DISTRACTED DRIVING:

Exploring Data Analysis Using Multi Attribute Task Battery II

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Teacher's Guide (Annotated)

Lesson Overview and Content Focus

This lesson focuses on Data analysis using the Multi Attribute Task Battery II (MATB-II) simulation software. The software will be used to simulate the effect of being distracted while driving. Students will work collaboratively and each individual student in the group will perform the MATB simulation for two trials. One trial using the MATB simulation only and a second trial using the MATB simulation while simultaneously texting. The students will use the data generated from the simulation to create graphs to compare the two trials as well as analyze their overall performance. Students will use their overall data to summarize their findings and generate a conclusion based on their performance and understanding of math applications through modeling and simulation.

Grade Level and Student Prerequisites

- Grades 9-12
- Students will need an understanding of statistics and data analysis.
- How to represent data graphically using Microsoft Excel.

Learning Objectives

Students will be able to:

- Work in collaborative groups
- Understand and utilize the MATB software
- Analyze and interpret univariate and bivariate data
- Use Microsoft excel to generate calculations
- Use the analyzed data to generate graphs using Microsoft excel
- Summarize findings and conclusions based on overall performance
- Compare performance results based on trial factors
- Use real world application to understand mathematical modeling and simulation

Materials and Resources

Handouts

- See Teacher Resources
- See Student Resources

Internet

To access MATB software:

Go to http://matb.larc.nasa.gov-Request MATB software

Equipment

Computer

MATB II software

Microsoft Excel

Joystick

Headset

Supplemental Readings or Websites

What is Modeling and Simulation - http://www.systems-thinking.org/modsim/modsim.htm

MATB II applications - http://matb.larc.nasa.gov

Distracted Driving Facts-
http://www.aaafoundation.org/multimedia/distracteddriving.cfm?gclid=CNbcp7bjzLECFYVgTAodA2IAtw

Videos
http://www.distracteddrivinghelp.com/videos

From the National Transportation Safety Board website
http://www.ntsb.gov/doclib/fact_sheets/PED_Ban_Fact_Sheet.pdf

Presentations
http://www.ntsb.gov/news/events/2012/attentive_driving/presentations.html

Challenges in stydying the risks of cellphones and driving
http://www.ntsb.gov/news/events/2012/attentive_driving/presentations/Mccartt.pdf

Time Required

Approximately 2 hours

Procedure

Engage (10 min):

- Video of MATB functions
- With students in groups of two present them with the following question: "What other applications can this simulation be used to generate a conclusion based on human performance". Allow students to discuss their thoughts as a group before sharing with the class.

Explore (15-20 min):

- Distribute "Representation of Each Task" and "Student Worksheet" (Handouts #1 & #2)

Teacher demonstrates basic functions of the MATB_II software explaining the representations of each task in the simulation. (***See Teacher Resources handout #4***) The tracking task will replicate driving a vehicle, the communication task will represent following a GPS system, the system monitoring will represent the function of traffic signals, and the resource management represents a full tank of fuel. Using these representations on MATB_II the students will perform the simulation for two separate trials. One trial simply implementing the MATB_II and the second trial using MATB_II while text messaging. The MATB_II will collect data every 15 seconds and output the session times, number of samples, Run_SUM_OF_sQUARES, and the Figure of Merit (FOM) for each trial. At this time the teacher will discuss where to find the output data and what each variable represents as well as answer any questions the students may have.

Explain: **(90-100 Min)**
The experiment will begin with two students per group. One student at a time will run the MATB_II simulation while the other student observes and completes a frequency table found on the student worksheet. The frequency table will record each time the student running the simulation makes a driving error. ***(See Teacher Resources handout #4)*** The simulation will run for 2 minutes. The goal of the simulation within the two minutes is to perform the tracking, communications, and system monitoring task all while making as few errors as possible***.*** At

the end of the simulation a percentage value will appear in the upper right of the screen next to the elapsed time. This percentage is called the Figure of Merit (FOM). This score is given at the end of the run to assess the student's performance. The students must record this value on the student worksheet.

