

## *Robotics and Future Technology*

### *Science Topic: Physics*

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**Grades:** 9<sup>th</sup> – 12<sup>th</sup>

#### **Essential Questions:**

##### **Big ideas**

- Computers only do what they are programmed to do.
- Fires are extinguished by depriving them of one of the fire triangle elements: oxygen, fuel source, and heat
- Robots are used in the Navy and industry to perform tasks difficult or impossible for humans.

##### **Big questions**

- What is needed to put out a fire?
- How does a computer/robot work?
- What design aspects would a robot need to put out a fire on Navy ship?
- What can a robot do that a person cannot?

##### **Guiding questions**

- What is the fire triangle?
- What role does each side of the fire triangle play in creating fire?
- Which side of the fire triangle does a given controlling agent remove?
- What kinds of fire are there?
- How do you make a computer imitate a human behavior?
- How does a computer make decisions?
- What is the difference between automation and artificial intelligence?
- What is the difference between simulated intelligence and intelligence?
- How much of the navy robot should be artificial intelligence and how much should be remote sensing?
- Why is a robot needed to put out a fire?
- How could a robot put out a fire and what decision-making ability would the robot need?

#### **Lesson Overview:**

Students will learn how the Navy and industry use robots and the reasons that robots are used for certain jobs. The students will be given a design challenge to create a robot design that can be used to extinguish a fire.

**A companion interactive resource that incorporates video and glossary terms used throughout this lesson is provided to use in classroom.**

**Learning Objectives:**

*Knowledge*

Students will be able to define fire, fire triangle, oxidation, flash point, design process, automation, remote sensing, artificial intelligence, robotics, and engineering.  
 Students will be able to draw the fire triangle.  
 Students will be able to name the classes of fire.

*Comprehension*

Students will be able to discuss fire and explain how it is controlled.  
 Students will demonstrate how carbon dioxide can put out a fire.  
 Students will be able to identify reasons a robot is needed to put out fires on a ship.  
 Students will discuss how a computer cannot create something new.  
 Students will be able to generalize the types of things robots are used for in the Navy and industry.

*Application*

Students will be able to role-play the part of the computer completing a task.  
 Students will be able to role-play the part of the computer in solving a problem that requires decisions.

*Analysis*

Students will be able to determine which leg of the fire triangle a controlling substance eliminates.  
 Students will be able to determine the best controlling substance to use given a particular type of fire.

*Synthesis*

Students will design a plan for a computer simulator to use in completing a task.  
 Students will design a plan for a computer simulator to use in solving a problem.  
 Students will rewrite their plan for a computer simulator to use in solving a problem, improving on it post testing.  
 Students will rewrite their plan for a computer simulator to use in completing a task, improving on it post testing.

Design a robot capable of:

- |  |   |
|--|---|
| ○ Bipedal locomotion in all directions                 | ○ Manipulating of fire suppression equipment                |
| ○ Balancing in sea state conditions                    | ○ Surviving high heat situations                            |
| ○ Stepping over obstacles                              | ○ Sensing through smoke                                     |
| ○ Absorbing shocks                                     | ○ Operating fire suppression equipment                      |
| ○ Navigating shipboard terrain (stairs, ladders, etc.) | ○ Launching Propelled Extinguishing Agent Technology (PEAT) |

Students will modify their design and incorporate the suggestions provided by the other teams as they find necessary.

*Evaluate*

Students will evaluate their plans for computer simulators and predict the possibility of success.  
 Students will critique the designs of all the teams and recommend suggestions for improvements.

## **EDUCATION STANDARDS**

### **Next Generations Science Standards Framework**

- Science Core Ideas ETS2.B: INFLUENCE OF ENGINEERING, TECHNOLOGY, AND SCIENCE ON SOCIETY AND THE NATURAL WORLD

### **Common Core Math Standards**

- CCSS.Math.Practice.MP1 Make sense of problems and persevere in solving them
- CCSS.Math.Practice.MP3 Construct viable arguments and critique the reasoning of others.
- CCSS.Math.Practice.MP6 Attend to precision.

