How Do You Turn This Driving Simulator On?

Tutorial for Traffic Engineering and Roadway Design Research Using Driving Simulation

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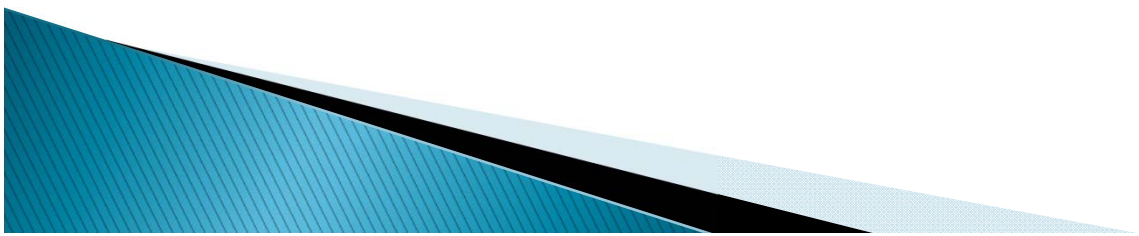
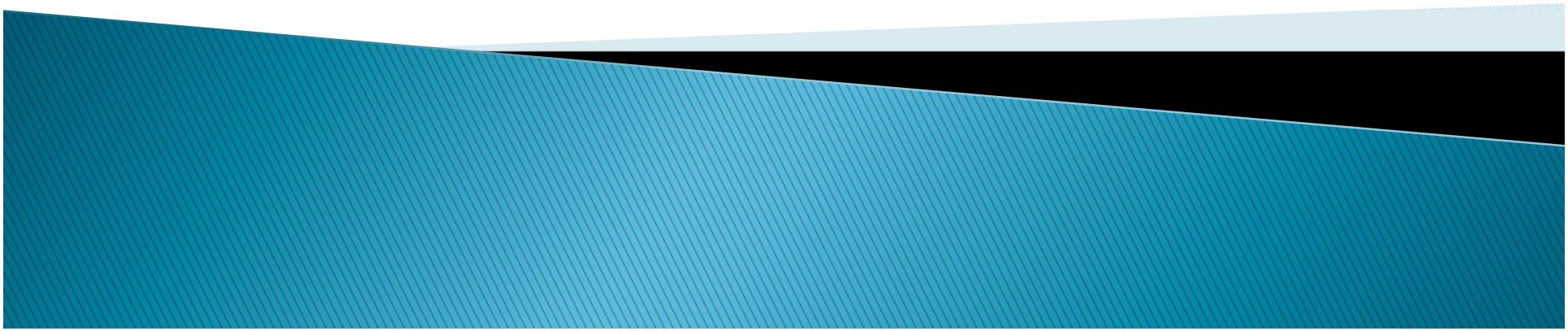
Agenda

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



Experimental Design Concepts

Linda Ng Boyle



Experimental Design

Preparation is very important in a simulator study to help you identify:

- Which variables will influence the outcomes
- What values to set/manipulate so that
  - Findings are useful
  - Variability within a level is small
  - Effects of non-controlled/uncontrollable factors are minimized (e.g., ambient traffic)

Experimental Design

- **PILOT TESTING IS VERY IMPORTANT** (including data reduction, data analysis)
- **If simulator study designed correctly,**
  - Reduced variability
    - To generate significant outcomes
  - Improve outcomes
    - Reduce the need to redo/recollect data
  - Reduced development time
  - Reduced overall costs

Steps Involved

1. Problem statement
2. Choice of factors and levels
3. Selection of the response variable
4. Choice of experimental design
5. Performing the experiment
6. Data analysis
7. Conclusions and recommendations

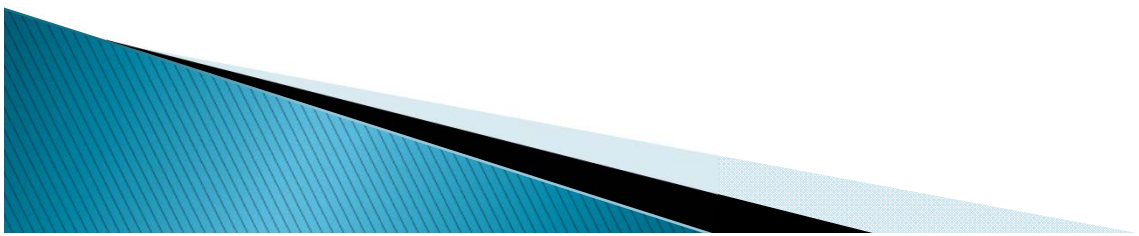
Problem Statement

- What is the GOAL of conducting a simulator study?
  - Repeatable study
  - Reduce operator risks
    - Cannot manipulate distraction factors in real-world
  - Identify causal effects
    - Does texting really CAUSE greater variation in lane position?
- Back to Sue's presentation (Research Topics)