After the first trial is completed open the data folder TRCK_2012_MMDD####.csv Each student will have their own data file once they have completed a simulation. The student should pay close attention to the date and time on their file. In this file they will find three sets of output data, the SESSION_TIME, INT_NUM, and RUN_SUM_OF_SQUARES. The students will already have excel open and must complete the chart by calculating the RUN_NUMBER OF SAMPLES and the RMSD. ***See Teacher Resources handout #3***

Once calculations are completed for *Trial 1: Driving (MATB only)*, the student will repeat these steps for *Trial 2: Driving while texting.* The students do not create a frequency for this trial. except for creating a frequency table. For *Trial 2: Driving while texting* each student should have a cell phone with texting capabilities. One student should send messages every 30 seconds until the 2 minute run is complete, while the other student using the MATB_II simulation immediately responds to the texts. To keep the procedures consistent, make a table of the same send and response messages for the class. At the end of the simulation record the FOM percentage.

At this point each student in the group should have completed both trials individually. Using the Session_Time and Root Mean Square Deviation (RMSD) values calculated from each trial. The student should graph a Time v. RMSD scatterplot, graphing both trials in one graph.

The student will use the data from the frequency tables in trial one and create a histogram in excel. One histogram per student creating two histograms per group. At the end of the simulations the students will answer driving questions found at the end of the STUDENT WORKSHEET to create a summary.

Elaborate (30 min): Students will use the "Class Data Sheet" (Handout #5) to collect each student's RMSD and FOM value at exactly 2 minutes from either trial. As a class students will create a bar graph in excel or the graphing calculator. They must make a conclusion based on the graph and describe any relationships between the two values.

Students Assessment(s)

- Workload Rating Scale Self-evaluation rubric **(see handout # 6)**
- Data Analysis Rubric **(see handout # 7)**

Alignment with National and State Standards

Virginia Standards-

Algebra, Functions, and Data Analysis:

AFDA.8 The student will design and conduct an experiment/survey. Key concepts include
- d) data collection; and
- e) data analysis and reporting.

Technology

Computer Technology

Basic Operations and Concepts

C/T 9-12.1 The student will demonstrate knowledge of the nature and operation of technology systems.

- Identify and describe the impact of new and emerging technologies and their applications.

Social and Ethical Issues

C/T 9-12.3 The student will demonstrate knowledge of ethical, cultural, and societal issues related to technology.
- Assess the potential of information and technology to address personal and workplace needs.
- Identify the role that technology will play in future career opportunities.

C/T 9-12.4 The student will practice responsible use of technology systems, information, and software.
- Adhere to fair use and copyright guidelines.
- Adhere to the school division's Acceptable Use Policy as well as other state and federal laws.

- Model respect for intellectual property.

C/T 9-12.5 The student will demonstrate knowledge of technologies that support collaboration, personal pursuits, and productivity.

- Respectfully collaborate with peers, experts, and others to contribute to an electronic community of learning.
- Model responsible use and respect for equipment, resources, and facilities.

Computer/Technology

Technology Research Tools

C/T 9-12.6 *The student will use technology to locate, evaluate, and collect information from a variety of sources.*

- Integrate databases, spreadsheets, charts, and tables to create reports.
- Use available technological tools to expand and enhance understanding of ideas and concepts.

C/T 9-12.7 The student will evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.

- Analyze and draw conclusions about the comprehensiveness and bias of electronic information sources.

Problem-solving and Decision-making Tools

C/T 9-12.8 The student will use technology resources for solving problems and making informed decisions.

- Investigate and apply expert systems, intelligent agents, and simulations in real-world situations.
- Select and apply technology tools for information analysis, problem-solving, and decision-making.
- Use technology resources such as educational software, simulations, and models for problem-solving, and independent learning.

National Standards

Mathematics

Standards: Develop and evaluate inferences and predictions that are based on data

- use simulations to explore the variability of sample statistics.
- understand how basic statistical techniques are used to monitor process characteristics in the real world.

Standard: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them

- understand the meaning of measurement data and categorical data, of univariate and bivariate data, and of the term variable;
- understand scatterplots and use them to display data;
- compute basic statistics

Select and use appropriate statistical methods to analyze data:

- for bivariate measurement data, be able to display a scatterplot, describe its shape, and determine regression coefficients, regression equations, and correlation coefficients using technological tools;
- identify trends in bivariate data and find functions that model the data or transform the data so that they can be modeled.