### **ISTE's NETS for Students**

- Iste.nets-s.1.Creativity and Innovation - Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology
- Iste.nets-s.4. Critical Thinking, Problem Solving, and Decision Making - Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
- Iste.nets-s.6. Technology Operations and Concepts - Students demonstrate a sound understanding of technology concepts, systems, and operations

### **Time Frame:**

Two 90-minute sessions

**Vocabulary:**

**Robotics** - The branch of technology that deals with the design, construction, operation, and application of robots.

**Engineering** - The branch of science and technology concerned with the design, building, and use of engines, machines, and structures

**Fire triangle** - the three things a fire needs to burn: oxygen, fuel, and heat

**Fire**- also called burning or combustion, is a rapid chemical reaction that results in the release of energy in the form of light and heat. Most combustion involves very rapid oxidation

**Oxidation** - the chemical reaction by which oxygen combines chemically with the elements of the burning substance producing heat.

**Flash point** - the lowest temperature at which a flammable substance gives off vapors that will burn when a flame or spark is applied.

**Design process** - process involves a series of steps that lead to the development of a new product or system

**Automation** - the use of largely automatic equipment in a system of manufacturing or other production process.

**Remote sensing** - the gathering and recording of information without actual contact with the object or area being investigated

**Artificial intelligence** - a branch of computer science dealing with the simulation of intelligent behavior in computers and the capability of a machine to imitate intelligent human behavior.

**Video used in associated Power Point lesson plan:**

- **Robotics Technician** - Robotics technicians design, maintain, and implement robots: STEM Careers for Students: Volume 01, Pure Imagination

## Background for the Teacher:

### Common Misconceptions

- 1) A candle in a closed jar goes out when it runs out of oxygen. This assumption is false because the flame produces carbon dioxide, which will not burn, and when enough has been produced the carbon dioxide displaces the oxygen away from the flame, which puts the flame out. There is still oxygen in the jar. Two candles in a jar, one short and one tall can test this. The tall one will go out first as the carbon dioxide it produces displaces the oxygen down.
- 2) Computers can easily replace humans. This Assumption is false because the human machine is more complex than any machine on earth. It takes years of work and research to create robots to perform tasks humans do easily. Robots are stronger and more durable but cannot do all that humans can do.

### Science Background for the Teacher

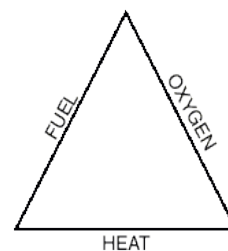
Three things are required for a fire. They are a combustible material, a high temperature, and oxygen. This makes the fire triangle. Fires are generally controlled and extinguished by eliminating one side of the fire triangle.

The first thing a fire needs is heat. Fire, also called burning or combustion, is a rapid chemical reaction that results in the release of energy in the form of light and heat. Most combustion involves very rapid oxidation. This is a chemical reaction by which oxygen combines chemically with the elements of the burning substance. In order to have a combustible fuel or substance take fire, it must have an ignition source.

The lowest temperature at which a flammable substance gives off vapors that will burn when a flame or spark is applied is called the flash point. The second thing a fire needs is fuel. A fuel may be a solid, liquid, or a vapor. The last thing a fire needs is oxygen.

The oxygen side of the fire triangle refers to the oxygen content of the surrounding air. Ordinarily, a minimum concentration of 15 percent oxygen in the air is needed to support flaming combustion.

However, smoldering combustion can take place in an atmosphere with 3 percent oxygen. Air normally contains about 21 percent oxygen, 78 percent nitrogen, and 1 percent other gases, principally argon.



In general, fires may be extinguished by removing one side of the fire triangle (fuel, heat, or oxygen) or by slowing down the rate of combustion. The method or methods used in any specific instance will depend upon the classification of the fire and the circumstances surrounding the fire.

- Removing Fuel – this is usually difficult to accomplish.
- Removing Heat - The fire will go out if you can remove enough heat by cooling the fuel to below temperature at which it will support combustion. To eliminate the heat side of the fire triangle, cool the fire by applying something that will absorb the heat. Although several agents serve this purpose, water is the most commonly used cooling agent.

