How Do You Turn This Driving Simulator On?

Tutorial for Traffic Engineering and Roadway Design Research Using Driving Simulation

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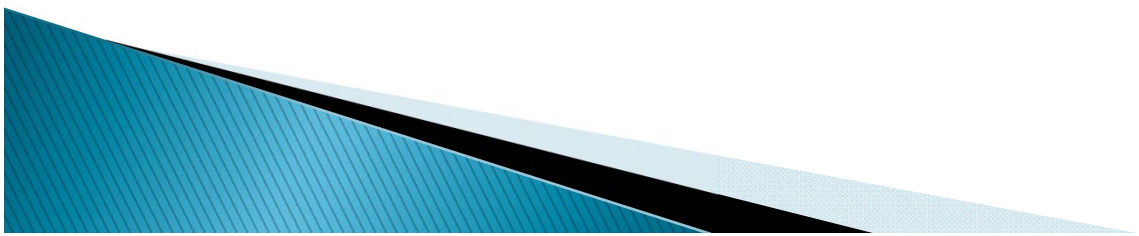
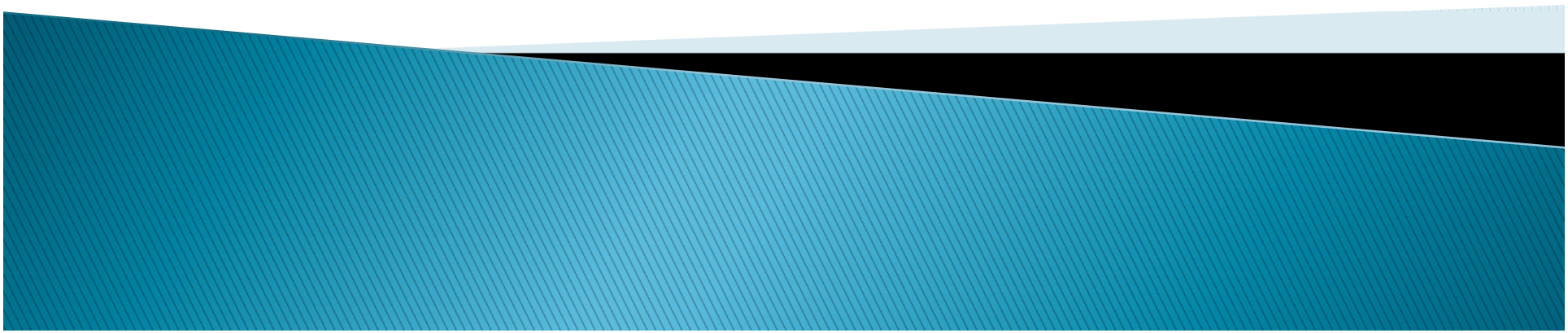
Agenda

1:30 Introductions
1:45 Hardware Selection and Room Set-up
Richard Romano
2:05 Research Topics and Scenarios
Sue Chrysler
2:20 Experimental Design Concepts
Linda Ng Boyle
2:40 Data Collection Tips
Sue Chrysler
3:00 Group Exercise
4:00 Discussion and Questions
4:30 Adjourn