Science

Science as Inquiry

Content Standard A

All students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Science and Technology

Content Standard E

All students should develop

- Abilities of technological design
- Understandings about science and technology

Science in Personal and Social Perspectives

Content Standard F

All students should develop understanding of

- Science and technology in local, national, and global challenges

History and Nature of Science

Content Standard G

All students should develop understanding of

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

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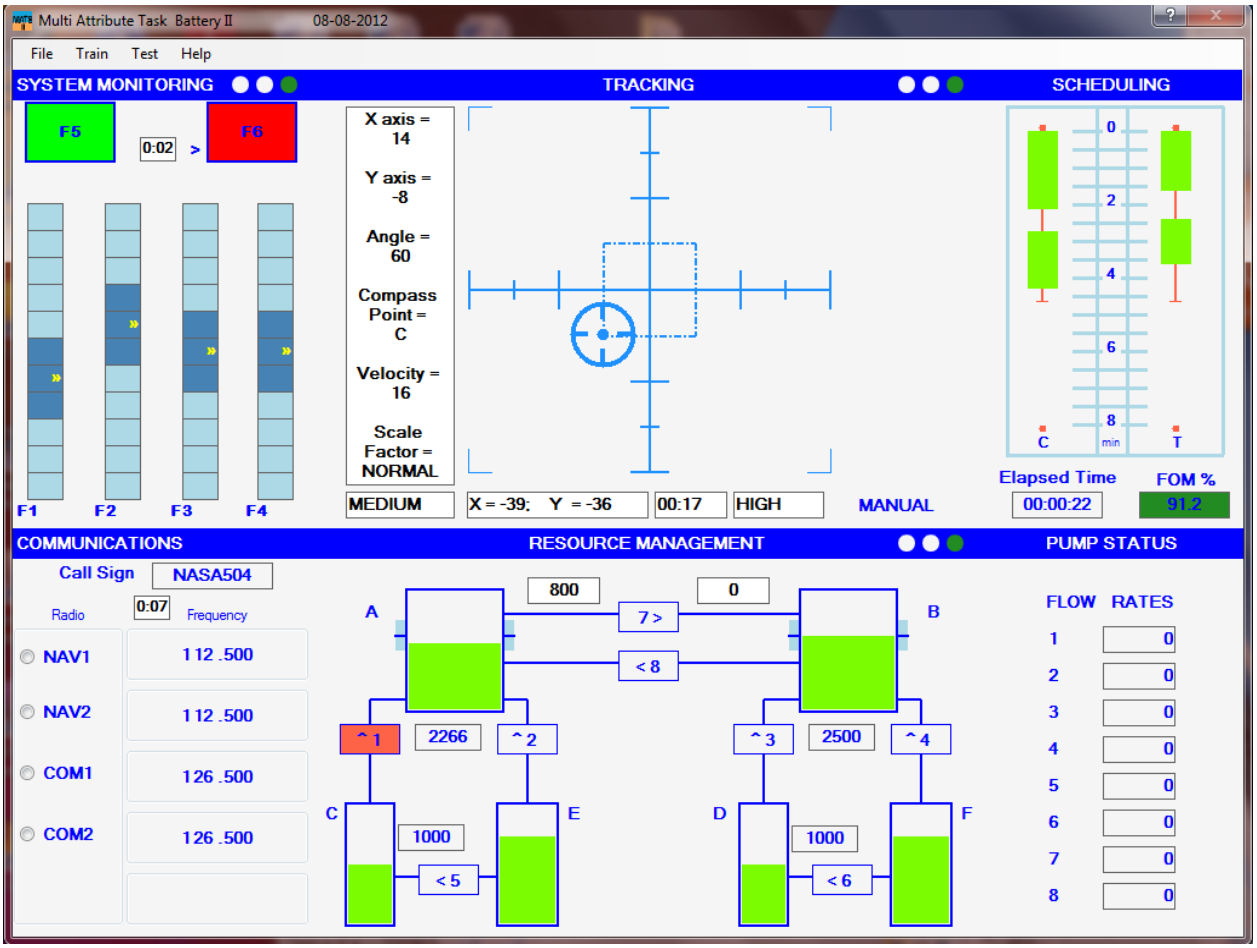
Student Resource Pages

Handout #1 REPRESENTATION OF EACH TASK



Tracking: The grid located in the tracking task with the target simulates driving a vehicle. The student must use the joystick to maneuver the target. Keeping the target within the square located in the center of the grid indicates exceptional driving skills. *However, not keeping the target within the box indicates driving off a road. Whenever this action occurs a tally will be recorded in the Driving errors frequency Table.*

System Monitoring: This task will represent traffic lights. The F5 button represents a green traffic light and the F6 button represents a red traffic light. The Green F5 button must remain lit throughout the simulation if the F5 button shuts off and the red F6 button lights red you must click or press the F6 function key to turn off and turn the green F5 function key light back on.

