannot ***DEFINE*** How to Maintain Track

(X-Ray Diffraction) from the Racing Surfaces Lab

Design & maintenance is defined by rainfall & materials

	Clay content (%)	Organic content (%)	Annual Precipitation
Shallow Sand	2.35 (1.02)*^	0.26 (0.25)*^	120.2 (28.3)*^
False Base	3.57 (1.53)*	0.47 (0.35)*	107.7 (45.2)*†
False Base with Pad	6.76 (3.60)*^	2.49 (2.70)*^	66.0 (25.2)*^†

* ANOVA $p<0.05$

^ † Tukey-Kramer post-hoc $p<0.05$

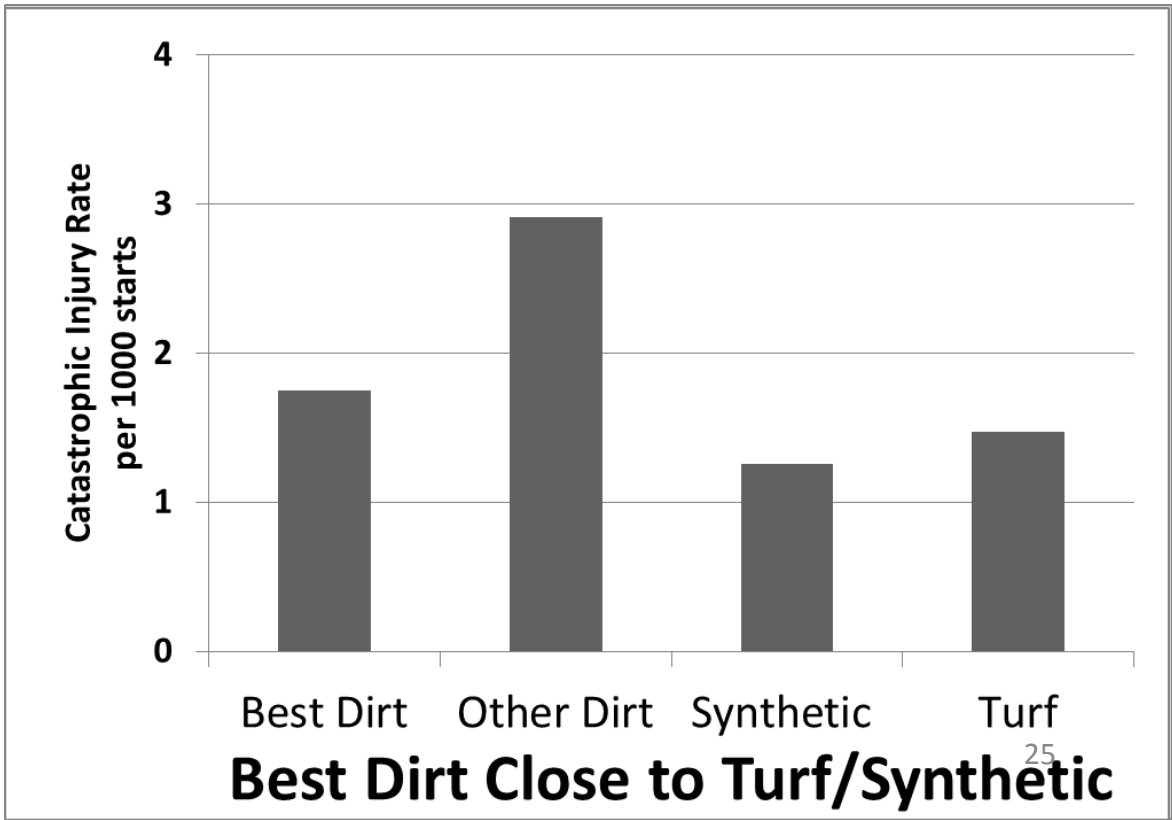
Outcome: Maintenance must match materials

Christie A. Mahaffey, Michael Peterson, C. Wayne McIlwraith, Sports Engineering March 2012, Volume 15, Issue 1, pp 21-27

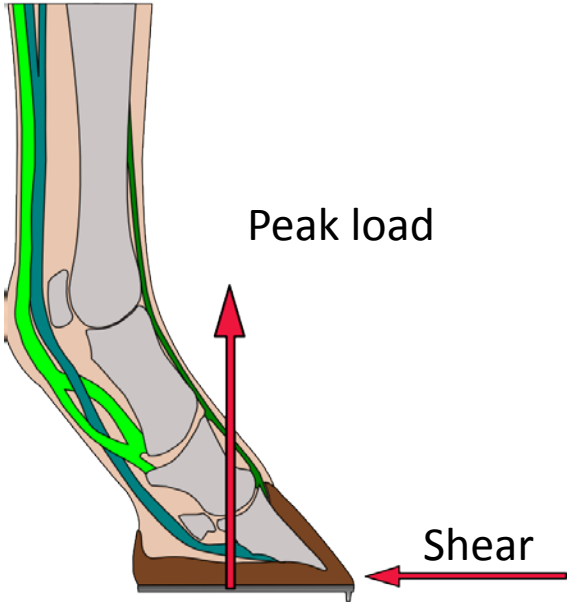
What about Safety of Horse and Rider?

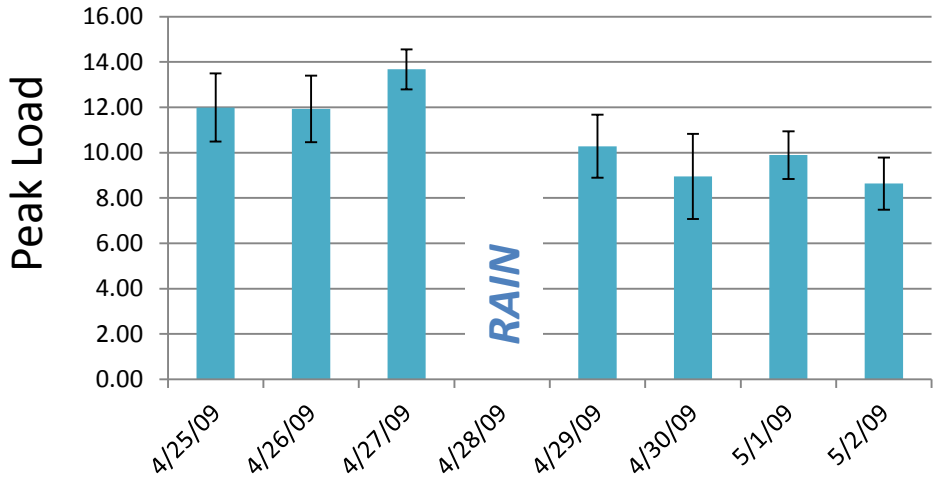
- 3 different racetrack designs,
  Defined by maintenance, climate and clay mineralogy
- What is safest?
- Data is not statistically significant:
  This year, may not be the same next year

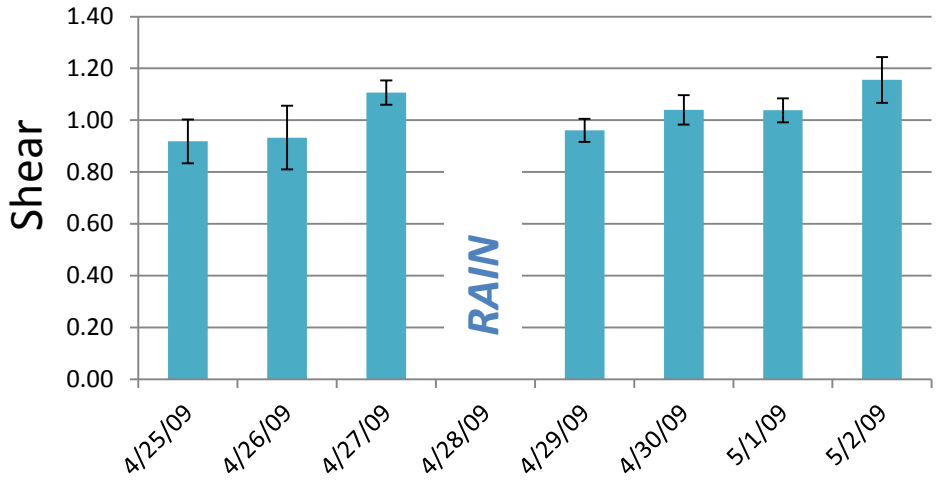
Best Dirt Almost as Safe as Synthetic!



