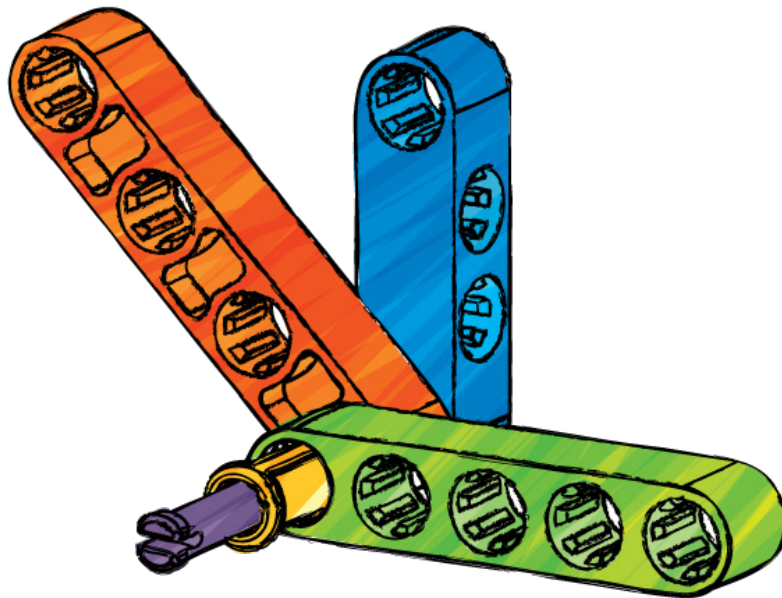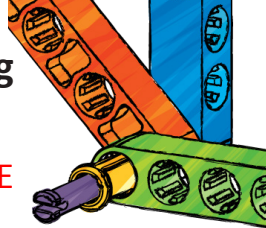# D R O N E S

MINDS-i

STEM INTEGRATED ROBOTICS

U N I T   5
Applied System Thinking

Introduction

In this lesson students be introduced to the concepts of systems: open systems, closed systems, inputs, outputs system boundaries and interdependence. Students will then demonstrate understanding of the concepts of a system.

Concepts

1. Systems are all around us, they are within us, and they make up everything we see (or don't see) in the physical universe
2. Any system may be thought of as containing subsystems, and as being a subsystem of a larger system
3. Systems have boundaries, that are sometimes hard to define, depending on the level being observed
4. Systems have inputs and outputs, Systems can be open or closed
5. Components within a system rely on "interdependent" relationships
6. Systems break down when the relationships between components becomes unbalanced or broken
7. Systems contain constraints, often they are the limiting factor on the performance as a whole
8. Optimization is the goal of all natural systems, man made systems have to be studied to learn what to change to be better optimized.

Materials

- PowerPoint, What is a System, System Inputs, Outputs & Constraints
- MINDS-i Design Journal
- Worksheet, "What is a system?"

Procedure
Time: 3 Day(s)

Day 1: What is a System

Prep:
Before students arrive in class access the powerpoint presentation <u>What is a System?</u>

Presentation:
As the class follows through the presentation have the students take notes in their Journals. Discuss the various aspects of a system with the class. Ask students for examples of things they think are systems and why.

Exercise:
After discussion, hand out worksheet "What is a system?" and have the students (individually or as a group) complete the sheet. Allow the students access to internet and any relevant research materials.
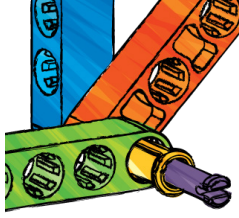
Day 2: System Inputs, Outputs & Constraints

Prep:
Before students arrive in class access the powerpoint presentation <u>System Inputs, Outputs & Constraints</u>.

Presentation:
With the class follow through the presentation having the students take notes in their Journals. Discuss the

various aspects of inputs & outputs in a system with the class, ask students for examples of an input or an output of a system.
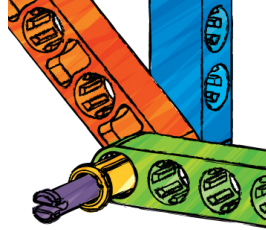
Background

Vocabulary

- System:

    Two or more parts working together to perfom a task or function. Matter and Energy flow through it.