Not pressing the red F5 button in the allotted time will indicate running a red traffic light and indicate a failure in this task. Whenever this action occurs a tally will be recorded in the Driving errors frequency Table.

Communications: The communications task with the call sign "NASA504" represents the GPS system in a vehicle. The call sign will be recited by an audio voice during the simulation. Only when the audio recites the name "NASA504" will the student follow the voice's directions to change the frequency on the radio. The student must click on the correct radio and use the up/down arrows to change the frequency. Changing the radio to the correct frequency in the allotted amount of time will indicate making a correct turn on the GPS. *Not Changing the radio to the correct frequency in the allotted amount of time will indicate making a incorrect turn on the GPS and whenever this action occurs a tally will be recorded in the Driving errors frequency Table.*

Resource Management: This task does not have to be manipulated at any time during the simulation. However this will remain full indicating the fuel source of the vehicle.

Scheduling: This task does not have to be manipulated at any time during the simulation.

Pump Status: This task does not have to be manipulated at any time during the simulation.

Handout #2

DISTRACTED DRIVING:

Exploring Data Analysis Using Multi Attribute Task Battery II

STUDENT WORKSHEET

MATERIALS/EQUIPMENT:

- Computer
- Joystick
- MATB_II software
- Microsoft Excel
- Graphing calculator (optional)

Group Names: _____

_____

TRIAL 1: DRIVING (MATB only)

1. One student will run the MATB_II simulation while the other student observes and completes a frequency table of driving errors. The frequency table will record each time the student running the simulation makes a driving error. ***(See Handout #1 REPRESENTATION OF EACH TASK).*** The simulation will run for 2 minutes. Within the two minutes you must perform the tracking, communications, and system monitoring task while making as few errors as possible. *Remember you are driving a vehicle*. At the end of the simulation record the FOM percentage.

Student Name:_____

Driving errors

Student Driving Error w/o distractions	Frequency
System Monitoring: Running Traffic light	
Tracking Task: Driving off Course	
Communications: Making a wrong Turn	

Figure Of Merit (FOM)% _____

Student Name:_____

Driving errors

Student Driving Error w/o distractions	Frequency
System Monitoring: Running Traffic light	
Tracking Task: Driving off Course	
Communications: Making a wrong Turn	

Figure Of Merit (FOM)% _____

2. After the first trial is completed open the data folder located in C:/MATB/DATA. There you will open TRCK_2012_MMDD####.csv. In this file you will find three sets of output data. ***(see example below)***

SESSION_TIME	INT_NUM	RUN_SUM_OF_SQUARES
0:15	368	624844
0:30	366	1310098
0:45	368	5601442
1:00	364	8999305
1:15	368	9492065
1:30	368	12146654
1:45	366	16896236
2:00	366	21997194

The Absolute Value of the Vertical Pixel and Horizontal Pixel offsets from the Center Point are added and the sum squared

RMSD-C is the Root Mean Square Deviation from the Center Point in Pixel Units

RMSD-C = Square Root (SS / NUM)

SESSION_TIME= 15 second intervals during simulation
INT_NUM= Interval Number of Samples
RUN_SUM OF SQUARES= sum of squares
SS = Sum Of Squares; NUM = Number of Samples
RUN_NUMBER OF SAMPLES= cumulative sum of INT_NUM

3. Use excel to complete the chart and calculate the RUN_NUMBER OF SAMPLES and the RMSD. ***See example below***

Trial #1

SESSION_TIME	INT_NUM	RUN_NUM	RUN_SUM_OF_SQUARES	RUN_RMSD_C
0:15	368		624844	
0:30	366		1310098	
0:45	368		5601442	
1:00	364		8999305	
1:15	368		9492065	
1:30	368		12146654	
1:45	366		16896236	
2:00	366		21997194	

4. Once calculations are complete in excel, proceed to Trial #2

- Calculations are per student. There should be two charts of data for each student in the group. One chart of data per trial.
- When graphing there should be one graph with two sets of data per student.

TRIAL 2: DRIVING WHILE TEXTING

5. Repeat steps 1-4. However, this time run trial 2 using MATB_II while simultaneously texting. Each student should have a cell phone with texting capabilities. One student should send the following messages every 30 seconds until the 2 minute run is complete, while the other student using the MATB_II simulation responds. To keep the procedures consistent, make a table of the same send and response messages for the class. At the end of the simulation record the FOM percentage.

