Design Studio – Project 3 (Week 2)

This week you will:

- Plan the work for Project 3 with our team

- Observe the effects of integrating and differentiating real data

- Develop MATLAB functions for your design

- Create a test plan for checking your design

Assignments:

- Prepare for a review to determine your readiness to test (exercise worksheet and memo)

Project 3 – Review

For the last five weeks of Studio, your team will be working on designing and developing Project 3, **a sensor-based application**.

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Sensor → Measure data → Condition data → Analyze data → Reported result
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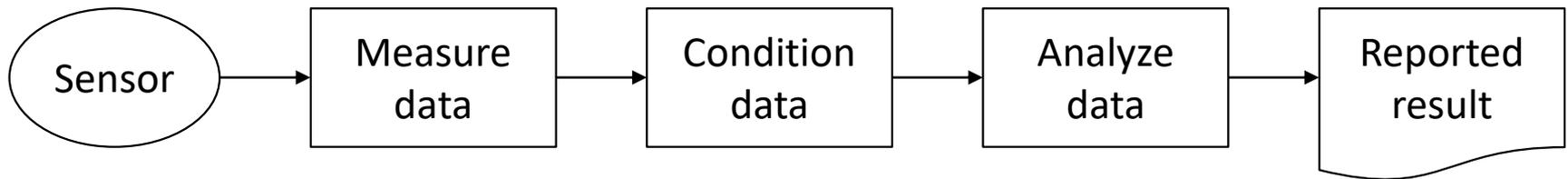
To prototype your design, your team will:

- Collect relevant sensor data using your **smartphone**

- Build a basic version of the application using **MATLAB**

Project 3 – Week 2 to Week 3
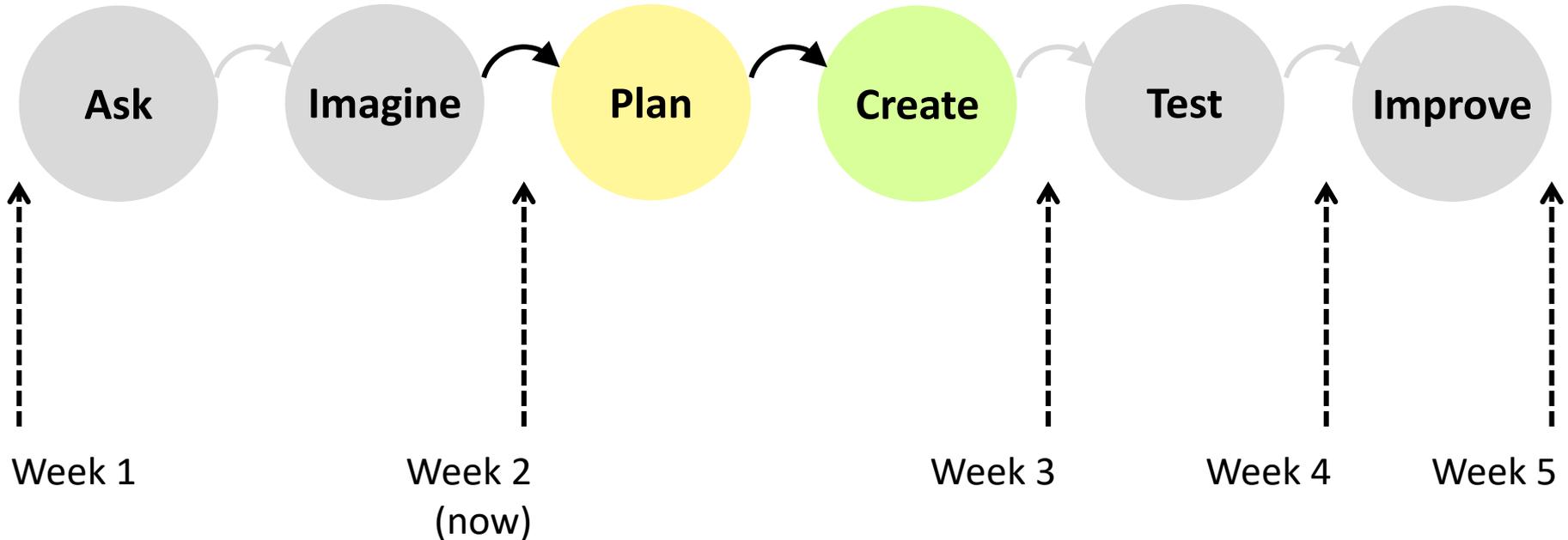
Over the next week you distribute the work to build the parts of your design and describe how you will test them all together.

