Maintenance Quality System, Track Design & Equine Injury Database

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Welfare & Safety Summit

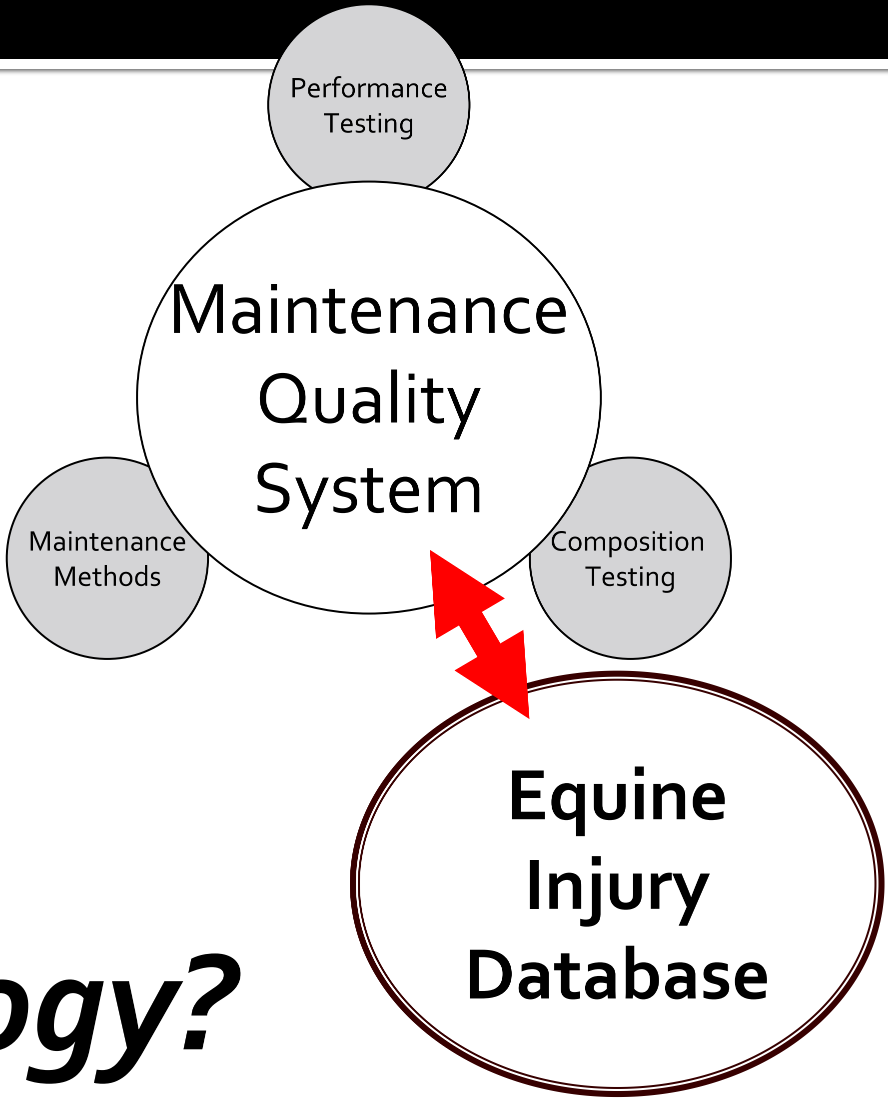
A *Culture of Data*

- Equine Injury Database
- Jockey Injury Database

Maintenance Quality System

- Surface Data Including….
  - Design data
  - Track Inspection
  - Maintenance Tracking

Goal: Find good (better?) surfaces



The more critical question:

Epidemiology?

What matters is that we protect horses and riders

A Useful Result?

- Basic Track Design Information on 40 Racetracks
- Track Design
  - Turn radius
  - Banking & Design