- Inputs:

    Are inserted into the system and which activate or modify a process. Both Matter and Energy can be inputs to the system.

- Outputs:

    Are what can be measured from the system. Both Matter and Energy can be outputs of the system.

- Boundaries:

    The outside border of a system. We can change boundaries when we want to study a smaller or larger aspect of the system.

- Interdependence:

    A relationship in which each member is mutually dependent on the others.

- Goal / Objective:

    A desired result a person or a system envisions, plans and commits to achieve—a personal or organizational desired end-point in some sort of assumed development.

- Optimization:

    The Alignment of all components within a system toward the goal / objective of the system.

- Constraints:

    A limitation or restriction.

Videos

- Systerms Thinking - Animated

    https://www.youtube.com/watch?v=lhbLNBqhQkc

Resources

- http://en.wikipedia.org/, www.google.com

DRONES

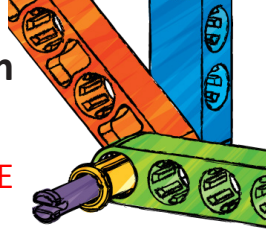**MINDS-i**®
STEM INTEGRATED ROBOTICS

What is a System?

Name:_____Date:_____

Using the picture below,

- Circle the sub-systems below
- Label sub-systems describing its core function
- Use dashed circles to identify boundaries within or around the system

Notes:

Introduction

Students will be attempting to analyze and determine how the multitude of drone components and sub-systems interdependently work to enable the drone to achieve mission functionality.

Concepts

1. Identify, Understand and Label the interrelating Inputs and Outputs between components in a system
2. Identify, Understand and Label the Constraints between components in a system
3. Understand how the components work together as a system, making the whole greater than the sum of the parts.

Materials

- Worksheet, "Interrelationship Diagram"
- MINDS-i Design Journal

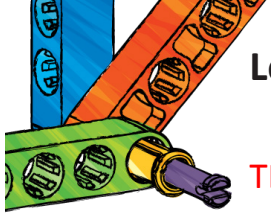# Procedure

Time: 1 Day(s)

Day 1: Interrelationship Diagram

Exercise:

Hand out worksheet "Interrelationship Diagram" and have the students complete the sheet. Allow the students access to internet and any relevant research materials.
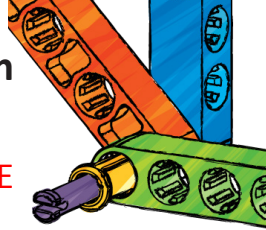
Discussion:

Discuss the worksheet with the class, asking for answers for several of the examples.

DRONES

MINDS-i
STEM INTEGRATED ROBOTICS

Instructions

1. Use the included words and phrases to best describe the inputs, outputs, relationships and constraints in the system below.