Research Question Must…

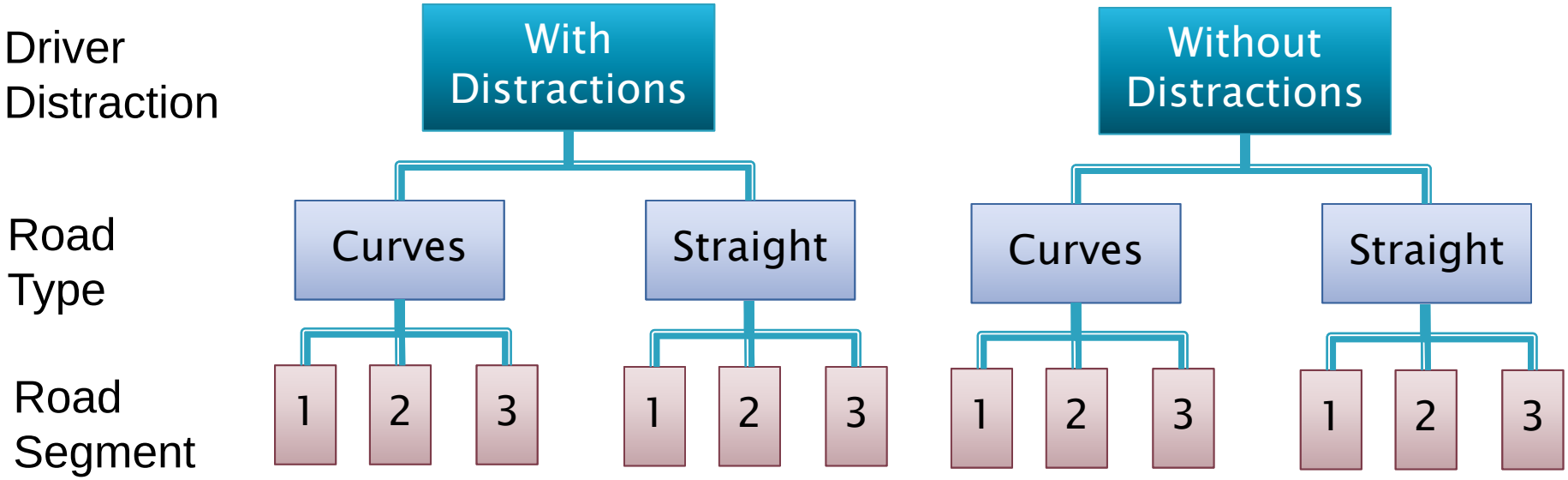
- Fit your equipment
  - Roadway design reasonable given the constraints of your simulator
- Fit your available participant pool

- Is a simulator study the right tool for your research question?



Selection of Independent Variables

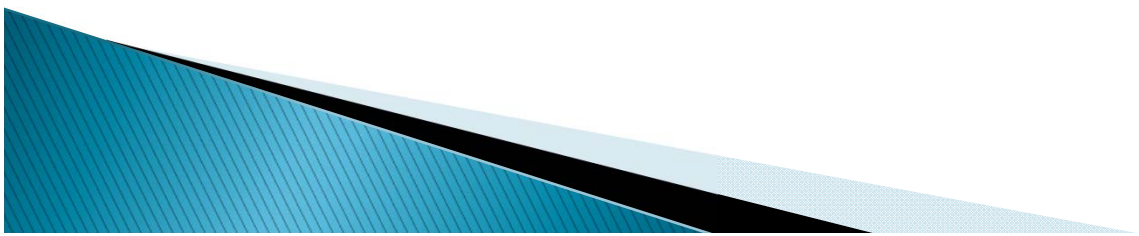
- Variables (or Factors) to control: manipulated by the experimenter
- Can have several levels



Selection of Independent Variables

Factors	Levels	No of Levels
Distractions	With, Without	2
Road Type	Curves, Straight	2
Road Segments	1, 2, 3	3

This is a 2x2x3 within subject design



Selection of Independent Variables

- Will affect the dependent (response) variable
  - Want to be able to identify differences in measures given limited resources
- Need to determine whether factor is
  - Held constant/specified (FIXED effect)
  - Determined by a process of randomization (RANDOM effects)
    - Example: Subject/Participants – can only select n=20 out of all possible participants

Choosing the right levels

- How many levels should you have?
  - Too many levels: parse out the data too much
  - Too few (or too close together): may not get the insights you need
- Consider power
  - How large a sample size given the number of conditions
- Consider your participant
  - How many trials/scenarios do you want them to undergo?