Track Design Information

What Matters

Equine Injury Database
Seven years of Data

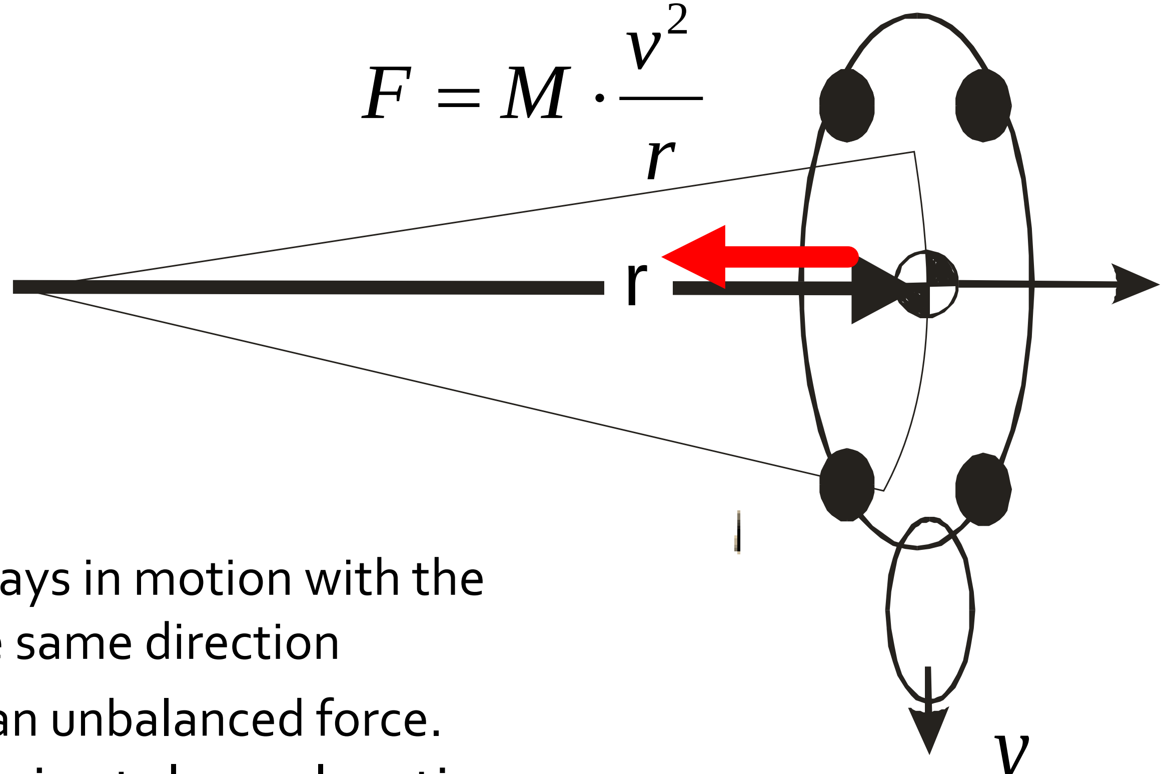
Look at turns…

Important?

A clear first step

How Horses Turn…

$$F = M \cdot \frac{v^2}{r}$$



Curve negotiation:

- Newton's First Law
  - An object in motion stays in motion with the same speed and in the same direction
  - unless acted upon by an unbalanced force.
- Turning requires centripetal acceleration …
- The resulting force is an inwardly directed ground reaction force.

Racing Surfaces Testing Laboratory

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A Spherical Horse … A Point!

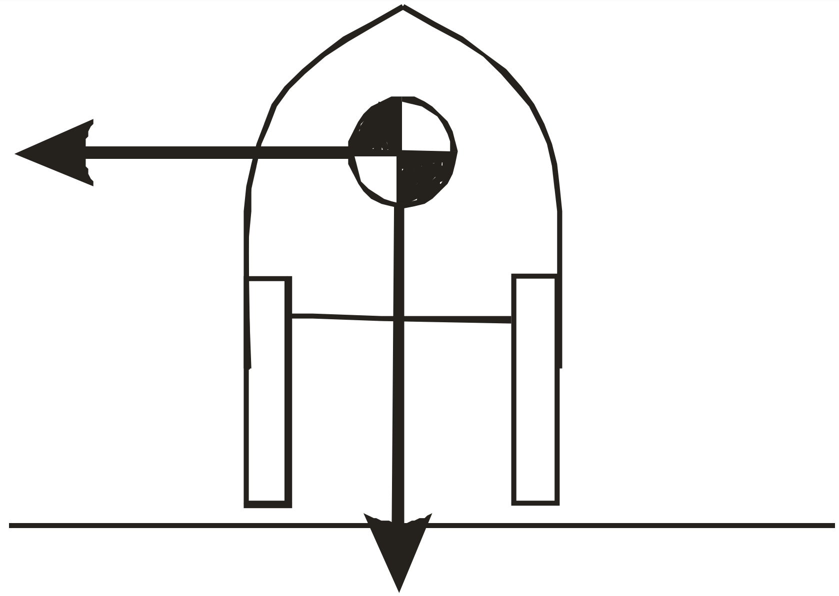
Forces are significant:

- Example
  - 415 ft. radius turns
  - 40 MPH
- 0.25 G acceleration
- 250 lbs of force

- The force from the turning results in a tipping (moment) on the horse, which must be resisted at the ground

The Weight of Horse Plus Turning

$$F = M \cdot \frac{v^2}{r}$$



$$F = Mg$$

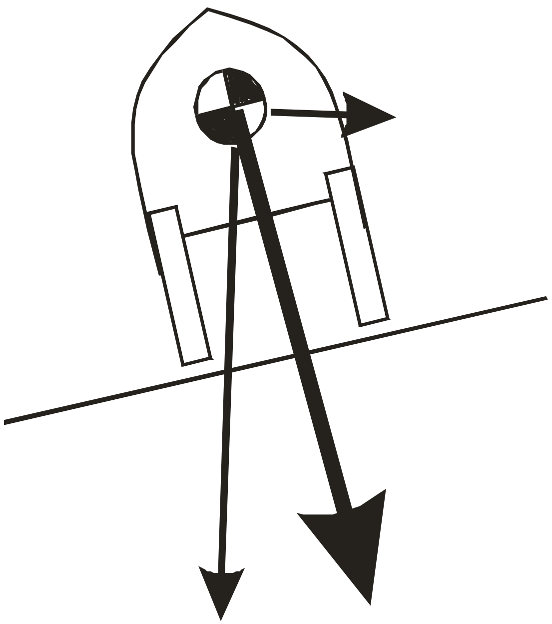
- Turning can push over with 250 lbs of force
- The weight of the horse is 1000 lbs

Outcome:

Laterality of injuries ....

Right leg fractures? **Does not match the data!**

Resist Tipping … banking



How much to bank the track?

- For the Example
  - 1000 lbs & 250 lbs turning
  - 25 degree banking

No!!

Banking of the track can keep the forces aligned with the limbs

Horses lean!!!

How much do horses lean?

- Limited data from gallop …
- More data from other gaits

What can we measure?

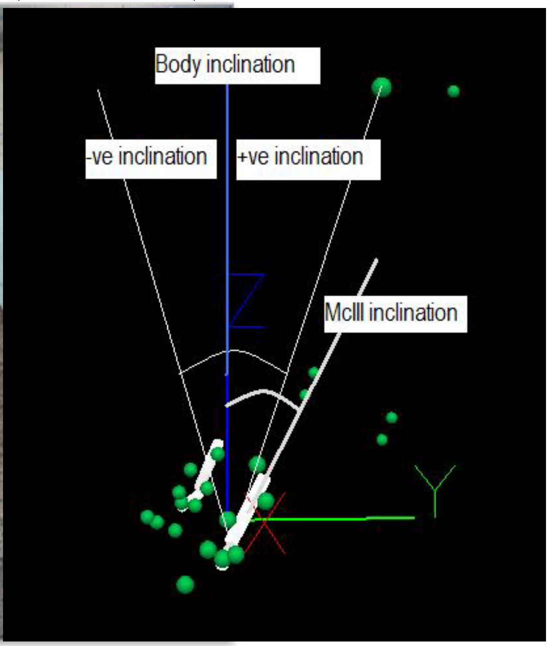
- Kinematics: the 3-D motion of the horse, leaning, rotation of the hoof and relative position of hooves
- Kinetics: the forces on the hooves, the way in which the load is shifted between legs

Outcome:

Obvious outcome …. laterality of injuries ….