- Controlling Oxygen - Oxygen is difficult to control because you obviously cannot remove the oxygen from the atmosphere that normally surrounds a fire. However, oxygen can be diluted or displaced by other substances that are noncombustible.

**Fires are classified according to the nature of the combustibles (or fuels) involved the classification of any particular fire is of great importance since it determines the manner in which the fire must be extinguished.**

**CLASS A:** Class A fires involve common combustibles such as wood, paper, cloth, rubber, trash and plastics. Water will work to put this fire out. Water is a cooling agent; aboard ship the sea provides an inexhaustible supply. If the surface temperature of a fire can be lowered below the ignition temperature of the fuel, the fire will be extinguished. Water is most efficient when it absorbs enough heat to raise its temperature to 212°F (100°C). At this temperature, the seawater will absorb still more heat until it changes to steam. The steam carries away the heat and results in the lowering of the temperature of the surface.

**CLASS B:** Class B fires involve flammable liquids' gases, solvents, oil, gasoline, paint, lacquers, tars and other synthetic or oil-based products. Class B fires often spread rapidly and, unless properly secured, can reflash after the flames are extinguished. To put this fire out one of the following can be used:

**Aqueous Film-Forming Foam (AFFF) -** Foam is a highly effective extinguishing agent for smothering large fires, particularly those in oil, gasoline, and jet fuels. AFFF, also known as "light water," is a synthetic, film forming foam designed for use in shipboard fire-fighting systems. The foam proportioning/injection equipment generates a white foam blanket. AFFF is equivalent to seawater when it is used to extinguish class A fires. The unique action of AFFF stems from its ability to make a light water film float on flammable fuels. As foam is applied over the flammable liquid surface, an aqueous solution drains from the foam bubbles and floats out over the surface to provide a vapor seal. This aqueous film-forming action enhances extinguishment and prevents reflash, even when the foam blanket is disturbed.

**Dry Chemical powders** extinguish a fire by a rather complicated chemical mechanism. They do not smother the fire and they do not cool it. Instead, they interrupt the chemical reaction of the fire by suspending fine particles in the fire. In effect, the dry chemicals put a temporary screen between the heat, oxygen, and fuel and maintain this screen just long enough for the fire to be extinguished.

**Carbon Dioxide (CO<sup>2</sup>)** is an effective agent for extinguishing fires by smothering them. CO<sup>2</sup> reduces the amount of oxygen available for combustion. This smothering action is temporary; the fire can quickly rekindle if oxygen is again admitted to the hot embers. CO<sup>2</sup> is a dry, noncorrosive gas that is inert when in contact with most substances. It is heavier than air and remains close to the surface. CO<sup>2</sup> does not damage machinery or other equipment. Although CO<sup>2</sup> is nonpoisonous, it is dangerous because it does not provide a suitable atmosphere for breathing. Asphyxiation can result from breathing CO<sup>2</sup>; therefore, self-contained breathing apparatus must be worn when CO<sup>2</sup> is used below decks or in confined spaces.

**Halon** is a colorless, odorless gas with a density approximately five times that of air. It does not conduct electricity or leave a residue. This extinguishing agent is effective against class A, class B, and class C fires.

However Halon can no longer be made. On January 1, 1996 the Environmental Protection Agency stopped the production and use of all class 1 ozone-depleting substances. Halon is a class 1 *Chlorofluorocarbons, refrigerants R-11, -12, -113, -114, -115, -502, and Halon. CFC's have not been produced since 1995 due to the very harmful ozone depletion effect.* New technology has been developed to replace Halon but the chemical does still exist in many fire suppression systems. These replacements would ideally be judged on the following criteria.

- (1) Low global environment impact (low ODP, GWP and atmospheric lifetime).
- (2) Acceptable (low) toxicity.
- (3) Cleanliness/volatility.
- (4) Fire extinguishing effectiveness.