Student Name: _____ Figure Of Merit (FOM)% _____

Student Name: _____ Figure Of Merit (FOM)% _____

6. Once calculations are complete in excel for Trial #2, graph the Time vs. RMSD for Trial#1 and Trial #2.

Trial #2

SESSION_ TIME	INT_NUM	RUN_NUM	RUN_SUM_OF_ SQUARES	RUN_RMSD_C
0:15	368		624844	
0:30	366		1310098	
0:45	368		5601442	
1:00	364		8999305	
1:15	368		9492065	
1:30	368		12146654	
1:45	366		16896236	
2:00	366		21997194	

Driving Simulation:
Time v. RMSD
Trial #1 & Trial #2

	Trial #1	Trial #2
SESSION_TIME	RUN_RMSD_C	RUN_RMSD_C
0:15		
0:30		
0:45		
1:00		
1:15		
1:30		
1:45		
2:00		

7. Repeat steps 1-6 with student number 2 in the group.

Summary and Conclusions

8. **Use these following Questions to complete a written summary of your findings.**

- Look at the histogram created from trial #1 and the Figure of Merit. How does the histogram and FOM compare or contrast?

- Look at the scatterplots of each student in your group (Time vs. RMSD). What percent of increase or decrease did you observe from trial 1 to trial 2. What factors might have contributed to these differences or similarities?

- Compare and contrast the data collected in your histogram and your scatterplot (Time v. RMSD).

Handout #3

CLASS DATA SHEET

Using Data from either trial, each student will record their RMSD-C and FOM value at exactly 2 minutes. Students will complete the table using values from the students in the class.

STUDENT NAME	RMSD-C	FOM

- Create a graph in excel or the graphing calculator using the data above.
- Make a conclusion based on the chart.
- What relationship does the data give us?
- What other observations or assumptions can you make from your overall experimental experience?

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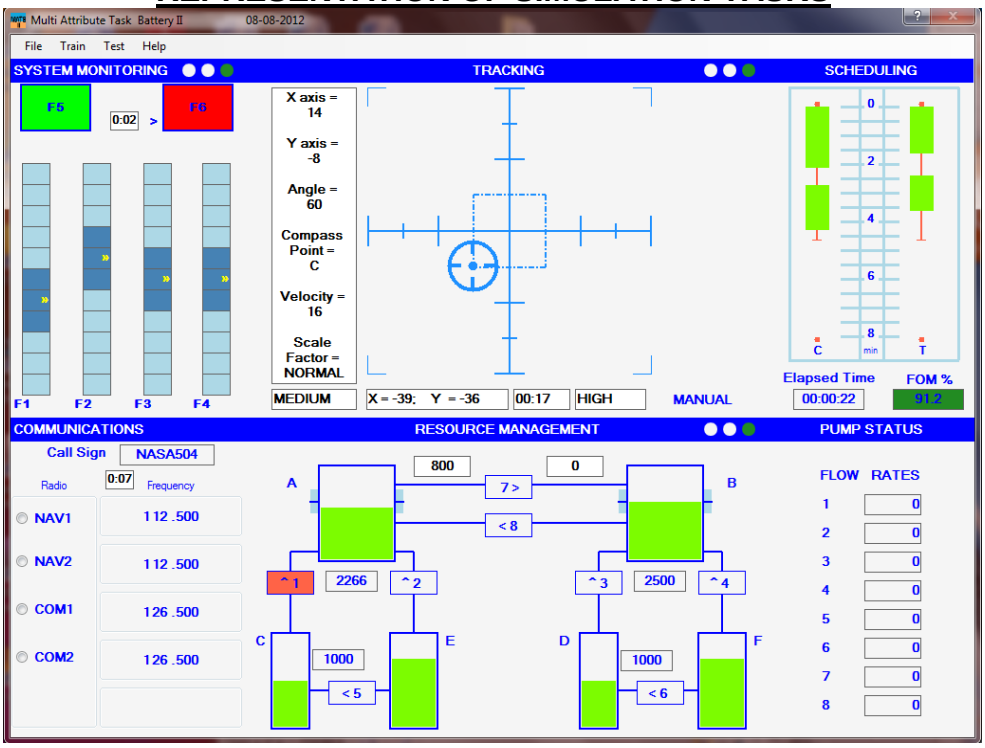
Teacher Resource Pages

Handout #4 Teacher Notes

REPRESENTATION OF SIMULATION TASKS



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Resource Management: This task does not have to be manipulated at any time during the simulation. However this will remain full indicating the fuel source of the vehicle.