Measurement Techniques

- Kinematic – 3D optical motion Hobbs et al. (2011)

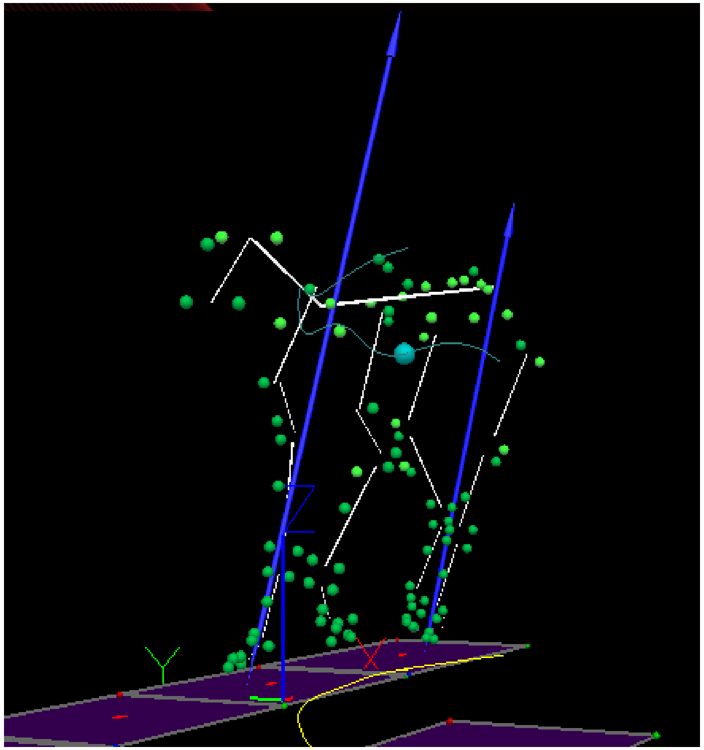


- Inertial sensor based Starke et al. (2012).

Limb Position

Measurement Techniques

- Kinetic – Force platforms as described by Clayton et al. (2014) that measure the GRF



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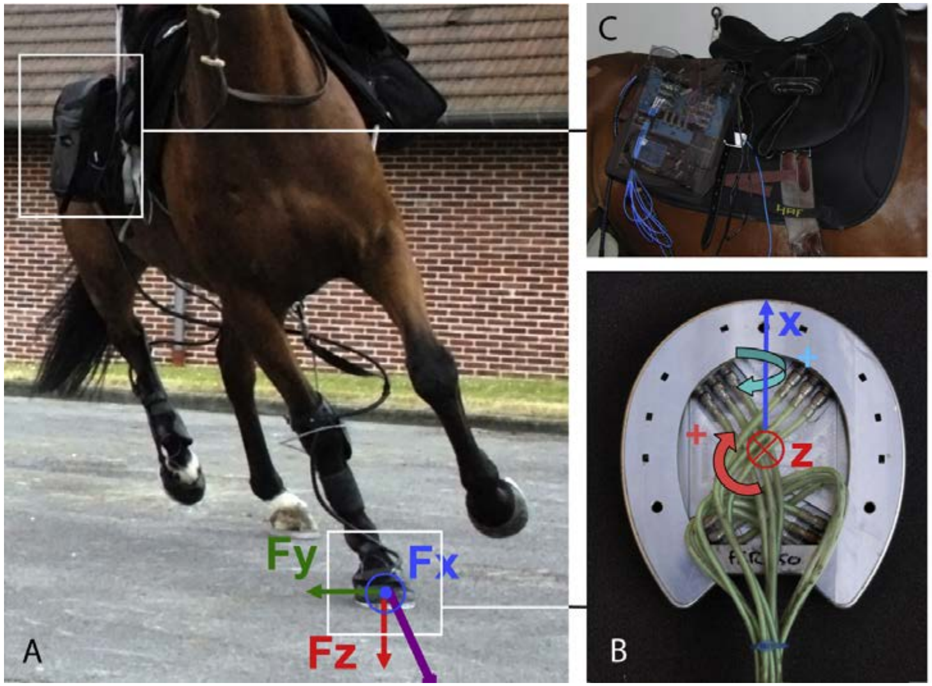
Measurement Techniques

- Kinetic – Force shoes measure limb forces Roland et al. (2005) and Chateau et al. (2013)