**CLASS C:** Class C fires involve energized electrical equipment, such as wiring, controls, motors, data processing panels or appliances. A spark can cause a power surge or short circuit and typically occur in locations that are difficult to reach and see. Although ABC and BC Dry Chemical extinguishers can control a fire involving electronic equipment, the National Fire Code (NFPA 75-1999 edition), Section 6-3-2, specifically advises against dry-chemical extinguishers for fires involving computers or other delicate electronic equipment due to the potential damage from residues. CO<sup>2</sup> is also effective. Since it is a nonconductor of electricity, CO<sup>2</sup> can safely be used to fight fires that might present electric shock hazards. However, the frost that collects on the horn of a CO<sup>2</sup> extinguisher does conduct electricity. Therefore, care should be taken and never allow the extinguisher to come into contact with electrical components.

**CLASS D:** Class D fires involve combustible metals such as magnesium and sodium. Combustible metal fires are unique industrial hazards, which require special dry powder agents, large volumes of water and sand. The metals should be thrown off the ship if possible due to the difficult nature of fighting this fire.

**CLASS K:** Class K fires involve combustible cooking media such as oils and grease commonly found in commercial kitchens. These fires require a special wet chemical extinguishing agent that is designed for extinguishing and suppressing these extremely hot fires that have the ability to reflash. Water should never be used.

### **PEAT (Propelled Extinguishing Agent Technology)**

A burning substance produces a number of chemical reactions. These reactions produce flames, heat, smoke, and number of gases and other combustion products. The gases and combustion products will reduce the amount of oxygen available for breathing. Fire fighters must be shielded from them to fight fires.

The fire-suppressing agents must be delivered to the fire. One new technology to do this is the Propelled Extinguishing Agent Launcher. A typical propelled extinguishing system contains:

- Container of various shape and/or caliber
- Extinguishing agent
- Propellant
- Electrical igniter (squib)
- Mount assembly

The Propelled Extinguishing Agent Technologies (PEAT) advantages are:

1. Smaller quantity use of conventional and environmentally friendly fire extinguishing agents (water, foam, powder, etc.) than their usual requirement.
2. No need for pressurized cylinders and piping.
3. Flexibility in system design.
4. Increased effectiveness on a weight/volume basis.
5. Discharge range is increased over that of the conventional systems.
6. Rapid discharge and suppression time (less than 0.1 sec to 1 sec).
7. Capability of being inert.
8. Large volume - rapid area coverage.
9. Cost effective (low cost of ownership and life cost cycle).
10. Simple installation and minimal maintenance required.
11. High efficiency operation at extreme temperatures (down to - 40 C).
12. Long shelf life (greater than 10 years)

### **SAFFIR - Shipboard Autonomous Firefighting Robot**

The Navy is currently working on a prototype robot (SAFFiR) that will fight fires on ships at sea. SAFFiR will be equipped with multiple sensory devices, including a video camera, gas sensor, and a stereo infrared camera that will allow it to see through smoke. The robot's upper body will be capable of operating fire suppression equipment and throwing propelled extinguishing agent technology (PEAT) grenades. Its lower body will be able to walk in all directions, step over obstacles, and maintain balance in pitching seas, thanks to six-axis force/torque sensors in the feet.

Weight will be minimized and distributed by an aluminum central structure, along with titanium springs at the joints. The battery pack should allow for approximately 30 minutes of firefighting action.



## **Classroom Activities**

### **Session One Materials**

For each group of/individual students:

- Jars that cover the tall candles
- Vinegar
- Baking soda
- Cup to mix in
- Measuring cup
- Matches to lite candles
- Pie trays or dishes to hold a small amount of water

### **Session Two Materials**

- Computer
- Drawing supplies

## SESSION 1 (5E's are highlighted in bold)

### Engage (5 min.)

Presentation Slides 3-5 and Prezi <http://prezi.com/lj6a9ghvzcdd/saffir-prezi/>

- Students will be presented with a Prezi describing the SAFFiR (Shipboard Autonomous Firefighting Robot) and its capabilities. (Students will use Prezi or other presentation application to create a 1 min explanation of their design)
- The students will be asked as a group to respond to the question: Why is a robot needed to put out a fire?