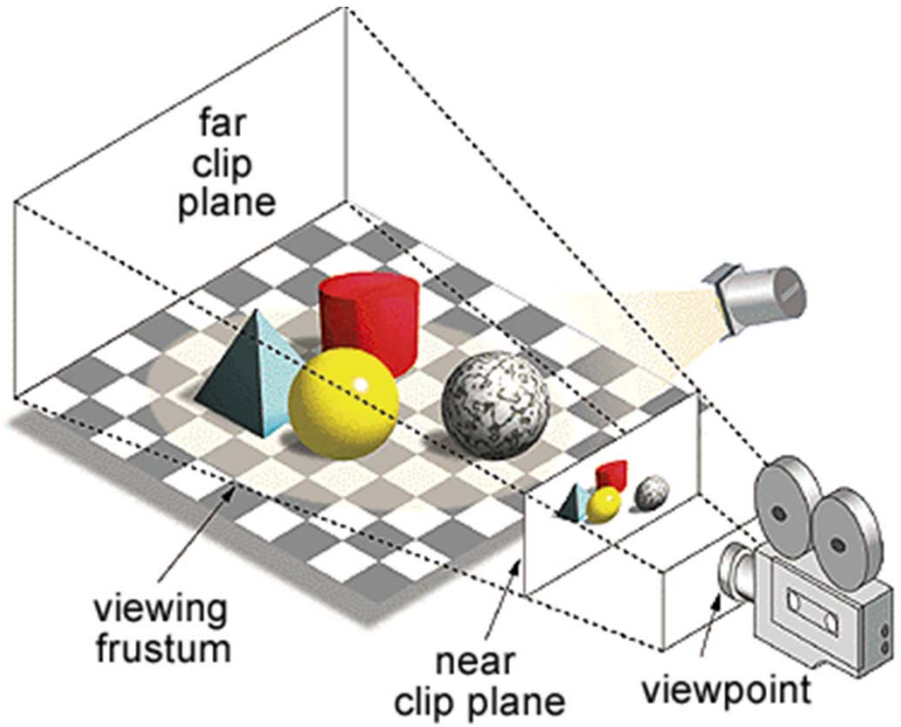
Hardware Selection and Room Set-up

Richard Romano



Eye Relief (Display Distance)

- It is important for visuals objects in simulator to be located “behind” the screen.
- Otherwise they look too big and too far away



Taken from thefreedictionary.com

Eye Relief

- When screens are too close (inside 4 feet ?)
  - Eye strain from accommodation
- Eye strain is worse than computer work
  - The “virtual” image is further away
  - Fights with accommodation reflexes

Taken from thefarmersdaughter.com

Selecting Cab Size

- Full vehicle is large, expensive, and hard to move into a room
- ½ cab can be effective
- ¼ cab (or desktop) are smallest
  - Eliminates the roof and pillars
  - Can make it difficult to locate your car in the virtual world.

Taken from bransonpianomo.com

Resulting Designs: Desktop Simulator

- Monitors are very close for larger field of view (FOV)
  - Smaller, cheaper monitors
  - Allow displaying interior elements of the vehicle (i.e. dashboard)
- Disadvantages
  - Close monitors can cause eye strain
  - No passengers
  - No interior components

Resulting Designs: Quarter Cab

- Bring monitors close to display vehicle mirrors and vehicle exterior in the monitors
- Can include center console
- Disadvantages
  - No passengers
  - Difficult to have a wide FOV
    - Vertical or horizontal
  - Can't test accommodation time changes from monitor
    - Out the Window to interior (cluster, etc.)

Resulting Designs: Full or Half Cab

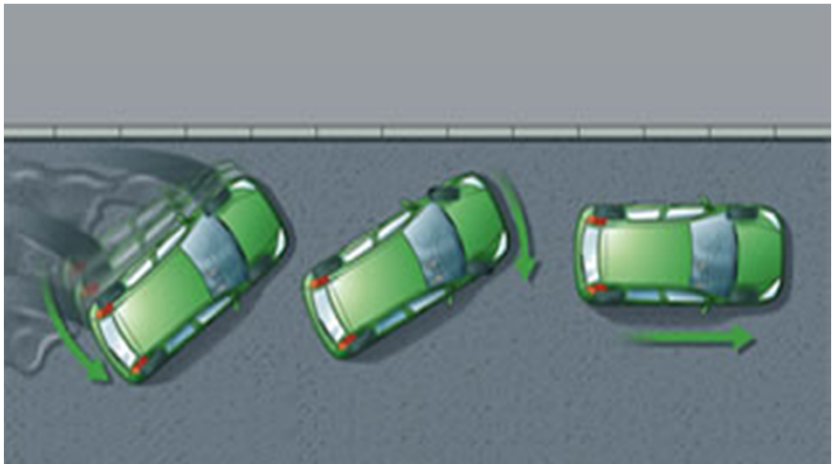
- Requires large room
  - Must push screens out beyond the vehicle
- Typically use projectors
- Stop signs on right and cars on left are “inside” screen so they don’t always look correct
  - Complaints that they look too big and too far away