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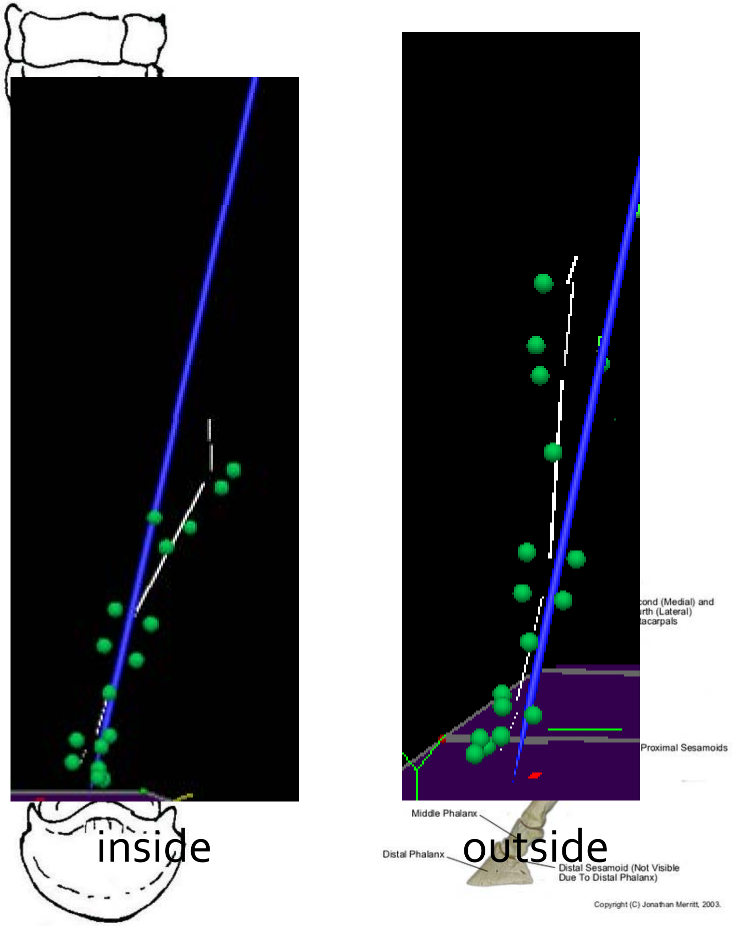
Third Metacarpal (Cannon Bone)

Trotting

- Inside forelimb: more inclined than body
- Outside forelimb: less inclined than body

- Hind: MtIII similar to body

(Hobbs et al., 2011; Chateau et al., 2013)

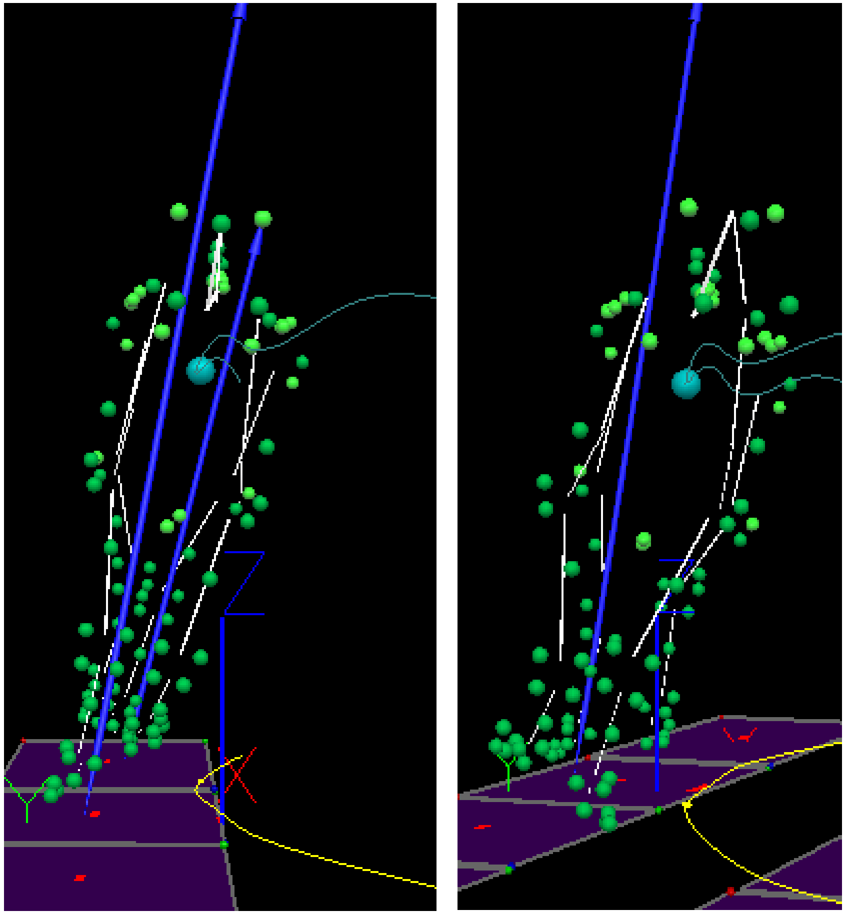


Angle of limbs is significant even lower speeds!