This week's exercise worksheet will help guide your way.

Risk Reduction

What is risk? How would you define it?

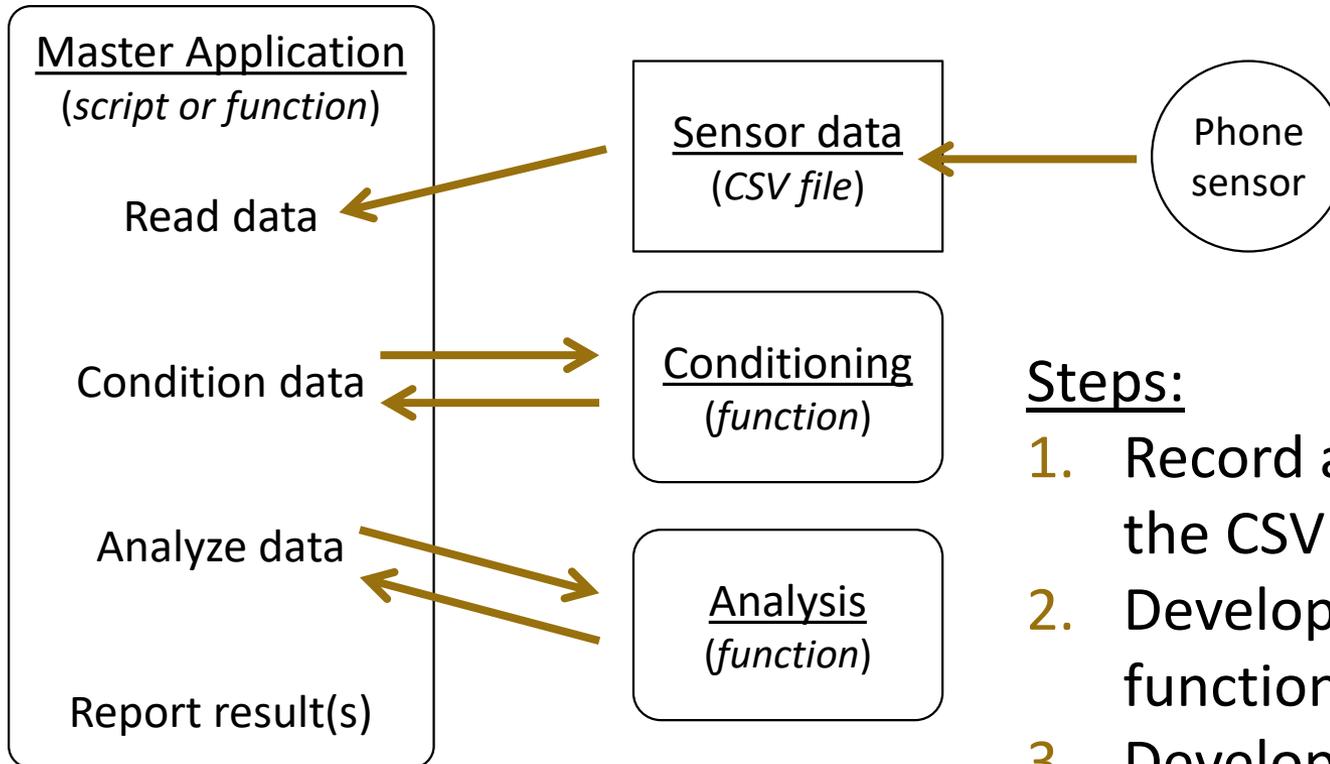Mathematically, the risk of an event can be simply defined as:

risk = probability x loss

In engineering design (and in most of life) we want to avoid risk. Some simple rules that can help avoid risk are:

- *"Fail fast, fail cheap."* – i.e. learn what may cause failure ASAP

- If order matters, do the thing that reduces risk first.