Age groups

10+ levels: 20-25, 26-30, 31-35, …. 71-75,76-80,80

3 levels: 25-35, 45-55, 65-75

2 levels: 18 year olds, 19 year olds

Order of Treatment Levels

- Randomized (BEST)
  - Order is completely randomized to average out effects of variables that cannot be controlled
- Rigidly controlled
  - variables remain fixed throughout the experiment (e.g., curves/straight roads always in same order)
- Counterbalanced
  - Not fully randomized, but some balancing of trials
  - Reduces experimental error

Counterbalancing: Latin Square

4x4		5x5
ABDC	ABCD	ADBEC
BCAD	BADC	DACBE
CDBA	CDAB	CBEDA
DACB	DCBA	BEACD
		ECDAB

Selection of Dependent Variable

- Also called responses, outcomes, measures of interest
  - e.g., Speed, Acceleration, Braking, SD Lane Position
- Cannot be manipulated by the researcher (only observed)
- Ensure that it will provide useful information
- Understand how it to measure, and what it means
- Understand how to reduce/segment/aggregate to a specific level

Choice of experimental design

- Most common for simulator studies
  - Repeated Measures ANOVA
    - Collect multiple measures on each participant
  - Mixed Model ANOVAs (between & within group situations)
- Rarely is it a completely randomized design
- How you design the study will impact how you analyze the data

Designing Experiments

- Use your nonstatistical knowledge of the problem
- Keep the design and analysis as SIMPLE as possible
- Recognize the difference between practical and statistical significance
- Experiments are usually iterative
- Generalizing to real world
  - Consider relative vs absolute outcomes

Example #1

- Study objective:

  Assess effects of drinking and driving
  - Day 1: Drive without drinking
  - Day 2: Drive with alcohol level 0.02
  - Day 3: Drive with alcohol level 0.08

What's wrong with this design ?

Picture from:
http://www.narconon.org/drug-information/drinking-and-driving.html

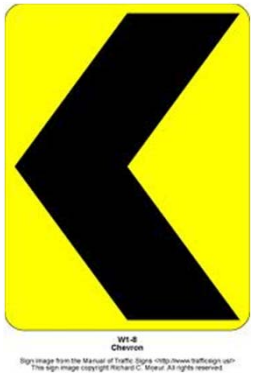
Confounding

- Confounding: The effects between 2 factors are inseparable: cannot tell whether a significant difference is due to Factor A or B.
- Alcohol dosage is confounded with days
  - Cannot tell if performance is getting worse because of alcohol or because of fatigue/boredom in simulator
- How do we fix this?

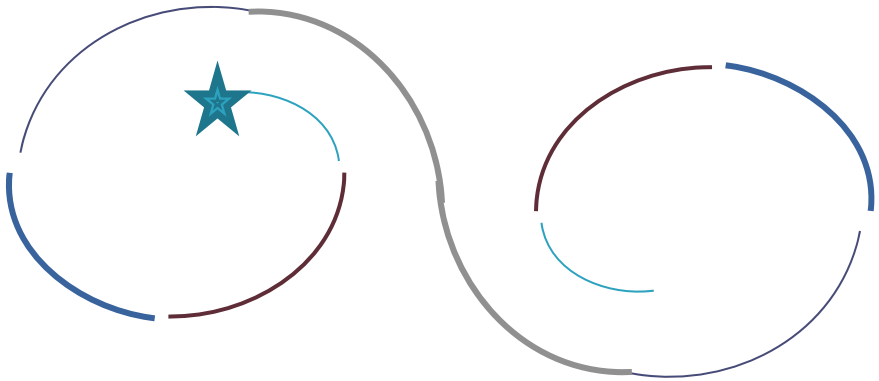
	Day 1	Day 2	Day 3
Order 1	0.0	0.2	0.8
Order 2	0.2	0.8	0.0
Order 3	0.8	0.0	0.2

Example #2

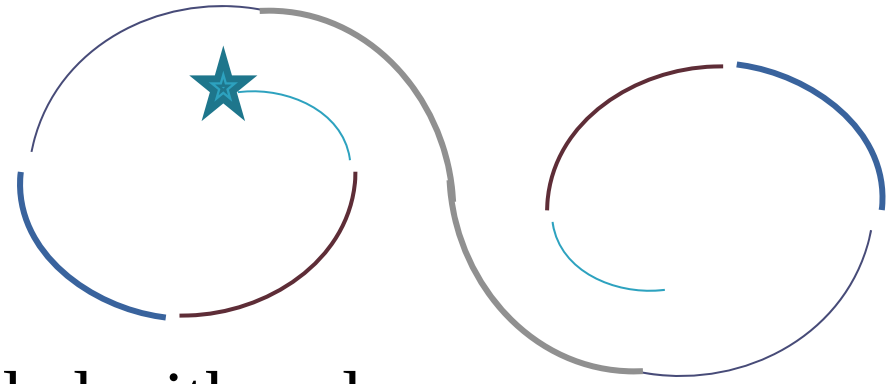
- Study objective: Assess effect of chevrons on speed for left and right hand curves
- Design: 5 curves of different radii, matched for left and right direction



What's wrong with this design ?



Confounding



- Curve direction is confounded with order
  - All the right hand curves come first
    - Practice, Fatigue, Boredom, Sickness
- How do we fix this ?

Questions

- What is the largest number of factors you included in your study?
- What issues did you have with lots of variables?