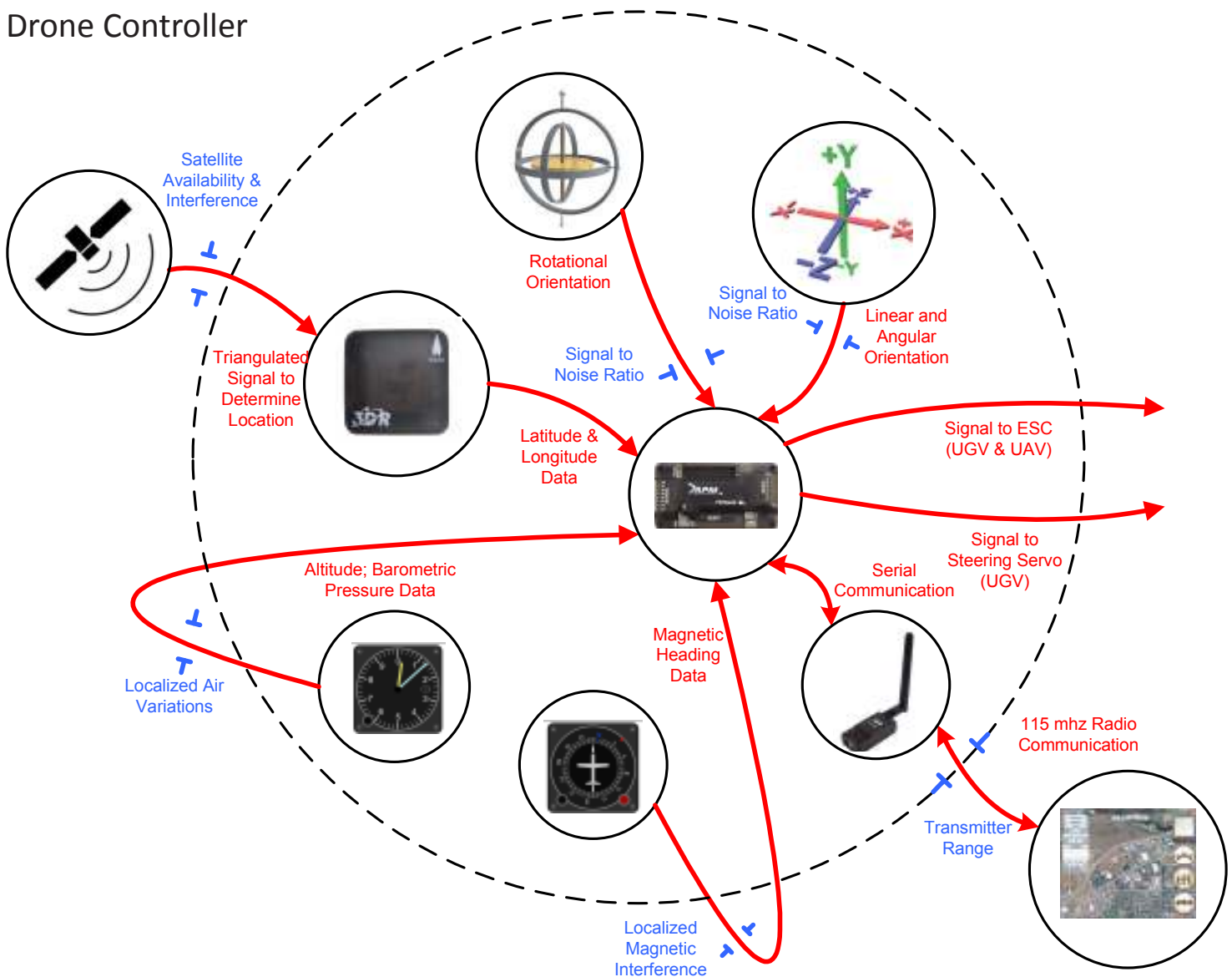**Inputs, Outputs and Relationships**
- Latitude & Longitude Data
- Rotational Orientation
- Linear & Angular Orientation
- Altitude / Barometric Pressure Data
- Magnetic Heading

Constraints
- Signal to Noise Ratio X2
- Localized Air Variations
- Localized Magnetic Interferance
- Transmitter Range
- Satellite Availability & Interference