Faceted vs. Curved Screens

- Curved screen has constant distance to the screen (good for accommodation cues)
- Head/vehicle motion causes a kink in the horizon on faceted screens

Steering Feedback

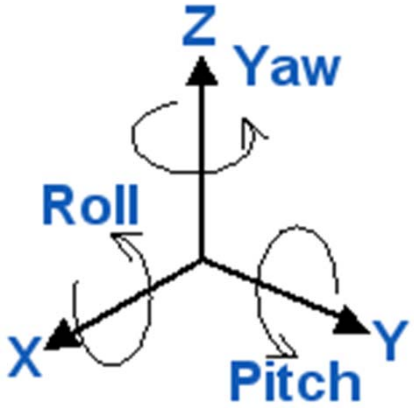
- Passive Steering
  - Spring feedback
- Active Steering
  - Motor mounted on steering wheel



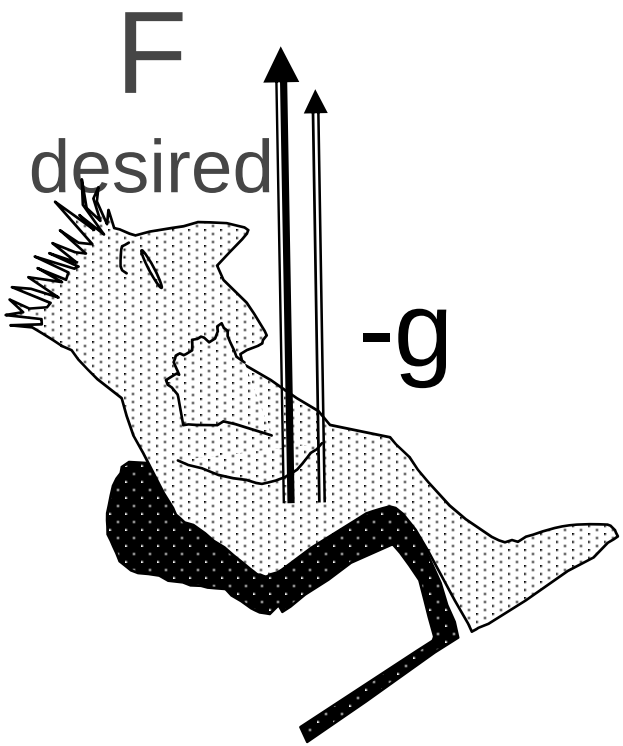
Taken from gov.uk

- Active Steering
  - More expensive
  - Can use tighter on center torque to help drive the car straight when looking away from the road
  - Helps you recover from a skid by turning the road wheels into the direction of travel

Motion Feedback



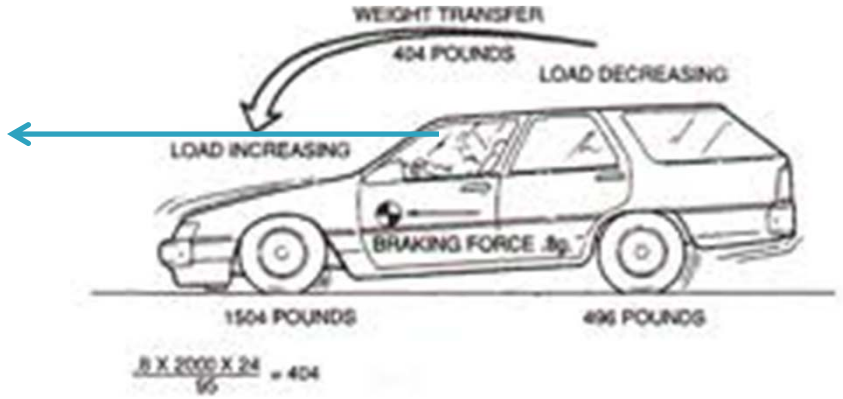
Tilt Coordination



- Is important for vehicle controllability
- Pitch and Yaw
  - Important motion cues for simulator sickness
  - Supports our ocular reflexes
- Vision uses position to interpolate velocity
- Acceleration feedback needed
  - From our vestibular system for good vehicle control
- High gain and high tilt rate motion improve controllability but does not feel good