From OBST Data .. WATER



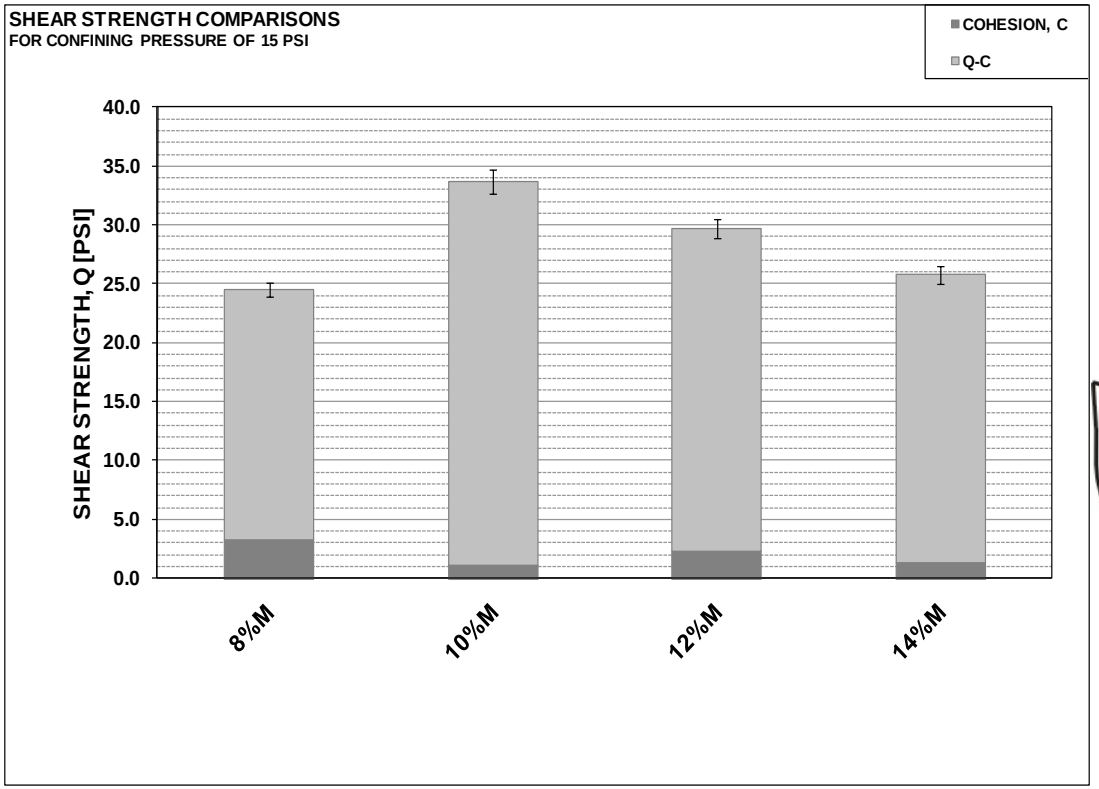


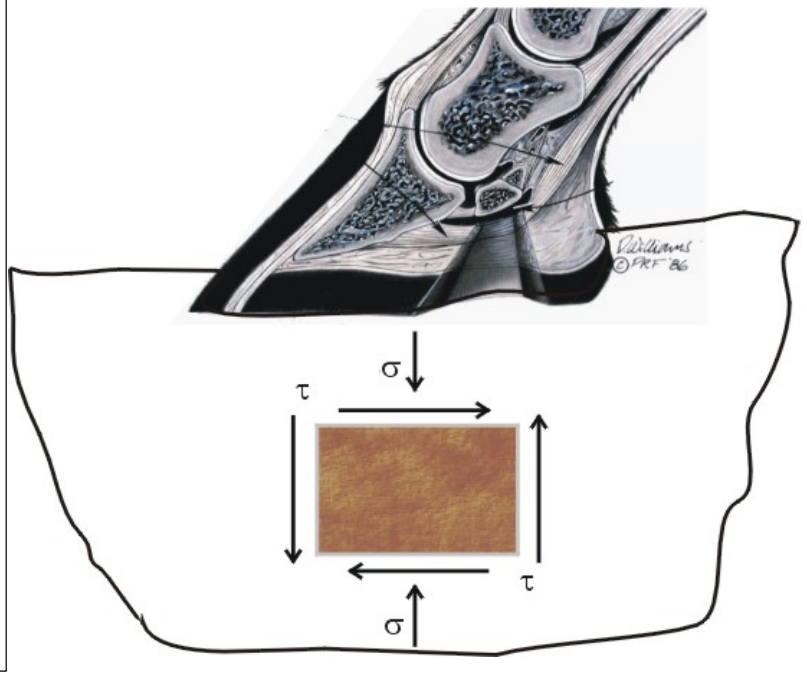


The OBST correlates to effects seen on the track

Same Effect in the Lab : WATER

On track it can easily vary from 10-14%



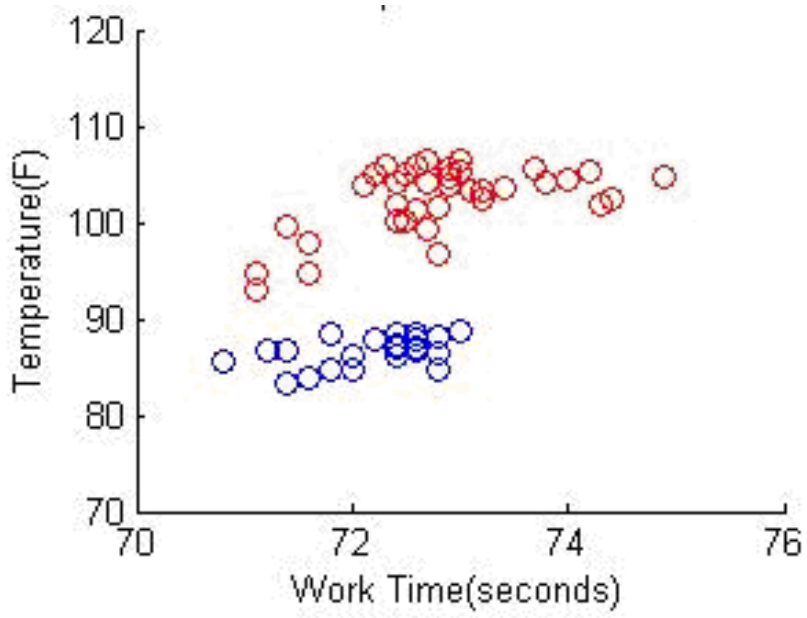


Moisture: 14% to 10%

Shear Strength: 24.6 to 33.7 psi

Synthetic Tracks, Temperature not water

Temperature at 100mm depth



Temperature is a better predictor than other Clegg, Penetrometer etc.