- Risk is not entirely bad if there is possibility of reward, but beware of risks from which you cannot recover.

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Project 3 – Development Visualization

Master Application
(*script or function*)

Read data

Condition data

Analyze data

Report result(s)

Sensor data
(*CSV file*)

Phone sensor

Conditioning
(*function*)

Analysis
(*function*)

Steps:
1. Record an example of the CSV file format
2. Develop the MATLAB functions
3. Develop the master application
& Develop the test plan, including data collection

Concept Review – Mechanics and Rates of Change

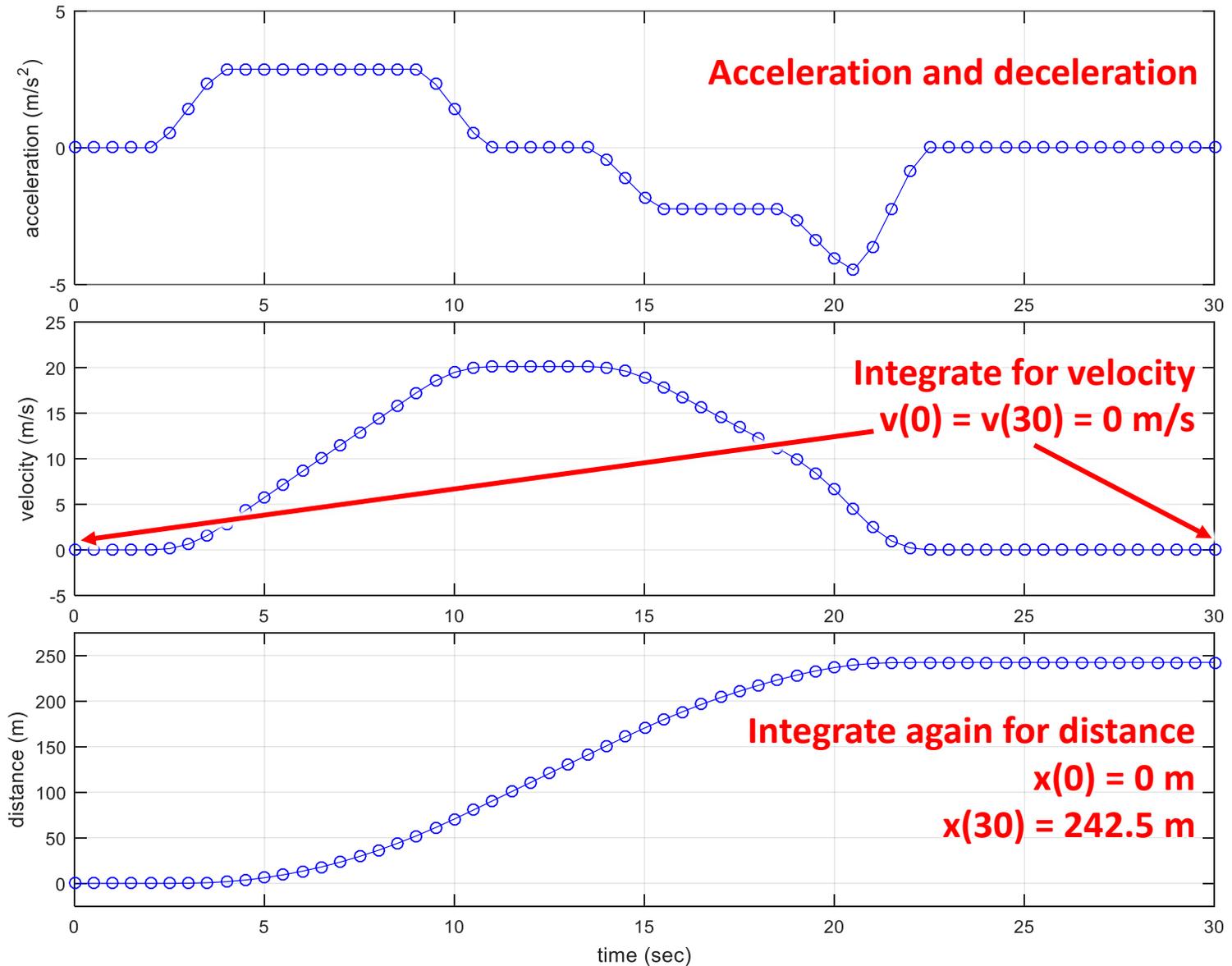Recall that acceleration, velocity, and distance are all related:

$$v(t) = \frac{dx}{dt} \quad \Leftrightarrow \quad x(t) = \int_0^t v(\tau)d\tau + x(0)$$

$$a(t) = \frac{dv}{dt} \quad \Leftrightarrow \quad v(t) = \int_0^t a(\tau)d\tau + v(0)$$

Hence, accelerometer data can be turned into velocity or distance.

There are some important things to consider, however:

- The impact of noise

- The orientation of the sensor (if it has more than one axis)

Concept Review – Integration of Data

Acceleration and deceleration

Integrate for velocity
v(0) = v(30) = 0 m/s

Integrate again for distance
x(0) = 0 m
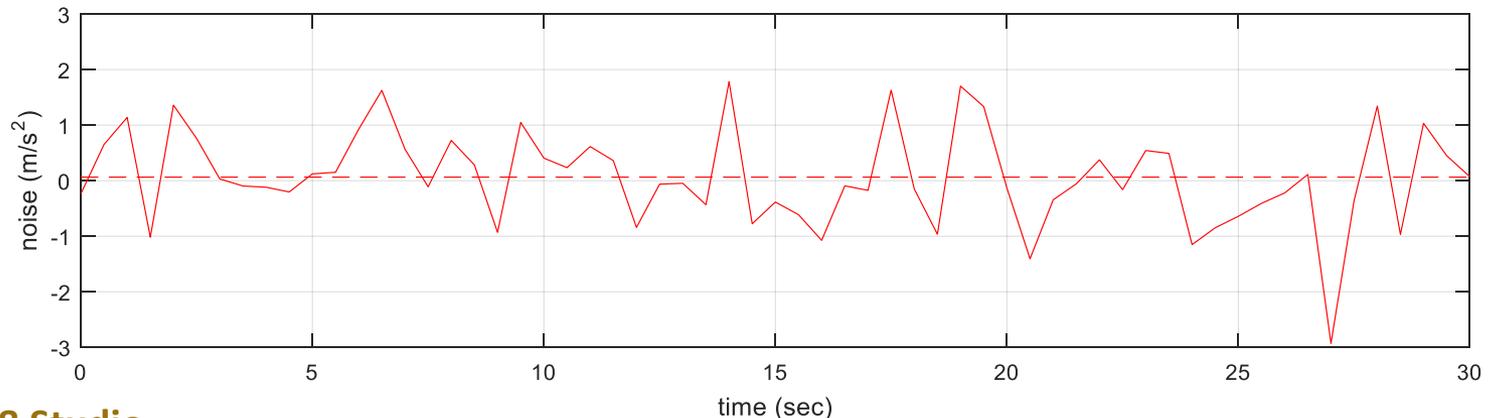**x(30) = 242.5 m**