Trotting - Head & Trunk

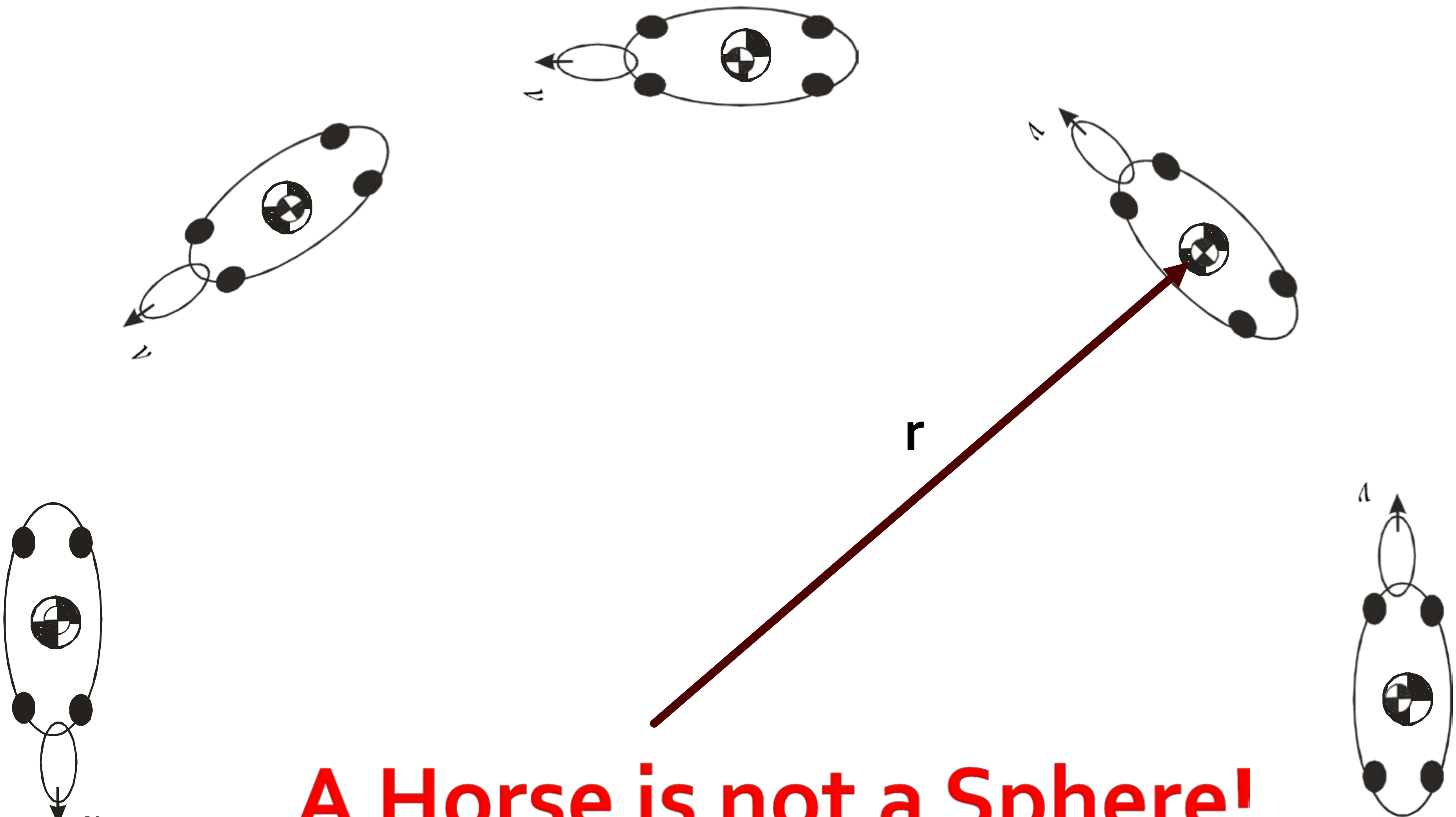
- Body Center of Pressure moves 20 mm (3/4 inch) to inside on 6 m circle
- Mild head nod down on stance of outside fore

(Clayton and Sha, 2006; Hobbs et al., 2011; Starke et al., 2012) Merritt et al., 2014)



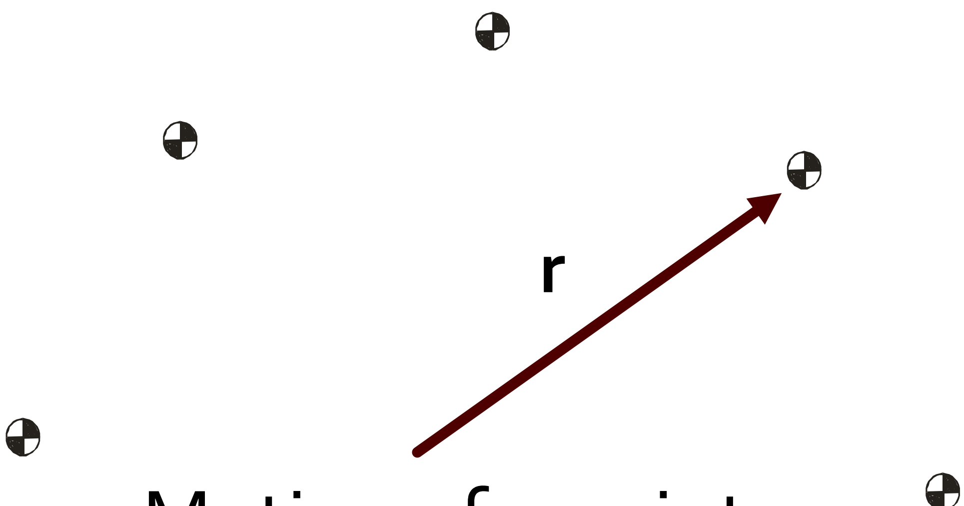
Lean is significant even at low speeds!