The entire synthetic track is at the same Temperature MORE CONSISTENT

To Make Dirt and Turf MORE CONSISTENT

WATER

M.L. Peterson, Raoul F. Reiser, II, Pei-Hsin Kuo, Donald W. Radford, C. Wayne McIlwraith , The effect of temperature on 6 furlong times on a synthetic racing surface, *Equine vet. J.* 42, 2010 351-357.

Major Message from Research

- Maintenance, especially water, needs to be controlled
- Different maintenance for different materials
  - Water
  - Harrow
  - Material addition
  - Grading
- Details matter ….

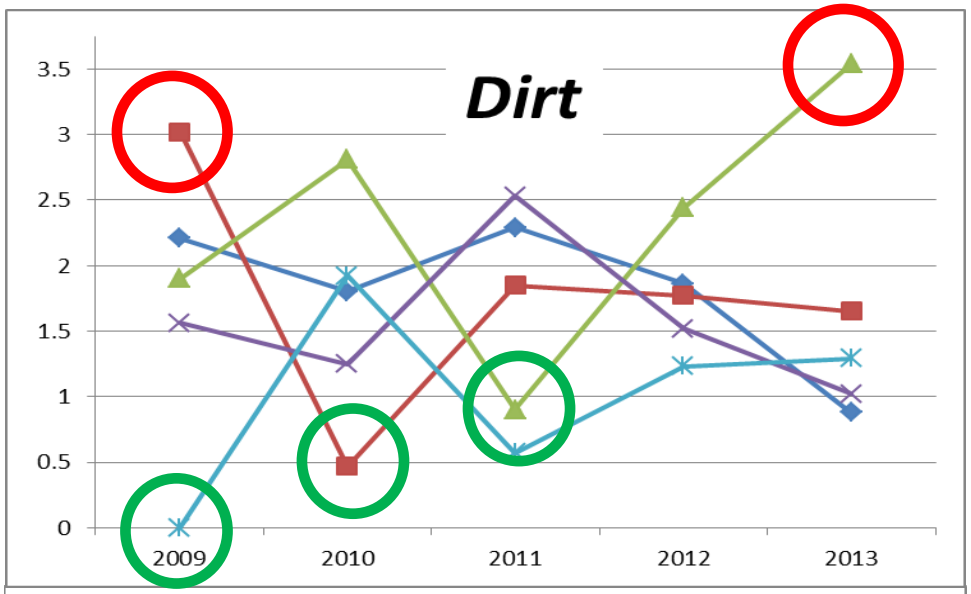
ISO Type Process

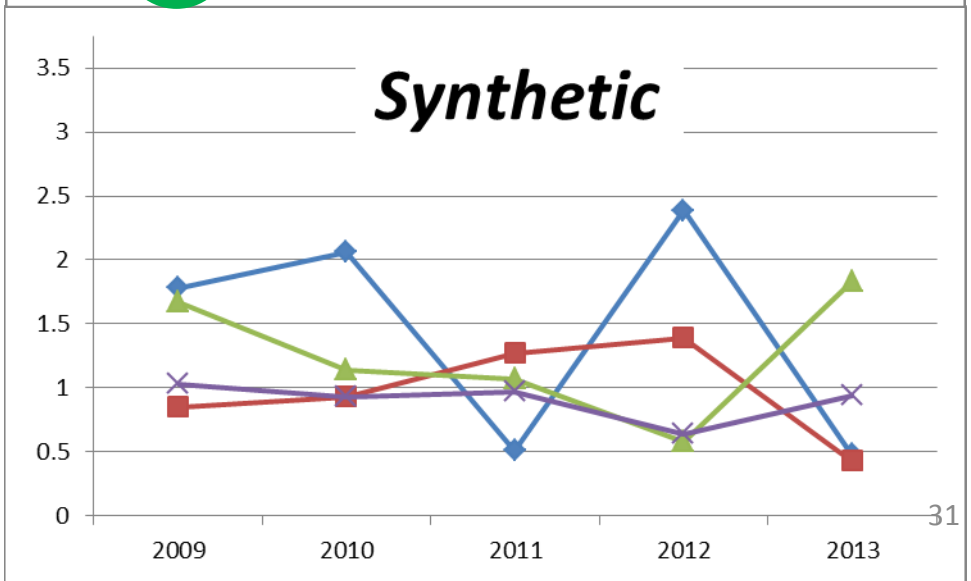
- The goal is not to define the maintenance process…
  1. What is going to be done
  2. What has been done
  3. How work is verified

Build a safety critical system every day

Dirt Tracks: Some Years are Bad

- Injury rates on dirt tracks very between years
  - Same people
  - Same methods
- Weather
- Response to weather
- Synthetic performance depends on temperature less variation



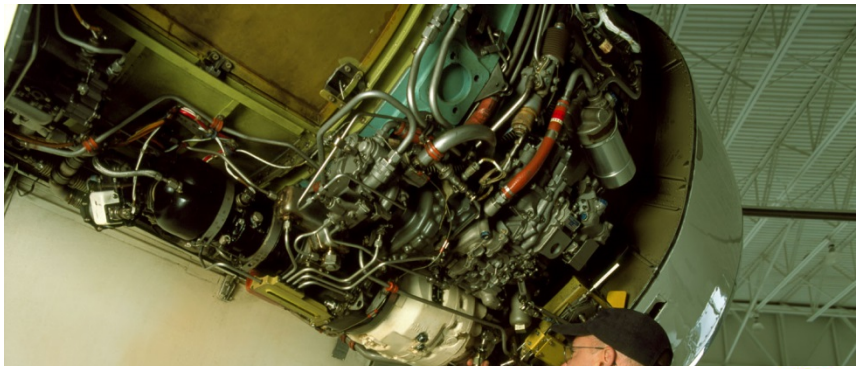


Understand and Control Track Variation

- Link testing to the outcomes .. Performance and safety
- Water is the single biggest input variable on turf
- Proper surface maintenance makes it consistent for turf:
  - Aeration
  - Top dressing
  - Verticutting

How Do Other Industries Do It?

- The goal is not to define maintenance process…
  1. What is going to be done
  2. What has been done
  3. How work is verified
- Approach suited to job: ***surgical outcomes improve with paper checklist***



Safety Checklist for Office-Based Surgery

from the Institute for Safety in Office-Based Surgery (ISOBS)