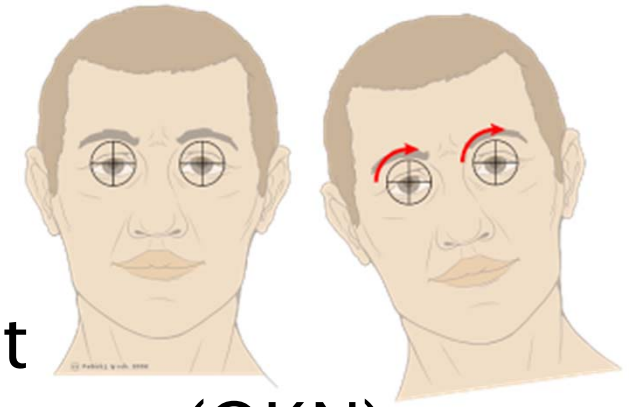
Motion and Sickness (Pitch)

- In real world
  - Vestibular ocular reflex makes it so the car pitches around your eyes.

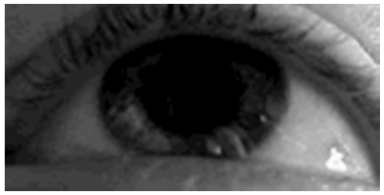


- In a fixed based simulator
  - Horizon just moves up
  - Issues with the car "pitching" too much
- A pitch motion base can support the reflex properly.
- Or turn off pitch motion in the dynamics.

Vestibular ocular reflex (VOR)



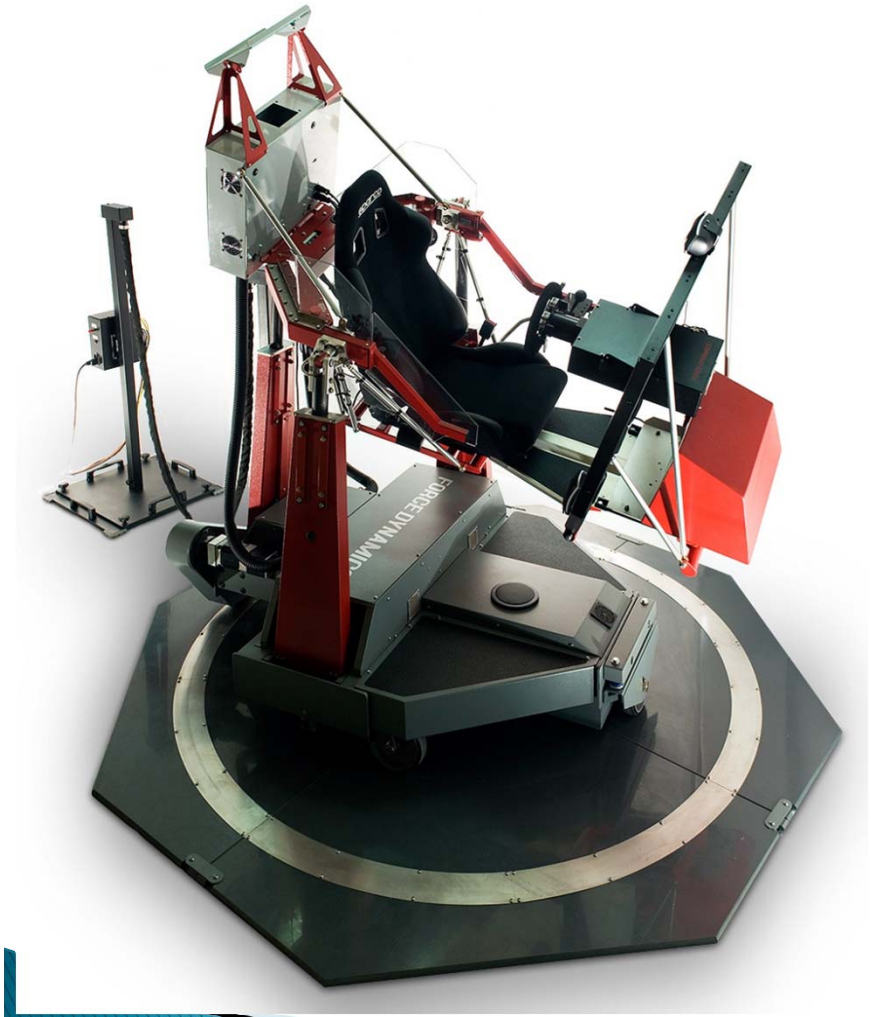
- Allows you to track the road
- Without vestibular feedback (yaw motion) the subject must rely on the Optokinetic Nystagmus (OKN)