Scheduling: This task does not have to be manipulated at any time during the simulation.

Pump Status: This task does not have to be manipulated at any time during the simulation.

DATA CALCULATIONS AND STATISTICAL DEFINITIONS

Students must understand the meanings of the symbols found in the output data.

RUN_SUM OF SQUARES= sum of squares
SS = Sum Of Squares :The Absolute Value of the Vertical Pixel and Horizontal Pixel offsets from the Center Point are added and the sum squared

SESSION_TIME= 15 second intervals during simulation
INT_NUM= Interval Number of Samples
NUM = Number of Samples

***RUN_NUMBER OF SAMPLES = cumulative sum of INT_NUM**

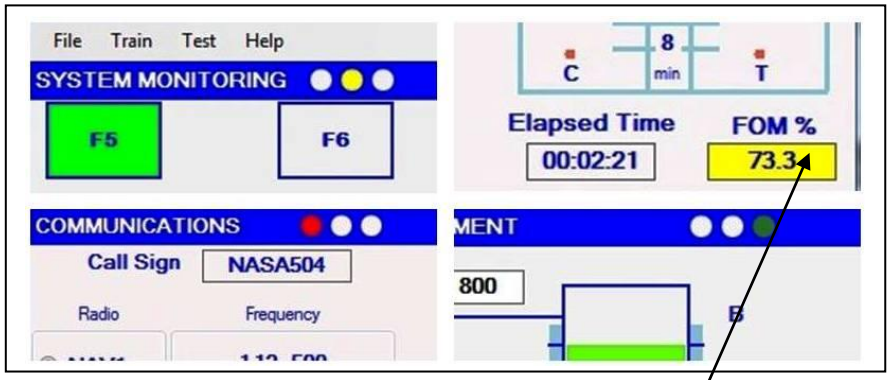
RMSD-C is the Root Mean Square Deviation from the Center Point in Pixel Units
***RMSD-C = Square Root (SS / NUM)**

- The Root Mean Square Deviation is one way to assess performance. The lower the RMSD value the better the performance. The higher the RMSD value the worst the performance.

FOM % = Figure of Merit is an actual score given at the end of the run to assess the student's performance. The total score is determined by the weighted participation of the active (e.g. manual mode) tasks.

FOM Task Percentages

Tracking-40%
System Monitoring-30%
Communication-30%
Resource Management-0%



The figure of merit is located next to the elapsed Time in either green, yellow, or red.
The figure of merit calculates an overall percentage for all four tasks using the following boundary scores:
Red = ≤ 60%
Yellow = 61%≤ actual score≤ 85%
Green = 86% ≤ actual score ≤100%