Introduction Preoperative encounter; with practitioner and patient	Setting Before patient in procedure room; with practitioner and personnel	Operation Before sedation/analgesia; with practitioner and personnel*	Before discharge On arrival to recovery area; with practitioner & personnel	Satisfaction Completed post-procedure; with practitioner and patient
Patient Patient medically optimized for the procedure? ☐ *Yes* ☐ *No, and plan for optimization made.* Does patient have DVT risk factors? ☐ *Yes, and prophylaxis plans arranged.* ☐ *No* *Procedure* Procedure complexity and sedation/analgesia reviewed? ☐ *Yes* NPO instructions given? ☐ *Yes* Escort and post-procedure plans reviewed? ☐ *Yes*	Emergency equipment check complete (e.g. airway, AED, code cart, MH kit)? ☐ *Yes* EMS availability confirmed? ☐ *Yes* Oxygen source and suction checked? ☐ *Yes* Anticipated duration ≤ 6 hours? ☐ *Yes* ☐ *No, but personnel, monitoring and equipment available*	Patient identity, procedure, and consent confirmed? ☐ *Yes* Is the site marked and side identified? ☐ *Yes* ☐ *N/A* DVT prophylaxis provided? ☐ *Yes* ☐ *N/A* Antibiotic prophylaxis administered within 60 minutes prior to procedure? ☐ *Yes* ☐ *N/A* Essential imaging displayed? ☐ *Yes* ☐ *N/A* *Practitioner confirms verbally:* ☐ Local anesthetic toxicity precautions ☐ Patient monitoring (per institutional protocol). ☐ Anticipated critical events addressed with team. ☐ Each member of the team has been addressed by name and is ready to proceed.	Assessment for pain? ☐ *Yes* Assessment for nausea/vomiting? ☐ *Yes* Recovery personnel available? ☐ *Yes* *Prior to discharge:* *(with personnel and patient)* Discharge criteria achieved? ☐ *Yes* Patient education and instructions provided? ☐ *Yes* Plan for post-discharge follow-up? ☐ *Yes* Escort confirmed? ☐ *Yes*	Unanticipated events documented? ☐ *Yes* Patient satisfaction assessed? ☐ *Yes* Provider satisfaction assessed? ☐ *Yes*

This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged. *Adapted from the WHO Surgical Safety Checklist.

Close the gap, all dirt tracks as good as best what is the best

- Difference is between good and bad years
  - Same people
  - Weather can vary
  - Respond to weather
- Document process (like aircraft maintenance)
  - Document what you will do
  - Document what you did
  - Document how you inspected it

Data input on tablet computer

DO NOT DEFINE WHAT IS DONE BUT FOCUS ON THE PROCESS

Make Every Dirt Track as Safe as the Safest Dirt Track!!!

- Goals from WSS …..
- Establish daily reporting of maintenance on racetracks
  - Provide information for track management, owners, trainers, jockeys and racing public
  - Institute database of daily maintenance of the main and turf course

Weather Station Summary | RSS Weather List | SIMM Data

Site ID	Track	WX Src	Last Weather	Batt	Links				
812	Aiken Training Track	WU	2012-10-14 23:55:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
801	Aqueduct	WU	2012-10-14 23:51:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
100	Arlington Park	WU	2012-10-15 21:45:00	6.54	Weather	Data Entry	Setup	Race Sched	Change Pwd
802	Belmont Park	Active	2012-10-15 22:45:00	6.30	Weather	Data Entry	Setup	Race Sched	Change Pwd
105	Calder Race Course	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
102	Churchill Downs	Active	2012-10-15 22:45:00	6.57	Weather	Data Entry	Setup	Race Sched	Change Pwd
813	Darley Stable	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
107	Del Mar	CHRB	2012-10-15 15:00:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
106	Emerald Downs	Active	2012-10-15 19:45:00	6.66	Weather	Data Entry	Setup	Race Sched	Change Pwd
303	Evangeline Downs	Active	2012-10-15 21:45:00	6.60	Weather	Data Entry	Setup	Race Sched	Change Pwd
103	Fair Grounds Race Course	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
803	Fair Meadows	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
301	Fairplex	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
307	Golden Gate Fields	CHRB	2012-08-02 08:00:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
804	Gulfstream Park	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
101	Hollywood Park	WU	2012-10-15 15:00:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
104	Keeneland	Active	2012-09-20 10:00:00	6.90	Weather	Data Entry	Setup	Race Sched	Change Pwd
306	Los Alamitos	CHRB	2012-10-15 15:00:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
805	Nicosia Race Club	WU	2012-10-14 23:50:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
814	Pegasus Training and Equine Rehabilitation Ce	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
806	Portland Meadows	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
807	Randall 'Doc' James Racetrack	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
201	Reeds-Brook Middle School	Active	2012-08-29 19:30:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
305	Remington Park	WU	2012-10-14 23:55:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
304	Santa Anita	CHRB	2012-10-15 15:00:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
809	Saratoga	WU	2012-10-14 23:53:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
999	test track		2012-06-19 17:00:00	6.69	Weather	Data Entry	Setup	Race Sched	Change Pwd
810	Turfway Park	WU	2012-10-14 23:52:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
815	Winstar Farm	WU	2012-10-14 23:54:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
811	Woodbine	WU	2012-10-14 23:00:00		Weather	Data Entry	Setup	Race Sched	Change Pwd
302	Zia Park	WU	2012-10-14 23:55:00		Weather	Data Entry	Setup	Race Sched	Change Pwd

Manual Maintenance Tracking System at 8 Racetracks, Automatic Tracking 6 Racetrack, Weather at 12 Racetracks

Critical to Track Data

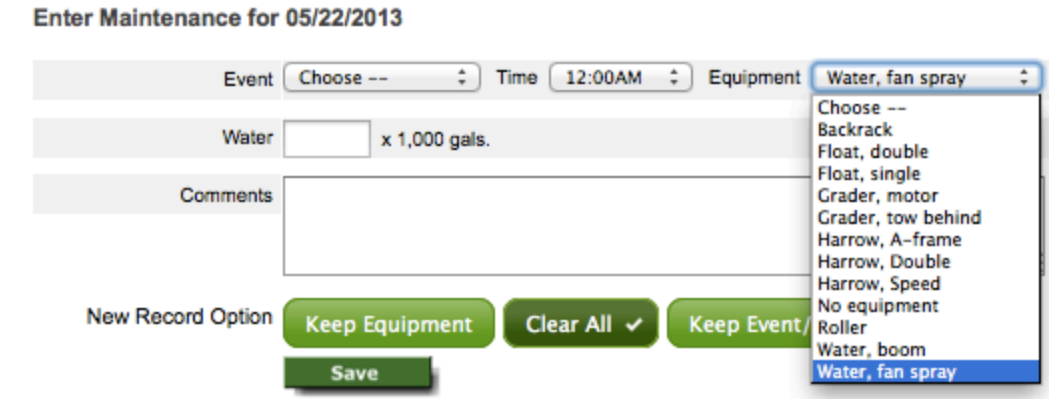
Maintenance ↔ Weather

- Weather data
  - Station at a standard track location
  - Weather logged to central database
- Water application – irrigation, water truck
- Evaporation model
  - Weather and water truck, estimate moisture content
  - Established methods from precision farming

Enter data for track maintenance

Form for turf

Form for training



Track Maintenance for 05/22/2013

Event	Break/ Race #	Time	Equipment	Direction	Rounds	Depth	Speed ()	Water x 1,000 gals.	Yards	Comments	Entered
Before Training		04:00AM	Harrow, A-frame	Racing direction	1		10.00			Edit	2013-05-22 04:21:15
Before Training		04:00AM	Harrow, Double	Racing direction	1		8.00			Edit	2013-05-22 04:21:44
Training Break	1	07:15AM	Water, boom					3.00		Edit	2013-05-22 04:22:20

Form for water truck use

Historical data

Select Date

Date 05/22/2013

✔ Training | Race Day # 19 | Training Breaks 2 | Races 9

Grading × No

Float × No

Sealed × No

Remained Sealed for Training × No

Save

Enter Maintenance for 05/22/2013

Event Choose -- | Time 12:00AM | Equipment Water, fan spray

Water x 1,000 gals.