Use the smart board and write the student responses to this question in the box provided. You can then save the notes the students make to each question by saving by one of the following methods:

- Press Print Screen button on keyboard and paste into a word document
- Use the screen capture feature of notebook software that comes with the smart board to add the screen to a set of class notes to be shared with the class later.
- Use PowerPoint's annotate pen and save the notes to the slide

### Explore (35 min.)

Presentation Slides 6-13 and 42-49

- The students will be put into groups (5 min)

Using the following roles

- Task Manager -*job is to keep group members focused.*
- Activity recorder- *job is to record what the team does & what questions the team has.*
- Evaluator- *job is to judge the effectiveness of the team (only shared within the team).*
- Life Line- *job is to leave the team and seek help if my team needs me to.*
- The students will work through two explore stations (Groups can be working at different stations at the same time to maximize resources). Each team will get an explore packet.

The first station will **Explore** Fire extinguishing. (15 min)

1. Students will time how long it takes for a short candle to go out when under a jar resting in water tray and how long a tall candle takes to go out under a jar resting in water. Then students will create a conjecture to explain what is causing the candles to go out at different times in the same size jars. (**Elaborate**)
2. Students will mix vinegar and baking soda in a cup and pour the created carbon dioxide over a lit candle. The students will observe what the carbon dioxide does to the flame.

The second station will **Explore** computer operation (15 min)

Students will role-play a computer in two scenarios:

1. The team will create a plan for a person taking the role-play part of a computer. The student playing the role of the computer will have to navigate a remote control car through a maze. This will take place on the computer using Scratch from MIT. (<http://scratch.mit.edu/projects/mrtommclaughlin/3075696>)\*. Pressing the left and right arrow keys controls the car. The car is always moving. A sample plan might be: First hold the left arrow for two seconds, next do nothing for 3 seconds, next hold the right arrow for three seconds. ...and continue.

The plan must be followed exactly with no decisions being made by the role-play computer. The students will then get the opportunity to **Evaluate** their plan and try to complete the task again. (\* If a computer is not available the instructor can set up a maze on the floor with tape and use a remote control car and allow the students to simulate the computer by using the RC controller)

2. Students will create a set of decision-making algorithms using sensory data of temperature and sight. They goal is to solve a labyrinth. The higher the temperature the closer they are to solving the labyrinth. At each juncture they will have to make a choice of two or three options (including going back a step). The students will then go to the website and try to solve the labyrinth using only the decision making algorithms and sensory input. This labyrinth was made with Scratch. (<http://scratch.mit.edu/projects/mrtommclaughlin/3091698>)\* The students will then get the opportunity to **Evaluate** their plan and try to complete the task again. (\*If a computer is not available one member of the team will play the role of labyrinth master. This student will have the labyrinth and will be responsible for tracing the path through the labyrinth as students make the decision. The labyrinth picture will also contain sensory data description to be read at each decision node.)

### **Elaborate (10 min.)**

*Presentation Slide 14*

Teams will report back to the group about their findings and experience

The guiding question, "How could a robot put out a fire and what decision making ability would the robot need?"

### **Explain (30 min.)**

*Presentation Slide 15-23 and 50-54*

Students will be presented content on the Fire Triangle, classes of Fire and how to extinguish them.

### **Evaluate (10 min.)**

*Presentation Slides 24*

- Students will work to complete the exit ticket in their teams. Each individual is responsible for turning in a completed exit ticket.

**Homework – (to be used in following day’s engage session) – this can be passed out while students are doing the exit ticket.**

*Presentation Slides 25-26*

Students are to create a Prezi highlighting one of the following robots. Each student should choose a different one or be assigned one by the instructor. They are to list its function, specifications and a picture. Students will share that Prezi with the instructor by making it public and emailing the link.

**AIR VEHICLE DOMAIN**

**PROJECTS:**

Airborne Remotely Operated Device (AROD)  
Autonomous UAV Mission System (AUMS)  
Multipurpose Surveillance and Security Mission Platform (MSSMP)

**GROUND VEHICLE DOMAIN**

**PROJECTS:**

Ground Surveillance Robot (GSR)  
Man-Portable Robotic Systems (MPRS)  
Mobile Detection Assessment and Response System (MDARS)  
Modular Robotic Architecture (ModBot)  
Novel Unmanned Ground Vehicle (NUGV)  
ROBART  
Segway Robotic Mobility Platform (SRMP)  
Surrogate Teleoperated Vehicle (STV)  
Teleoperated Dune Buggy  
TeleOperated Vehicle (TOV)