Assumed horse is a sphere

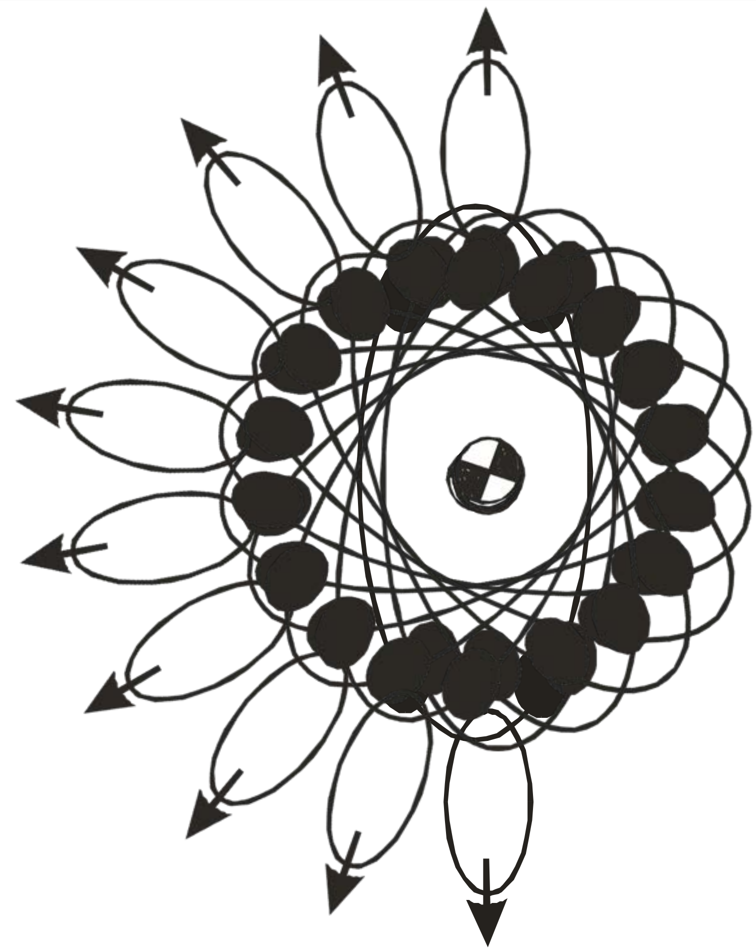


A Horse is not a Sphere!

The Body of the Horse Rotates



Motion of a point
PLUS
Rotation of the horse!



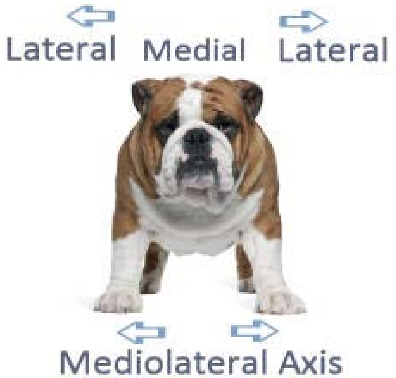
What rotates the horse?

Pull with left front and push with right rear

Hoof

Trotting

- Inside forelimb:
  - Abduction (away from midline) and internal rotation moment at hoof
  - Laterally positioned Center of Pressure (away from midline)
- Outside forelimb:
  - Adduction (to midline) and large external rotation moment at hoof
  - Medially positioned Center of Pressure (toward midline)



(Hobbs et al., 2011; Chateau et al., 2013)

Hoof rotates and shifts pressure … turns and makes banking… <u>if the surface supports the hoof</u>

What does this mean?

Outcome:

- The obvious outcome should be laterality of injuries ….
  - Lateral loading to outside
  - Need to produce turning forces, rotate the horse
- Left front and right rear fractures?

Outcome:

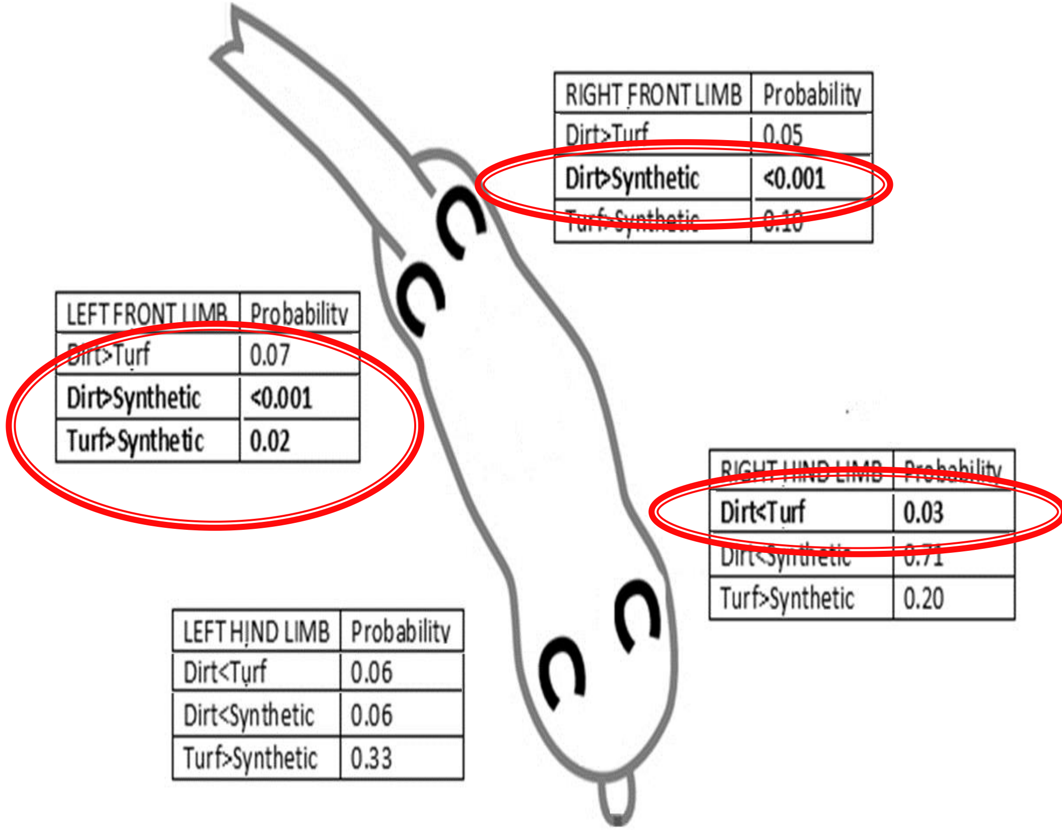
Fractures: Left front and right rear

Equine Injury Data

NO: Left front and right fracture differences are primarily on dirt!

Laterality of injuries is dramatically reduced on turf and synthetic surfaces.