Answer Key

Drone Controller

DRONES
MINDS-i
STEM INTEGRATED ROBOTICS

Instructions

1. Use the included words and phrases to best describe the inputs, outputs, relationships and constraints in the system below.
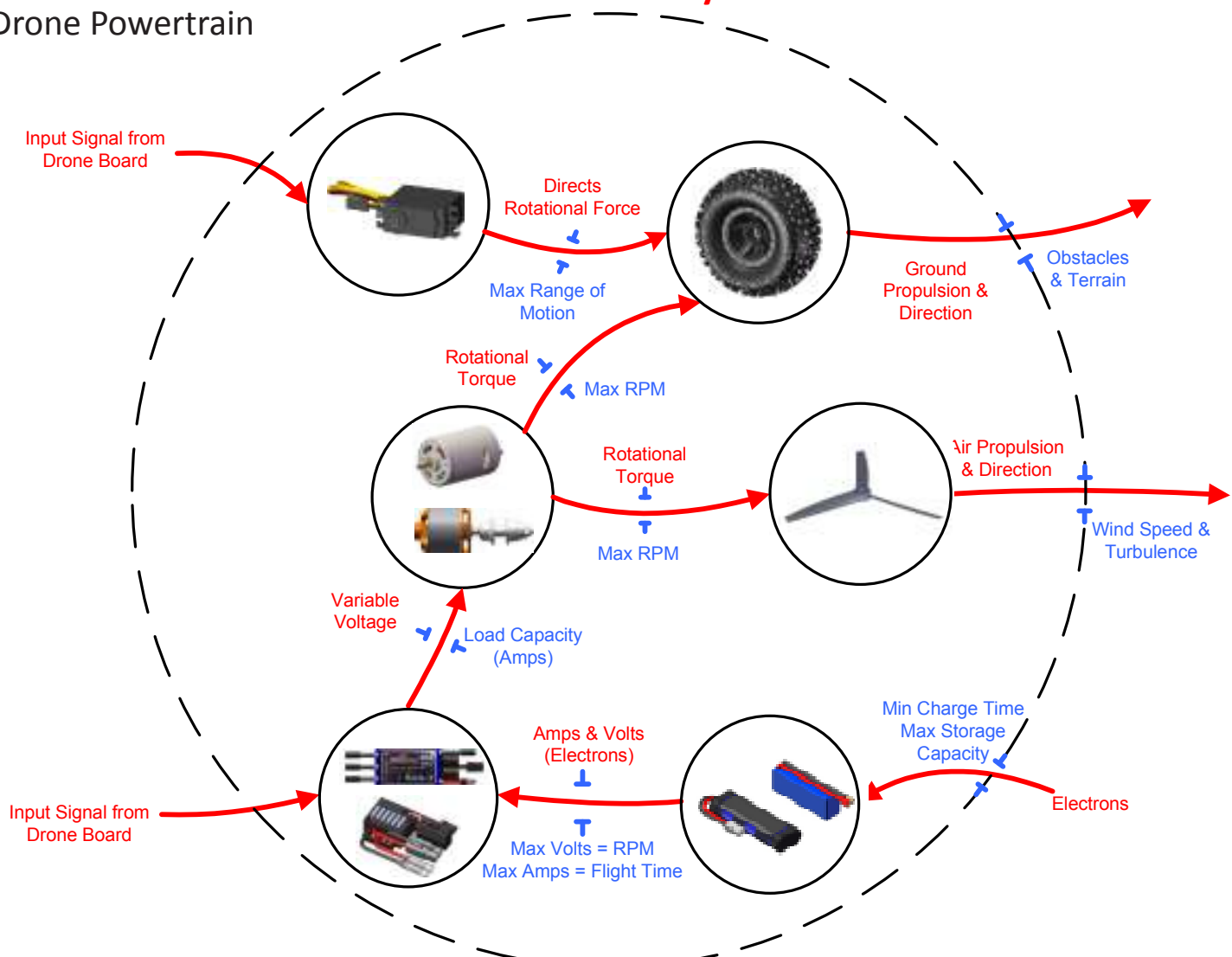
Inputs, Outputs and Relationships
- Directs Rotational Force
- Rotational Torque
- Rotational Torque
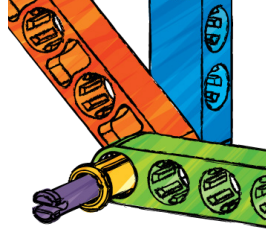- Variable Voltage
- Amps and Volts

Constraints
- Max Range of Motion
- Obstacles and Terrain
- Max RPM
- Max RPM
- Wind Speed and Turbulence
- Load Capacity (amps)
- Max Amps = RPM
  Max Volts = Flight Time
- Min Charge Time
  Max Storage Capacity

Answer Key

Drone Powertrain

Input Signal from Drone Board

Directs Rotational Force

Max Range of Motion

Ground Propulsion & Direction

Obstacles & Terrain

Rotational Torque

Max RPM

Rotational Torque

Max RPM

Air Propulsion & Direction

Wind Speed & Turbulence

Variable Voltage

Load Capacity (Amps)