********Have student print all graphs and charts made in excel to turn into the instructor*****

Graphing & Tables in Excel

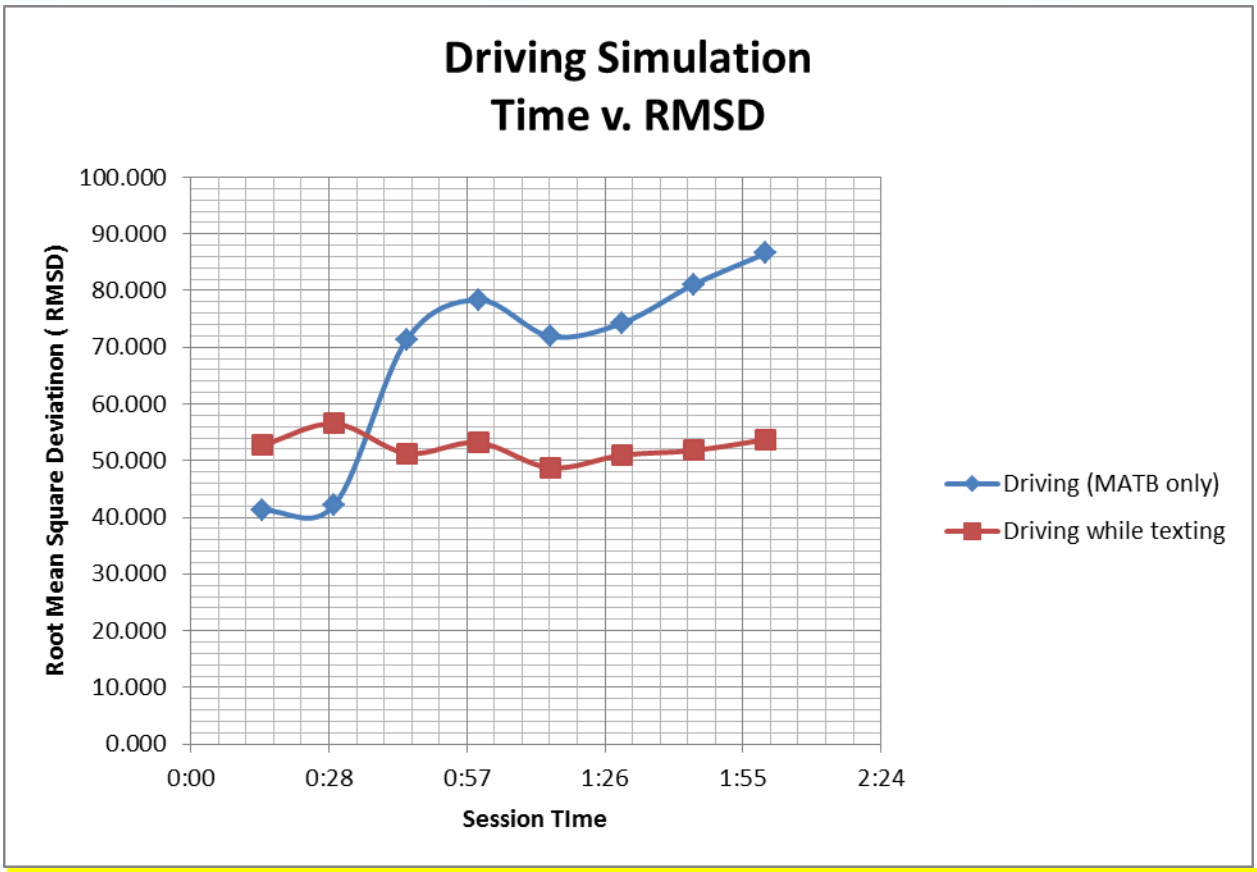
*********Each student's completed chart in excel should look similar to the example below using the formulas above.

SESSION_TIME	INT_NUM	RUN_NUM	RUN_SUM_OF_SQUARES	RUN_RMSD_C
0:15	368	368	624844	41.206
0:30	366	734	1310098	42.248
0:45	368	1102	5601442	71.295
1:00	364	1466	8999305	78.350
1:15	368	1834	9492065	71.942
1:30	368	2202	12146654	74.271
1:45	366	2568	16896236	81.114
2:00	366	2934	21997194	86.587