- If motion in simulator is scaled, eyes must use both OKN and VOR
- Motion bases can filter motion so the yaw rate is not constant, which makes it even worse

http://thesymbiont.blogspot.com/2010/08/gyroscopic-eyes-vestibulo-ocular-reflex.html

Motion and Sickness (Yaw)



- Lack of yaw motion cues
  - Make driving performance worse at intersections
  - Cause driver induced oscillations
- People complain about steering wheel and vehicle dynamics
- Simulator users tend to minimize many turns at intersections
- The only real fix is an unlimited motion yaw ring.

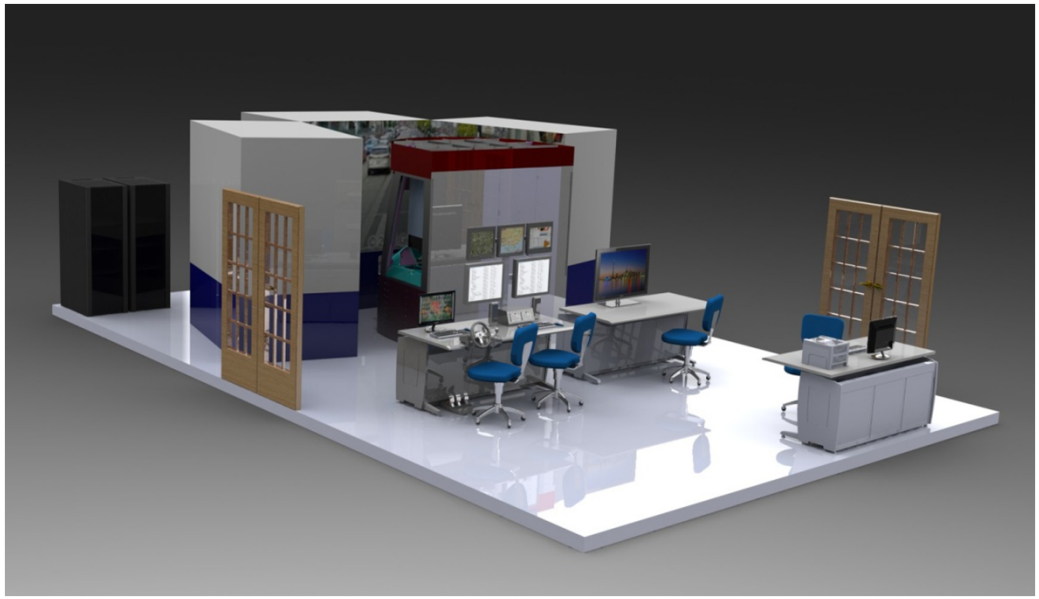
Taken from forcedynamics.com

Room Requirements

- No need to paint room black
  - But windows need to be close to light tight
- Power
  - May need several dedicated 120 V circuits
  - 600 W Computer -> 5 Amps -> 2000 BTU
- Air conditioning
  - 10000 BTU for multi channel desktop to 50000 BTU for larger systems).
- Need cool air flow past the driver
- Need a place for the computers
- Need a place for the experimenters
  - Tasks lights (desk lights) are a good

Work Flow

- Driver's enter and exit from the left side
- Sit so you can see the driver but they can't see you
- Enter from the back of the room if possible
- How about observers?



What Have You Done?

- What changes can/have you made to improve your room?
  - Air conditioning/lighting?
- What changes can/have you made to improve your simulator?
  - Different monitors/projectors?
  - Different control layout?
  - Changes to the cab?
  - Other accessories?