Left front, lower on turf and synthetic



RIGHT FRONT LIMB	Probability
Dirt>Turf	0.05
Dirt>Synthetic	**<0.001**
Turf>Synthetic	0.10

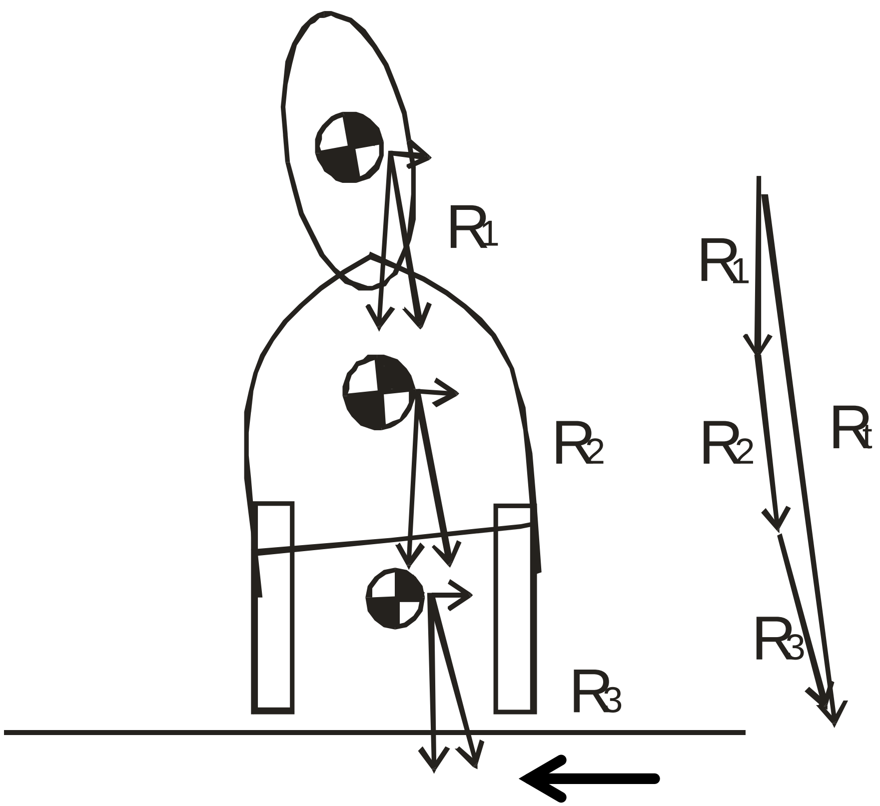
LEFT FRONT LIMB	Probability
Dirt>Turf	0.07
Dirt>Synthetic	**<0.001**
Turf>Synthetic	**0.02**

RIGHT HIND LIMB	Probability
Dirt<Turf	**0.03**
Dirt<Synthetic	0.71
Turf>Synthetic	0.20

LEFT HIND LIMB	Probability
Dirt<Turf	0.06
Dirt<Synthetic	0.06
Turf>Synthetic	0.33

Horse Alignment for Turning

- Horse moves into the turn to reduce the tipping moment.
- Creates banking with hooves
- Surface supports hoof rotation?

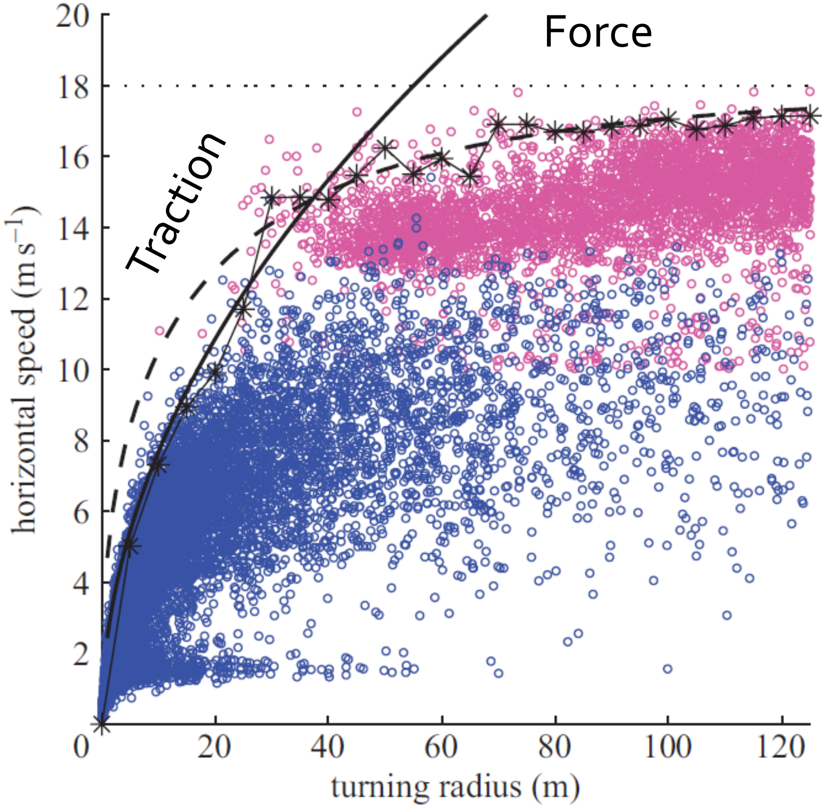


Turning is a significant risk to the horse and surfaces matter!

Tan & Wilson (2014):
Grip and limb force limits to turning

Two factors that might limit turning performances are: peak limb force & traction.

Different speeds (polo versus racing), traction versus force … all grass

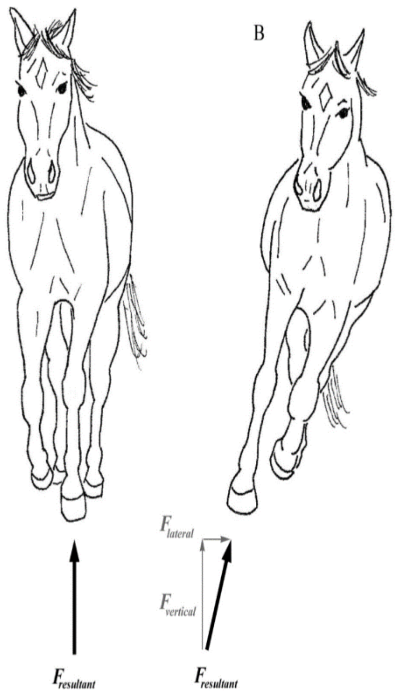


Racing:

- Synthetic and Turf: Force Limited?
- Dirt: Traction Limited?