Comments

New Record Option Keep Equipment | Clear All ✔ | Keep Event/

Save

Choose --
Backrack
Float, double
Float, single
Grader, motor
Grader, tow behind
Harrow, A-frame
Harrow, Double
Harrow, Speed
No equipment
Roller
Water, boom
Water, fan spray

Track Maintenance for 05/22/2013

Event	Break/ Race #	Time	Equipment	Direction	Rounds	Depth	Speed ()	Water x 1,000 gals.	Yards	Comments	Entered
Before Training		04:00AM	Harrow, A-frame	Racing direction	1		10.00			Edit	2013-05-22 04:21:15
Before Training		04:00AM	Harrow, Double	Racing direction	1		8.00			Edit	2013-05-22 04:21:44
Training Break	1	07:15AM	Water, boom					3.00		Edit	2013-05-22 04:22:20

Cushion depth map from probing

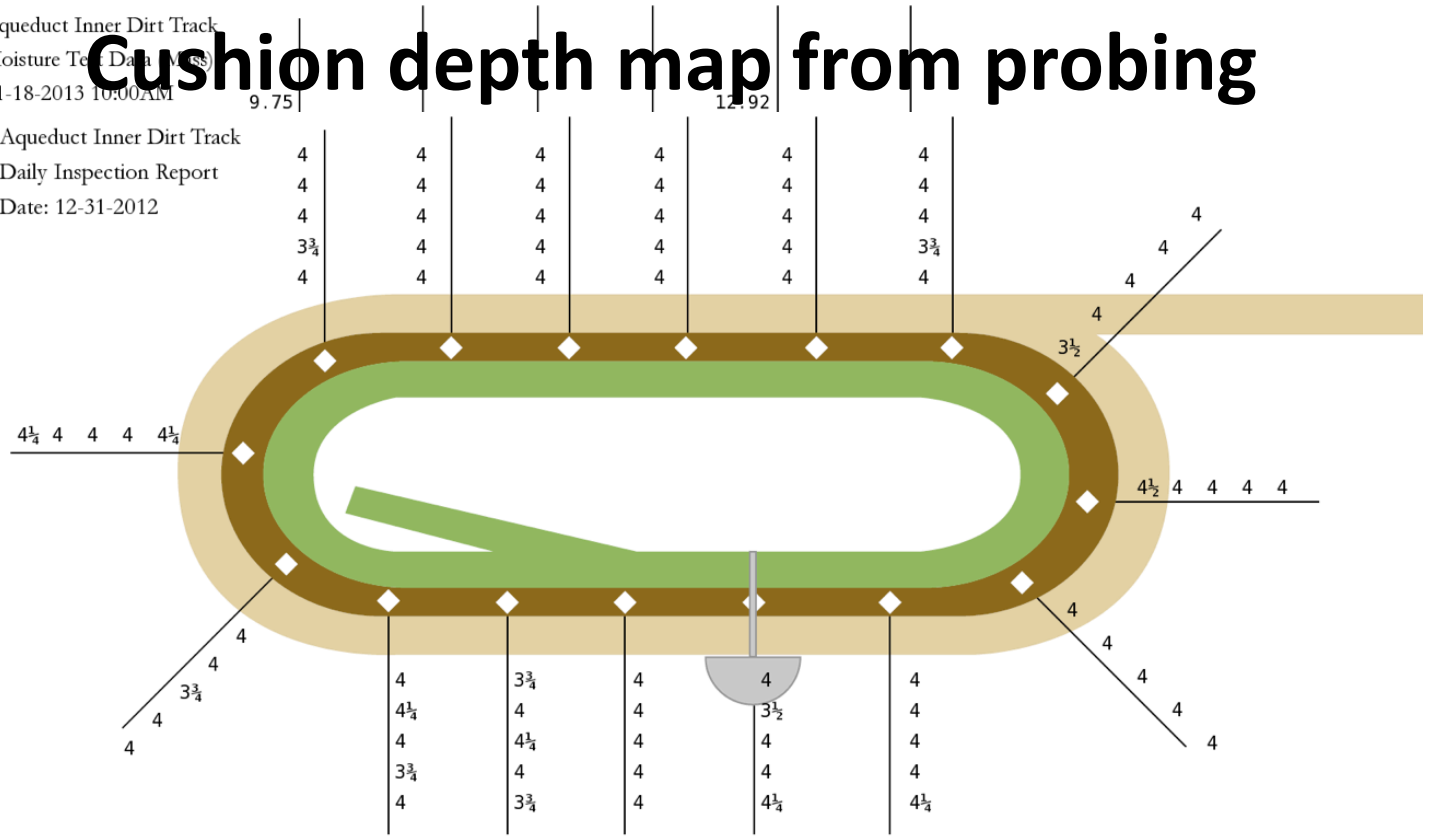
A

B

C

Aqueduct Inner Dirt Track
Moisture Test Data (%)
01-18-2013 10:00AM

Aqueduct Inner Dirt Track
Daily Inspection Report
Date: 12-31-2012



Comments:
Test set - not real data.

Last Update: 2013-04-11 14:48:00 View/Print Report

Comments

Save

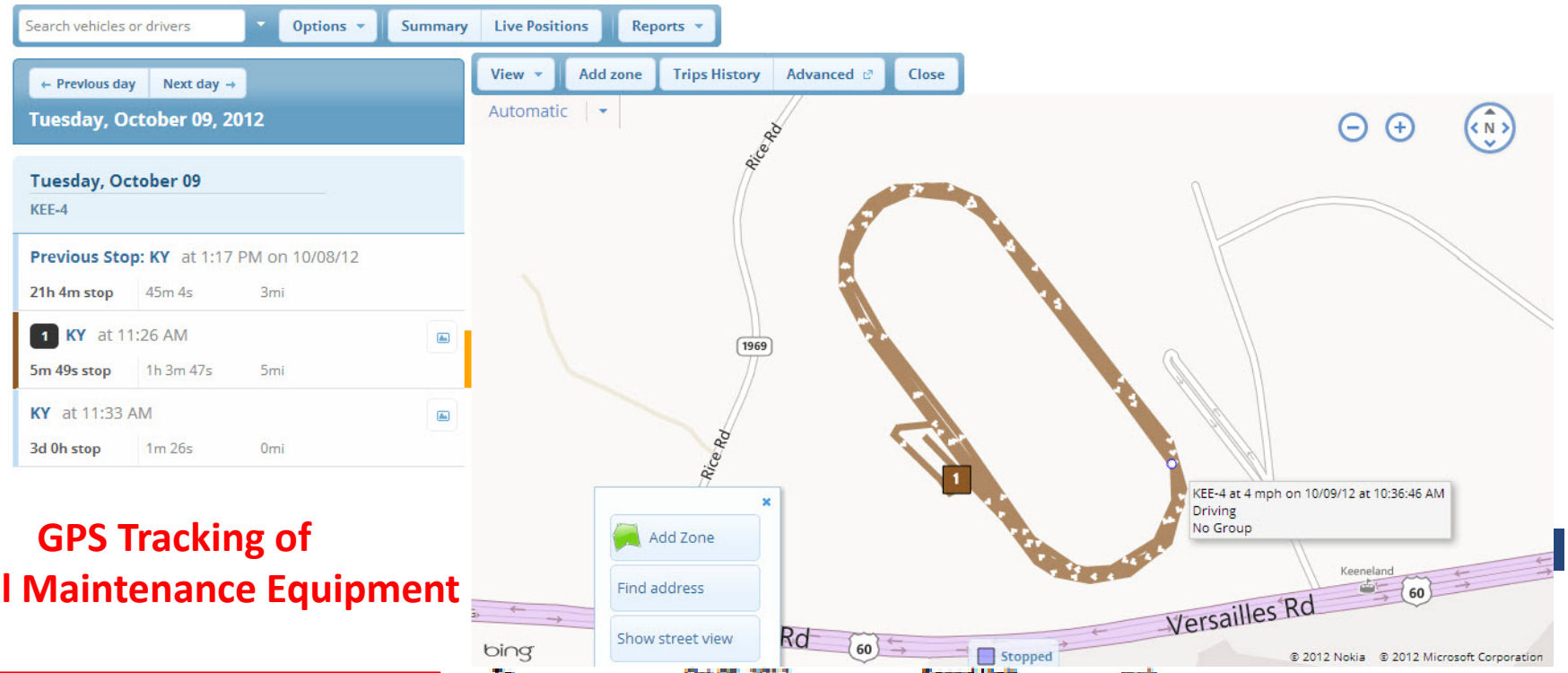
Track: 1/16 pole,3'	4 1/2	-¾	-½	-¼	4	in.	+0	+¼	+½	+¾
Track: 1/16 pole,10'	4 3/4	-¾	-½	-¼	4	in.	+0	+¼	+½	+¾
Track: 1/16 pole,20'	4 3/4	-¾	-½	-¼	4	in.	+0	+¼	+½	+¾
Track: 1/16 pole,30'	4 3/4	-¾	-½	-¼	4	in.	+0	+¼	+½	+¾
Track: 1/16 pole,40'	4 3/4	-¾	-½	-¼	4	in.	+0	+¼	+½	+¾
Track: 1/8 pole,3'	4 1/2	-¾	-½	-¼	4	in.	+0	+¼	+½	+¾
Track: 1/8 pole,10'	4 1/2	-¾	-½	-¼	4	in.	+0	+¼	+½	+¾