******Have student print all graphs and charts made in excel to turn into the instructor***

Example of Time v. RMSD graphs in Microsoft office excel- Handout #2

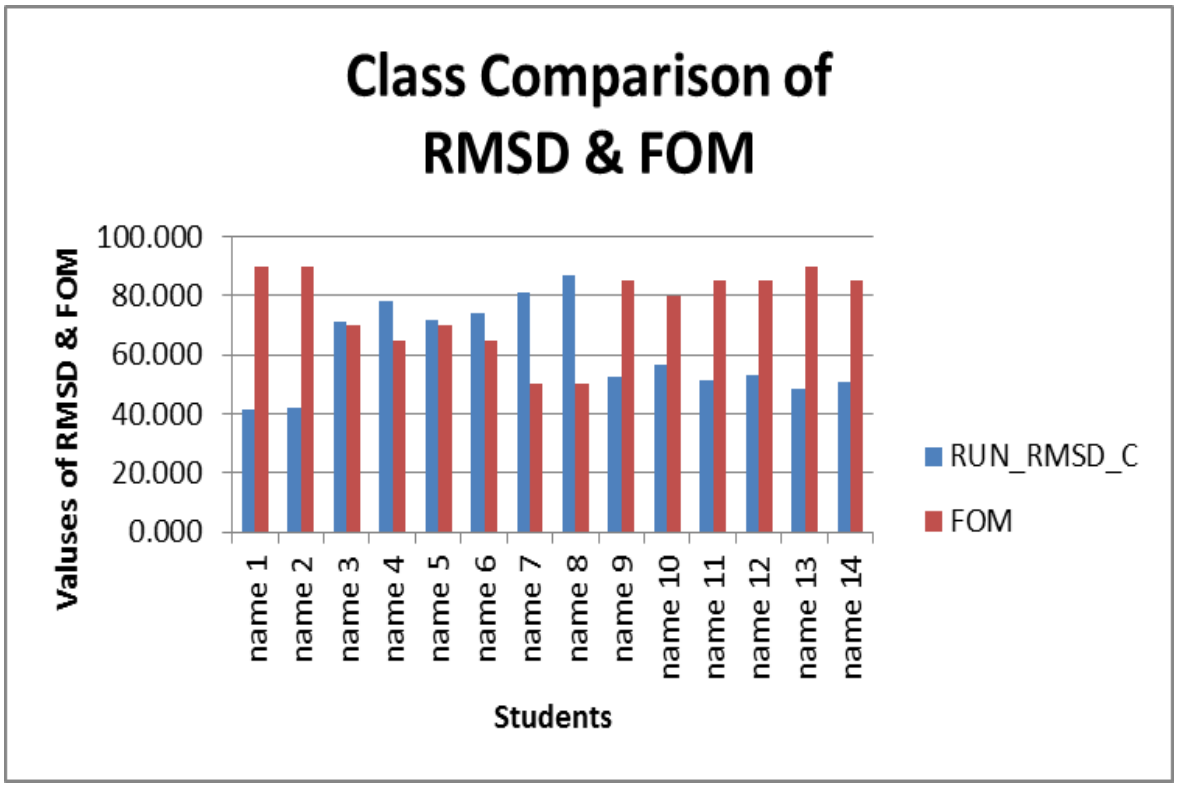
	Trial #1	Trial #2
SESSION_TIME	RUN_RMSD_C	RUN_RMSD_C
0:15	41.206	52.722
0:30	42.248	56.518
0:45	71.295	51.307
1:00	78.350	53.183
1:15	71.942	48.746
1:30	74.271	50.972
1:45	81.114	51.814
2:00	86.587	53.734



********Have student print all graphs and charts made in excel to turn into the instructor*****

Example of Class Comparison RMSD v. FOM- Handout # 3

Student Name	RUN_RMSD_C	FOM
name 1	41.206	90.000
name 2	42.248	90.000
name 3	71.295	70.000
name 4	78.350	65.000
name 5	71.942	70.000
name 6	74.271	65.000
name 7	81.114	50.000
name 8	86.587	50.000
name 9	52.722	85.000
name 10	56.518	80.000
name 11	51.307	85.000
name 12	53.183	85.000
name 13	48.746	90.000
name 14	50.972	85.000


Class Comparison of
RMSD & FOM
Valuses of RMSD & FOM
100.000
80.000
60.000
40.000
20.000
0.000
name 1
name 2
name 3
name 4
name 5
name 6
name 7
name 8
name 9
name 10
name 11
name 12
name 13
name 14
Students
RUN_RMSD_C
FOM

Handout #6

DISTRACTED DRIVING:

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Self-Evaluation
Workload Rating Scale

Place a check in the rating value that best describes your workload during the simulation
1-lowest 4-highest

	4	3	2	1
Mental Demand				
Physical Demand				
Temporal Demand				
Performance				
Effort				
Frustration				

Terms used in the Rating scales	Explanation
Mental demand	The level of mental activity required to perform the tasks.
Physical demand	The amount of physical activity required to perform the task
Temporal demand	Time pressure that you experienced (slow or rapid pace)
Performance	How well you think you performed
Effort	How hard you worked to achieve your level of performance
Frustration	How did you feel while performing the tasks, ranging from relaxed to very stressed

Adapted from The Multi-Attribute Task Batter II (MATB_II) Software for Human Performance and Workload Research: A User's Guide.

Handout #7

DATA ANALYSIS RUBRIC

	1	2	3	4
Excel spreadsheet Calculations of RMSD & FOM	Demonstrates no understanding of statistical calculations and how to generate in excel.	Accuracy is weak with very little correct statistical calculations in excel.	Accuracy needs to improve with most of the correct statistical calculations	Mastery of concept with accurate statistical calculations in excel.
Excel Graphs	Demonstrates no understanding of how to present graphical data in excel.	Accuracy is weak with very little correct graphs in excel.	Accuracy needs to improve with most of the graphs correct in excel.	Mastery of concept with accurate graphs in excel.
Statistical Analysis Summary	No organization of work or support for final analysis and conclusions	Very weak evidence of organization or support for final analysis and conclusions.	Organization needs to improve and some support for final analysis and conclusions.	Mastery of concept with Well-organized report with clear understanding and detailed support of final analysis and conclusions