Amps & Volts (Electrons)

Min Charge Time Max Storage Capacity

Electrons

Input Signal from Drone Board
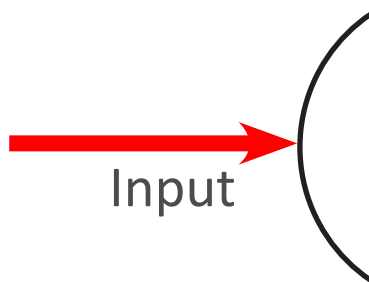
Max Volts = RPM
Max Amps = Flight Time

Symbol Guide

1. Use the definitions and symbols below to help you fill in the inputs, outputs, relationships and constraints on the following worksheets.
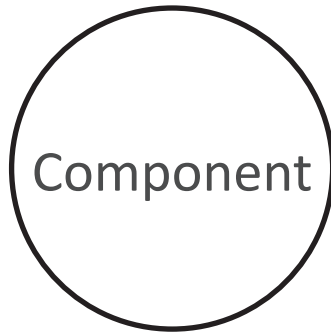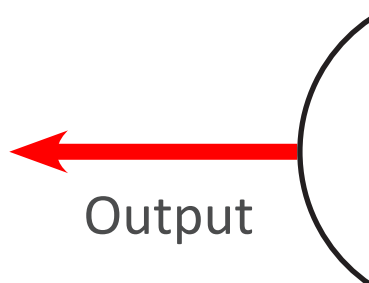
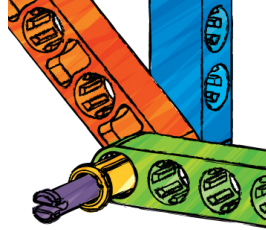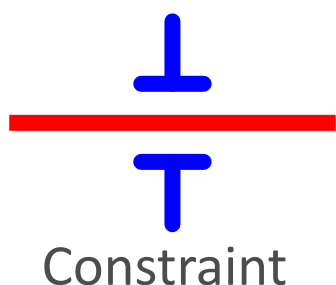| Component	Part, Factor, Sub-System, Material, Resource, Etc.
Boundary	The outside border of a system. We can change the boundaries when we want to study a smaller or larger aspect of the system.
Input	Flow of information, resources, materials, etc. <u>into</u> a component or environment.
Output	Flow of information, resources, materials, etc. <u>out</u> of a component or environment.
Constraint	A restriction or limitation, applied to volume or quality of an input or output. Constraints can be alleviated or manipulated to change the volume or quality.