Too nt

Racing Surfaces Testing Laboratory
Orono Maine USA

Use GPS Tracking to Monitor

THE UNIVERSITY OF MAINE



GPS Tracking of Critical Maintenance Equipment

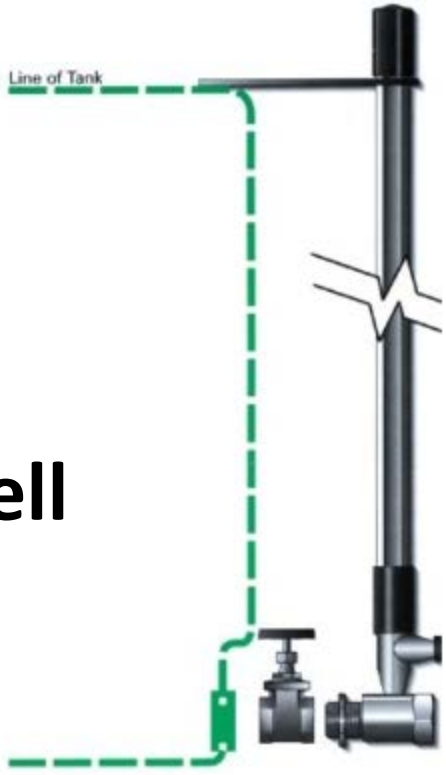
Daily report of activity:

Precision Farming For Horse Racing

To Oct 08, 2012 Speed Unit mph

Device	Device Group	Driver	Driver Group	Start DateTime	Dri
KEE-2	Entire Organization	No Driver Key Used	Entire Organiza	Oct 07, 2012 10:05:29 AM	
KEE-2	Entire Organization	No Driver Key Used	Entire Organiza	Oct 07, 2012 11:03:16 AM	
KEE-2	Entire Organization	No Driver Key Used	Entire Organiza	Oct 07, 2012 1:07:50 PM	
KEE-2	Entire Organization	No Driver Key Used	Entire Organiza	Oct 07, 2012 1:39:31 PM	
KEE-2	Entire Organization	No Driver Key Used	Entire Organiza	Oct 07, 2012 2:45:06 PM	
KEE-2	Entire Organization	No Driver Key Used	Entire Organiza	Oct 07, 2012 3:15:27 PM	
KEE-2	Entire Organization	No Driver Key Used	Entire Organiza	Oct 07, 2012 4:25:08 PM	
KEE-2	Entire Organization	No Driver Key Used	Entire Organiza	Oct 07, 2012 5:32:49 PM	
KEE-2	Entire Organization	No Driver Key Used	Entire Organiza	Oct 07, 2012 5:40:52 PM	

Tracking of Water Truck Depth Santa Anita

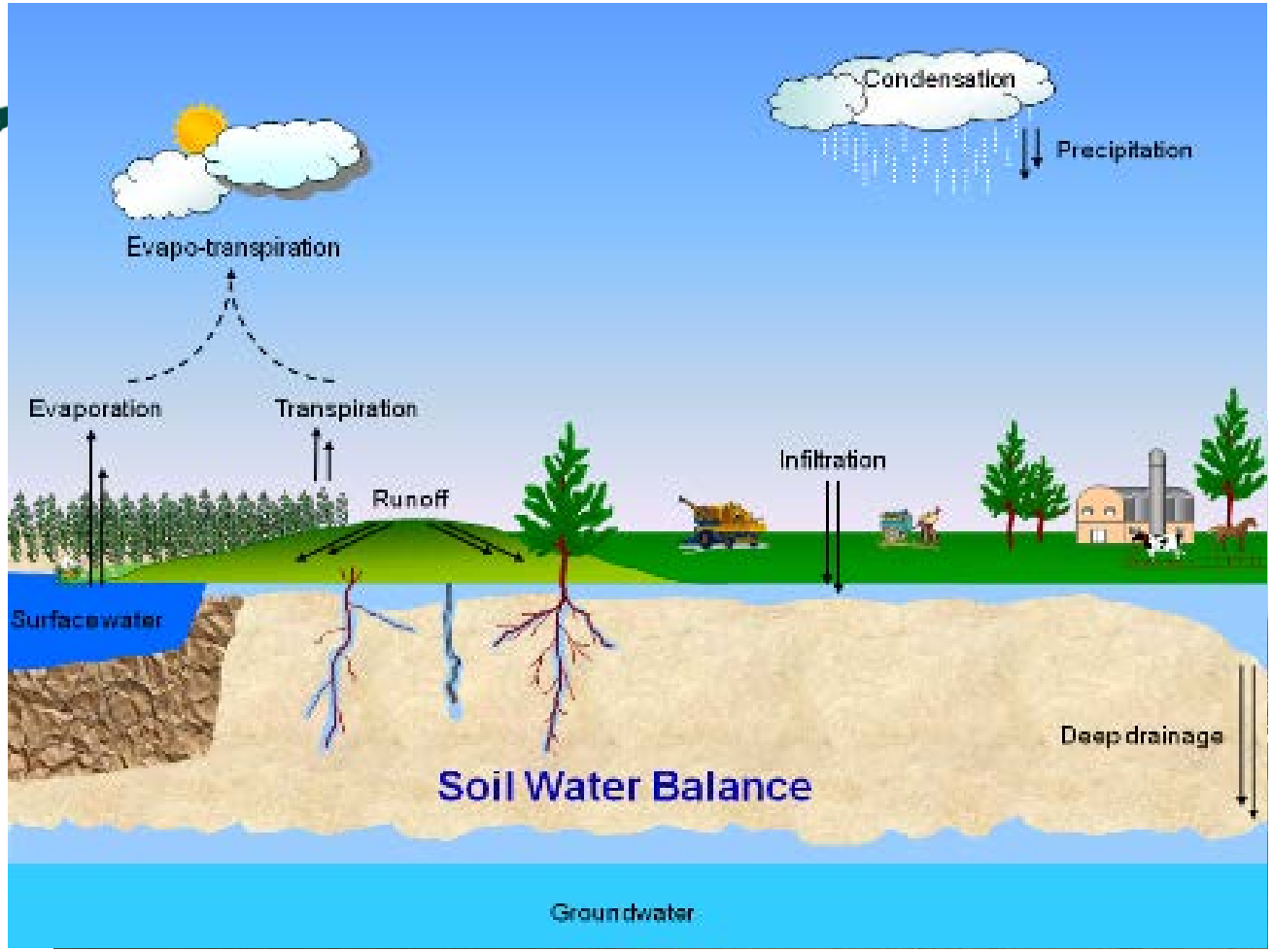


no	07:30:32	SA Tractor 1	b8	00:19:58	2.051951	8
no	08:37:29	SA Tractor 1	b8	00:34:04	2.364427	10
no	10:06:01	SA water truck 1	b2	00:13:43	2.325683	18
no	10:46:27	SA water truck 1	b2	00:08:05	1.12007856	14