Traction Limited Surfaces

- If traction is limited the ability to balance loads between limbs is limited
- Turning as an exposure variable
- Do traction limited horse have a certain number of allowable turning strides?
- Eliminate laterality of injuries, dirt safety closer to synthetic or turf?
- Understand Musculoskeletal Disease



Why We Care

- Need to Understanding Surfaces and Turning
  - Is Turning a Factor in Safety of Turf and Synthetic?
  - What Factors can be modified with dirt?
- Understand Musculo-skeletal Disease

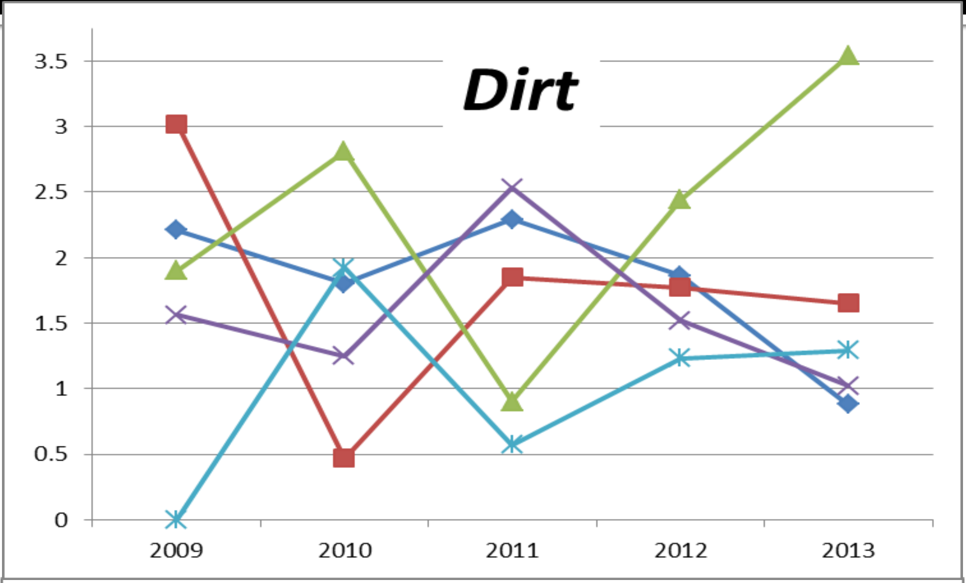
Surface

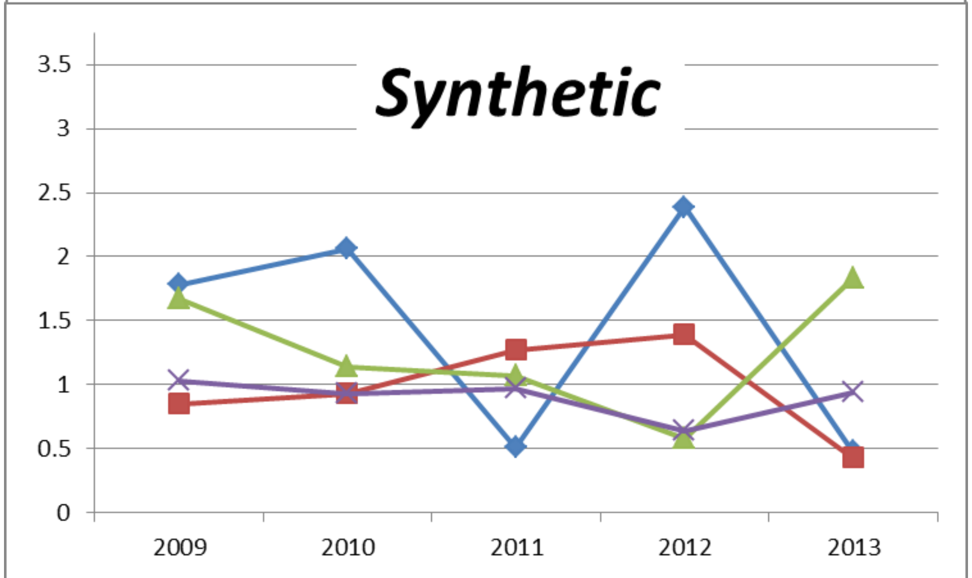
	2009			2010			
	Fatal injuries	Starts	per 1000 starts	Fatal injuries	Starts	per 1000 starts	Fatal injuries
ALL	790	395897	2.00	727	387671	1.88	713
Turf	88	45456	1.94	81	50701	1.60	77
Dirt	617	293306	2.10	585	286584	2.04	586
Synthetic	85	57135	1.49	61	50386	1.21	50

Make Dirt Consistently Safe?

- Good years on dirt
- Every year is pretty good on synthetic
- Understand dirt .... eliminate the bad years
- Turning may be a factor!

<u>***AND WATER***</u>





Maintenance Quality System

- Design Data
  - Type of dirt track: shallow sand, cushion, false base
  - Turn Radius
  - Banking Transitions
- Track Inspection Data
  - Grip
  - Firmness/Cushioning
  - Consistency
- Maintenance Data
  - Sealed
  - Weather, drier than normal wetter than normal

- Control for....
  - Type of horses
  - Training
  - Jurisdiction

Overall Theme:

A ***<u>Culture of Data</u>***

- Equine Injury Database
- Jockey Injury Database
- Maintenance Quality System

<u>Make Racing Safer with Data</u>

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Thank You!