**SEA SURFACE VEHICLE**

**DOMAIN PROJECTS:**

Unmanned Surface Vehicle (USV)

**UNDERWATER VEHICLE**

**DOMAIN PROJECTS:**

Advanced Tethered Vehicle (ATV)  
Advanced Unmanned Search System (AUSS)  
Distributed Surveillance Sensor Network (DSSN)  
Cable-Controlled Underwater Recovery Vehicle (CURV)  
Flying Plug  
Free Swimmer  
Mine Neutralization Vehicle (MNV)  
Remote Unmanned Work System (RUWS)  
Submersible Cable-Actuated Teleoperator (SCAT)  
Snoopy  
Solid Rocket Booster Nozzle Plug (SRB/NP)

**COMMAND & CONTROL**

**PROJECTS:**

Multi-robot Operator Control Unit (MOCU)

**TECHNOLOGIES AND RESEARCH PROJECTS:**

Autonomous Capabilities Suite (ACS)  
Automatically Deployed Communication Relays (ADCR)  
Autonomous Mobile Communication Relays (AMCR)  
Networked Remotely Operated Weapon System (NROWS)  
Railway Intrusion Detection System (RIDS)  
Technology Transfer  
Tele-Operator/Presence System (TOPS)  
Greenman

Students are to use the website below to do the research.

**Aerial**

<https://www.navy.com/about/equipment/UnmannedSystems.html#aerial>

**Underwater**

<https://www.navy.com/about/equipment/UnmannedSystems.html#underwater>

**Surface**

<https://www.navy.com/about/equipment/UnmannedSystems.html#surface>

## SESSION 2

### Engage (10 min.)

*Presentation Slides 28*

Student Prezi presentations from the previous session homework shall be presented. Presentations should be limited to a few volunteers. The links to the student Prezi presentations can then be put into one Prezi document the students can review later. (Alternately more presentations can be done and the explore section could be truncated to just the one video)

### Explore (15 min.)

*Presentation Slides 29-35 (15 min)*

The use of robots in the real world are demonstrated

And a follow up question about which are automations, which are artificial intelligence, and which are remote sensing. Some of them may fall into more than one category

(Slides 62 -65 contain pictures and text about the robots demonstrated in some of the videos)

### Explain (35 min.)

*Presentation Slides 36-37*

Students will use what they have learned to design a robot capable of:

- Bipedal locomotion in all directions
- Balancing in sea state conditions
- Stepping over obstacles
- Absorbing shocks
- Navigating shipboard terrain (stairs, ladders, etc)
- Manipulating of fire suppression equipment
- Surviving high heat situations
- Sensing through smoke
- Operating fire suppression equipment
- Launching propelled extinguishing agent technology (PEAT)

Each team will be responsible for choosing 3 aspects of the design to work on. There should not be overlap among the teams if possible. The students should draw a sketch of their robot including description bubbles as modeled on the SAFFiR robot picture from Session 1. Students may also use a drawing program on the computer to sketch the robot and a presentation application (PowerPoint, Prezi, Powtoon, slideshare.) to display their design. Students will have to come up with a 1 min presentation on their robot as well.

### Evaluate (15 min.)

*Presentation Slides 38*

Students will present their presentations and the other teams will critique their work and present constructive suggestions. The class can also discuss how all the design aspects come together to make one robot.

**Elaborate (15 min.)**

*Presentation Slide 39*

Students will go back to their teams to rework their designs as needed.

**EXTENSION**

*Presentation Slides 55-61*

We will examine what Eliza bot can do. First we will look at a sample chat between two Eliza bots then we can try to ask some questions ourselves.