The position of the truck is logged as well as the depth of the water in the tank.

Evaporation Model - Keeneland

Evapotranspiration Models
Well established for crops including turf



How to Inspect the Work

Recall:

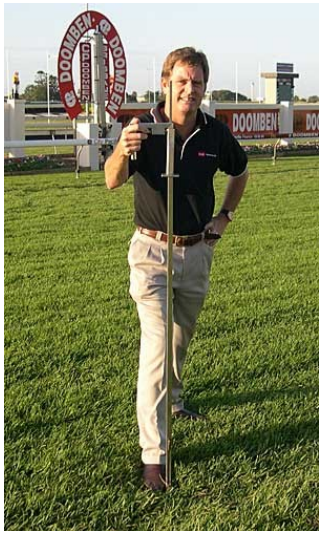
The maintenance process…

1. What is going to be done
2. What has been done
3. How work is verified

Surface Tester Used At Start of Meet and On the Big Days

Portable Inspection Tools

- Clegg Hammer
  - Does not correlate strongly to race times
  - Does not match biomechanics
    Lower speed and load than hoof strike
- Going Stick
  - Promising, link to biomechanics?
  - Assumes depth of cushion/turf homogeneity
- Penetrometer
  - Most well established, some link to penetration of shoe in breakover
  - "Penetrometer reading bears some relationship to winning times but is not a reliable predictor of such time" (Chivers, 1996, in Neylan & Stubbs 1997)



http://www.justracing.com.au

None are correlated to injury. Weaker correlation to race time than: Synthetic Track Temperature* or moisture in dirt/turf.

* Effect of temperature on 6 furlong times on a synthetic racing surface, M. L. *Peterson et. al. Equine Veterinary Journal, to appear*

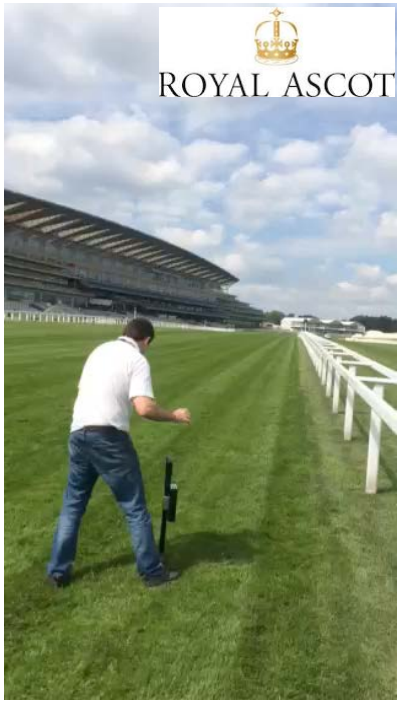
Current Status

- No simple tools measure everything penetrometer, Clegg and Going Stick
- Use the OBST on a periodic basis, multiple machines in North America and Europe
- Variables understood with OBST and controlled between visits
- Periodic inspection and tracking maintenance
  - Like the ISO certification of tracks
  - Using methods from aircraft maintenance