D R O N E S

MINDS-i

STEM INTEGRATED ROBOTICS

Instructions

1. Use the included words and phrases to best describe the inputs, outputs, relationships and constraints in the system below.
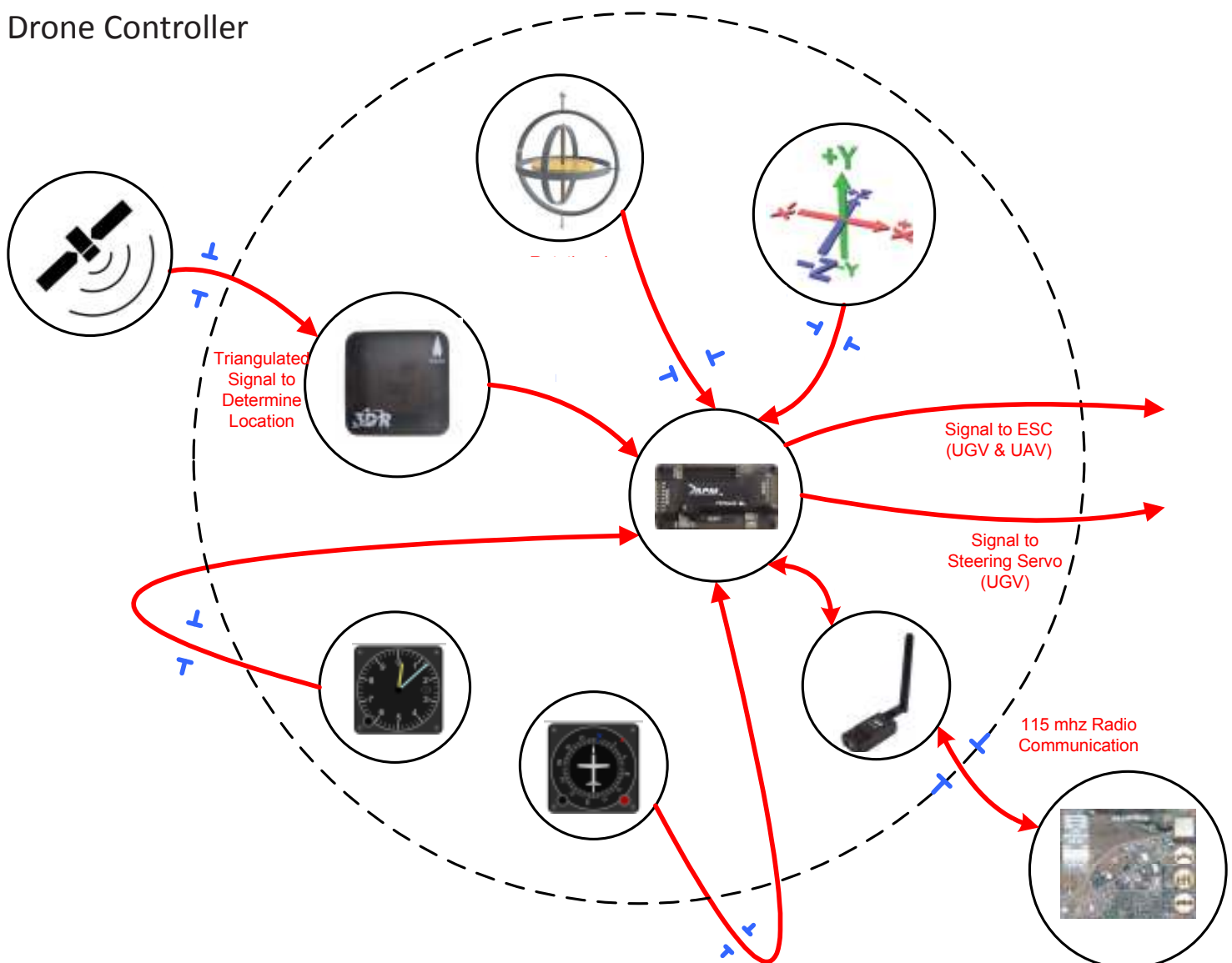
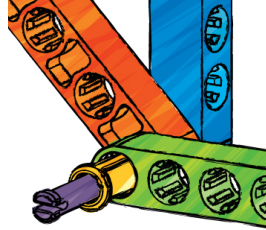Inputs, Outputs and Relationships
- Latitude & Longitude Data
- Rotational Orientation
- Linear & Angular Orientation
- Altitude / Barometric Pressure Data
- Magnetic Heading
- Serial Communication

Constraints
- Signal to Noise Ratio X2
- Localized Air Variations
- Localized Magnetic Interferance
- Transmitter Range
- Satellite Availability & Interference

Drone Controller

Triangulated Signal to Determine Location

Signal to ESC (UGV & UAV)

Signal to Steering Servo (UGV)

115 mhz Radio Communication

Instructions

1. Use the included words and phrases to best describe the inputs, outputs, relationships and constraints in the system below.

Inputs, Outputs and Relationships
- Directs Rotational Force
- Rotational Torque X2
- Variable Voltage
- Amps and Volts

Constraints
- Max Range of Motion
- Obstacles and Terrain
- Max RPM X2
- Wind Speed and Turbulence
- Load Capacity (amps)
- Max Amps = Flight Time
  Max Volts = RPM
- Min Charge Time
  Max Storage Capacity

Drone Powertrain

Input Signal from Drone Board

Ground Propulsion & Direction

Air Propulsion & Direction

Input Signal from Drone Board

Electrons