<http://www.masswerk.at/elizabot/>

Ask Eliza

We are looking to see if Eliza passes the Turing test for Artificial Intelligence - a proposed test of a computer's ability to think, requiring that the covert substitution of the computer for one of the participants in a keyboard and screen dialogue should be undetectable by the remaining human participant [Alan Turing (1912-54), English mathematician]

***Follow up questions:***

*Does this computer pass the Turing test?*

*Was the computer intelligent or just simulation intelligence?*

## EVALUATION OPPORTUNITIES

- 1) Participation
- 2) Lab Packet
- 3) Design Packet
- 4) Presentation of robot design

## Re-teaching – As you proceeded through the lesson

- Teacher should be moving through teams directing and clearing up misconceptions as needed while the students are working on explore labs
- When the teams are done the explore teacher should take that time to emphasize the expected results of the explore session
- After the presentation of content the teacher can use the vocabulary slide and game to review the important vocabulary.
- The teacher should correct and reteach incorrect ideas during the exit ticket session.

## Additional resources

### Content Websites

[http://www.hawsepipe.net/chiefhelp/firefighting/fundamentals\\_of\\_firefighting.htm](http://www.hawsepipe.net/chiefhelp/firefighting/fundamentals_of_firefighting.htm)

<http://www.smokesign.com/firetypes.html>

<http://fire.nist.gov/bfrlpubs/fire05/PDF/f05063.pdf>

### **Alice 3.01** <http://www.alice.org>

If students are interested in computer programming Alice 2.3 is a free download and is a great programming environment for student to learn from. It is 3D and drag and drop. The students will learn concepts of coding without having to deal with heavy syntax.

### **Scratch** <http://scratch.mit.edu/>

This is another place for students to investigate and learn about computer coding. It is also free to download. This is different from Alice in that it is 2D rather than 3D. It also has the advantage of allowing you to post your work on the Internet very easily. MIT has created an online community where you can play other programs and download them as starters for your own.

### **Link to online flash cards:**

<https://quizlet.com/19591203/stem-for-the-classroom-navy-robots-flash-cards/>

## *Homework*

You are to create a Prezi highlighting one of the following robots. Each student will Prezi on a different robot. You are to list the robot's function, specifications and a picture. You will share that Prezi with the instructor by making it public and emailing the link.

### Robot options

#### **AIR VEHICLE DOMAIN PROJECTS:**

**Airborne Remotely Operated Device (AROD)**  
**Autonomous UAV Mission System (AUMS)**  
**Multipurpose Surveillance and Security Mission Platform (MSSMP)**

#### **GROUND VEHICLE DOMAIN PROJECTS:**

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#### **SEA SURFACE VEHICLE DOMAIN PROJECTS:**

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**Submersible Cable-Actuated Teleoperator (SCAT)**  
**Snoopy**  
**Solid Rocket Booster Nozzle Plug (SRB/NP)**

#### **COMMAND & CONTROL PROJECTS:**

**Multi-robot Operator Control Unit (MOCU)**

#### **TECHNOLOGIES AND RESEARCH PROJECTS:**

**Autonomous Capabilities Suite (ACS)**  
**Automatically Deployed Communication Relays (ADCR)**  
**Autonomous Mobile Communication Relays (AMCR)**  
**Networked Remotely Operated Weapon System (NROWS)**  
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#### **Underwater**

<https://www.navy.com/about/equipment/UnmannedSystems.html#underwater>

#### **Surface**

<https://www.navy.com/about/equipment/UnmannedSystems.html#surface>



***Let's Explore***

***You will now work in teams to explore the concepts of Fire extinguishing and Computer Operations***

**The Team Members (4 - 5):**

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*List your team members here*

\_\_\_\_\_ is the Task Manager  
*My job is to keep group members focused.*

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**The Stations:**

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*Check off the stations as you do them:*

**Fire Extinguishing**

**Computer Operations**

**Station Instructions:** *Station 1: Fire extinguishing*

**Lab 1 -Candles in a jar**

Materials:

Short candle

Taller candle (birthday candles will work, one can be cut shorter)

Shallow tray to hold water

Lighter

Two jars of the same size to cover the taller candle

Procedure:

Set each candle in a shallow tray. (The bottom of the candle may need to be melted to get the candle to stand) Add some water just till the bottom of the tray is covered. Light the short candle and put a jar over it. Time how long it takes for the candle to go out. Light the taller candle and put a jar over it. Time how long it takes for the candle to go out. Now light both candles and put jars over them and record which goes out first.

Questions:

Why do the candles go out?