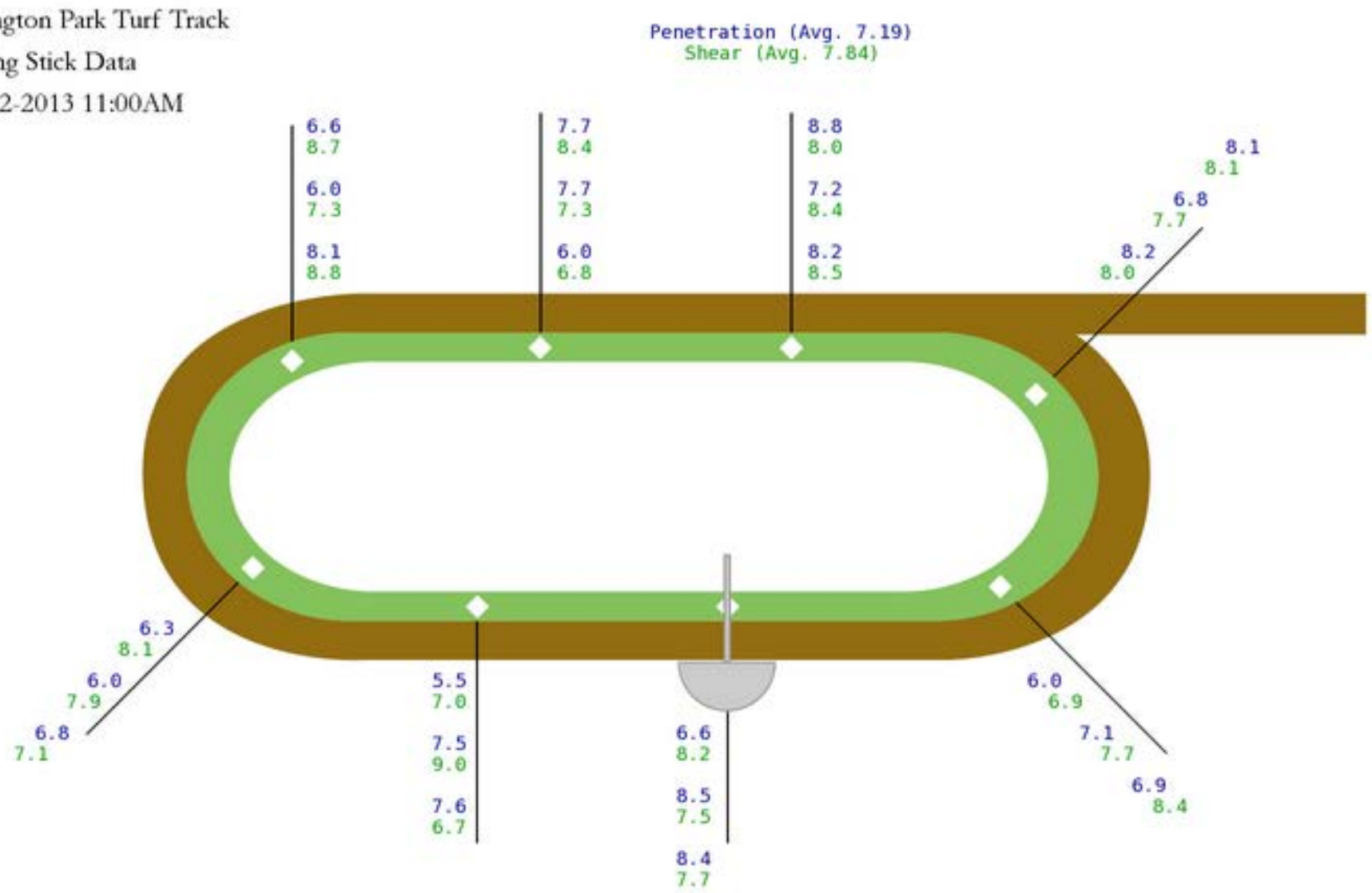
To Make Dirt and Turf MORE CONSISTENT

CONTROL WATER

3rd Step: Inspect What was Done

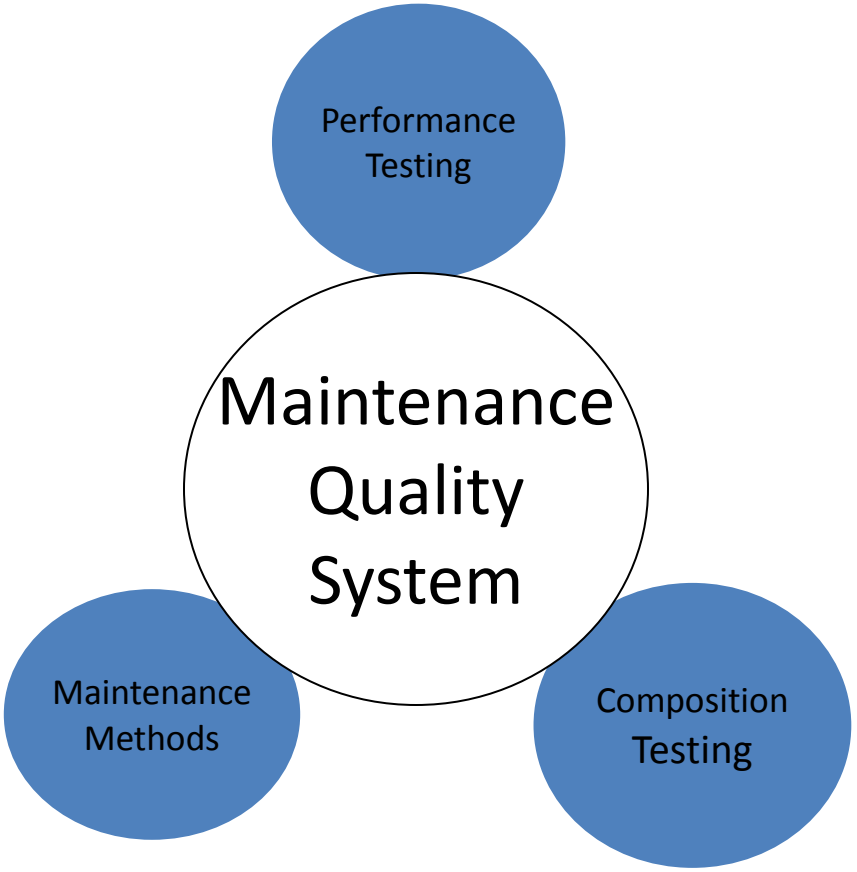


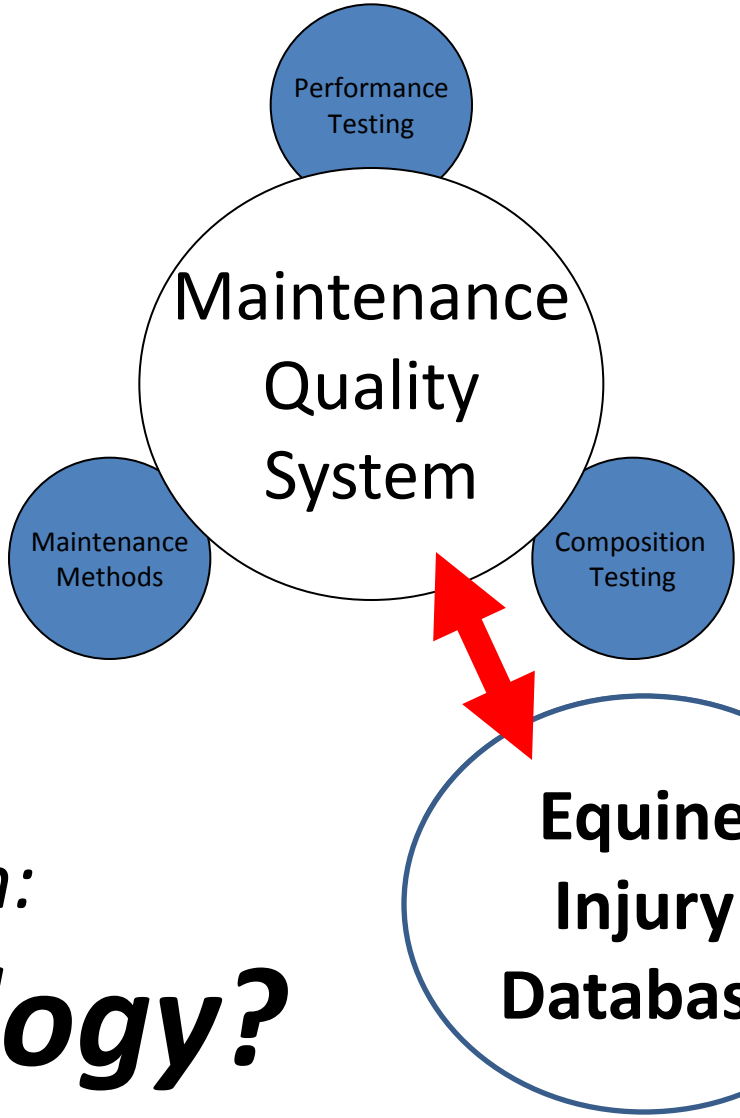
Map and upload to database



All Data: Central Database

- The goal is to IMPROVE…
  - What is going to be done
  - What has been done
  - How work is verified
- Data can be tied to outcomes
  - Injuries to horses and jockeys
  - Effectiveness of maintenance methods
  - Equipment & labor expenditures





The more critical question:

Epidemiology?

What matters is that we protect horses and riders

Surfaces do not "cause" injuries, they CAN improve the situation

For racing, no disease no breakdown….
Issues in Musculoskeletal Disease

- Conformation
- Individual predisposition
- Pre-existing disease
- Shoeing
- Training
- Track surfaces
- Multi-factorial risk

Everyone Cooperates

- Arlington and Churchill Downs: maintenance tracking and measurement of surfaces
- Santa Anita: Sand Durability, Water Truck Depth tracking
- NYRA: Maintenance Quality System
- Keeneland: Evaporation Model and XRD of candidate sand

Information shared industrywide:

Safer surfaces benefit all horses, riders, fans and owners

Acknowledgements

June 5, 2014 New York Times

SPORTS

The Complex Battle to Achieve the Perfect Dirt

Belmont Park, Site of Failed Triple Crowns, Requires an Army of Caretakers

By MELISSA HOPPERT JUNE 5, 2014

Kozak, 43, came to NYRA in 2008 … he has transformed an antiquated system that relied on old-school methods and paper records. Now NYRA maintenance workers are equipped with iPads and BlackBerrys and are entering data from the seats of their tractors. "He's the future, is what I tell people in track maintenance," said Mick Peterson, "He's able to look every day on his phone and see when the equipment went out, what time it went out, what they were doing. This is more like aircraft maintenance … but … we've got the health and safety of the horses and the riders at stake here"