Concept Review – Noise

Unfortunately, data are not perfect – they contain differences from the actual results. Noise is variation that is present in all real data.
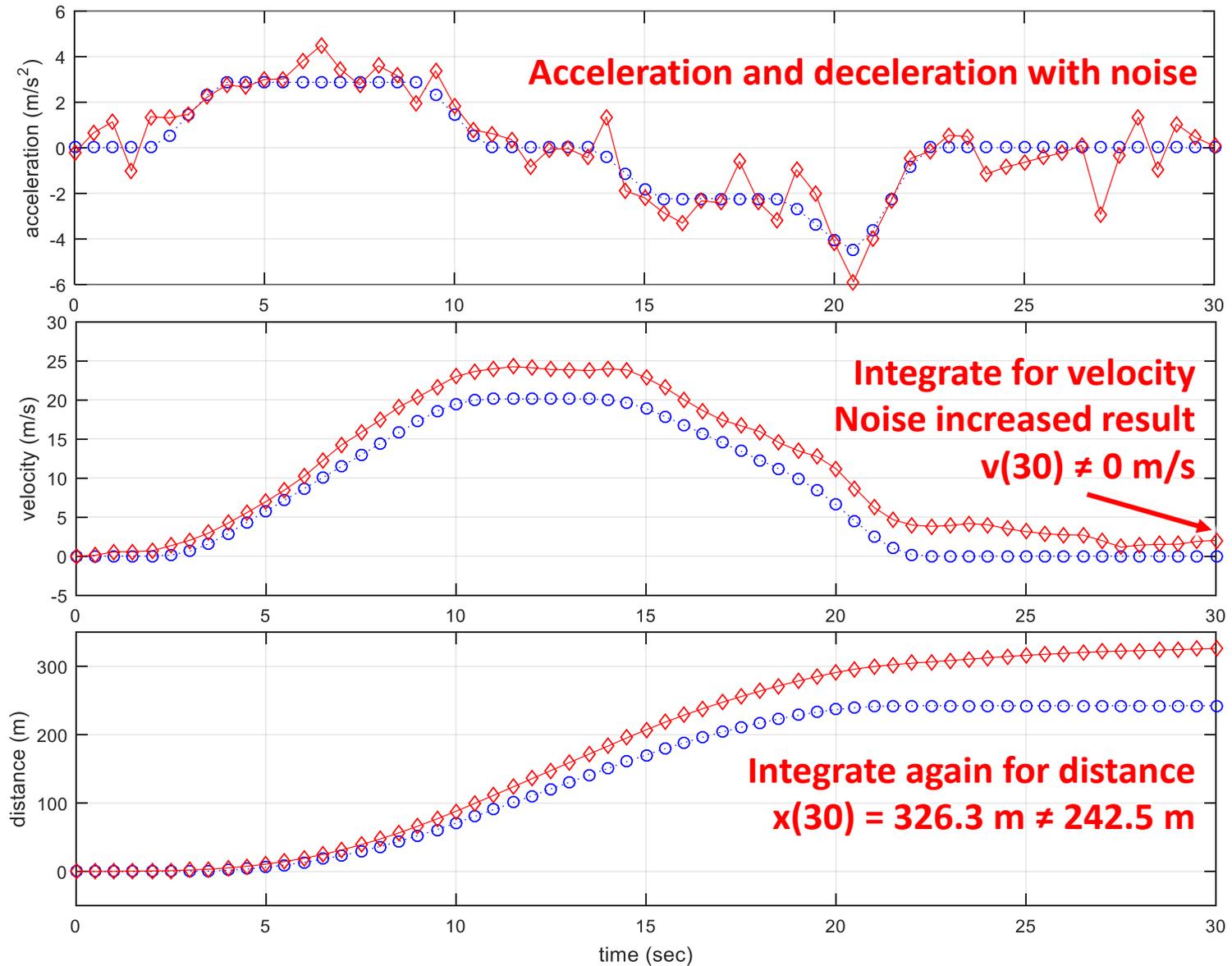
Often if you can't see the variation, it just means that your measurement equipment is not sensitive enough to detect it.

Noise can be considered as having two parts:

- The mean or average value, which affects integration (but has no impact on differentiation)

- The variance, which mainly affects differentiation

Concept Review – Integration of Data

Acceleration and deceleration with noise

Integrate for velocity
Noise increased result
v(30) ≠ 0 m/s

Integrate again for distance
x(30) = 326.3 m ≠ 242.5 m

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This Week's Assignments

Exercise

Complete the worksheet distributed by your instructor.

- Follow the directions to plan the tasks for your design and begin building your MATLAB functions and test procedures.
- Submit the completed worksheet and memo as directed by your instructor **before the start of the next Studio**.

With any extra time this week, your team can get continue building and testing your design.

This means:

- Finishing the code for the overall application

- Collecting test data for use in running the test plan