What is causing the candles to go out at different times in the same size jars?

What would happen if both candles were in the same jar?

**Lab 2 -Making our own fire extinguisher**

Materials:

Baking soda

Vinegar

Candle

Glass

Procedure:

In the glass, mix together a little baking soda and vinegar. Simply pour the gas from the glass onto the candle. The flame will be extinguished.

Another way to perform this trick is to pour the gas that you just made into an empty glass and then pour the apparently empty glass over the candle flame

Questions:

Why didn't the gas created just float out of the glass?

Why did the gas put out the candle?

**Station Instructions:** *Station 2: Computer operation*

### Lab 1: Robot Automation

#### Materials

A Computer\*

#### Procedure

The team will create a plan for a person taking the role-play part of a computer. One person in the team is to control the remote control car and guide it through the virtual maze following the team's plan. This will take place on the computer using a simulation written in the Scratch programming language.

<http://scratch.mit.edu/projects/mrtommclaughlin/3075696>

Pressing the left and right arrow keys controls the car. The car is always moving.

A sample plan might be:

First hold the left arrow for two seconds, next do nothing for 3 seconds, next hold the right arrow for three seconds... and continue.

After the team has had a chance to try out their plan they should modify it and try one more time.

#### Questions

What kinds of things could have made the plan the team created fail?

What would be important criteria when creating an automated system?

\* If a computer is not available the instructor can set up a maze on the floor with tape and use a remote control car and allow the students to simulate the computer by using the RC controller

\*\*If a computer is not available one member of the team will play the role of labyrinth master. This student will have the labyrinth and will be responsible for tracing the path through the labyrinth as students make the decision. The labyrinth picture will also contain sensory data description to be read at each decision node.

### Lab 2: Robot Artificial Intelligence

#### Materials

A Computer\*\*

#### Procedure

The team is to create a set of decision-making algorithms using sensory data of temperature and sight. The goal is to solve a labyrinth. The higher the temperature the closer the role-player will be to solving the labyrinth. At each juncture the role-player will have to make a choice of two or three options (including going back a step).

The students will then go to the website and try to solve the labyrinth using only the decision making algorithms they created and sensory input. This labyrinth was made with the Scratch programming language.

<http://scratch.mit.edu/projects/mrtommclaughlin/3091698> If the team finds that the algorithms are not successful the team should reevaluate the algorithms and try again.

#### Questions

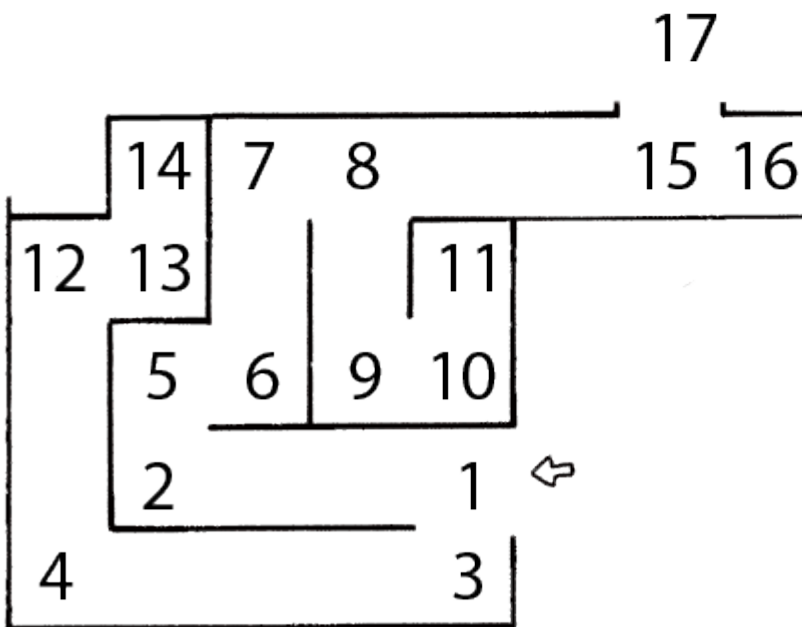
Is the computer actually thinking?

Is there a difference between intelligence and creative intelligence?

Computer Operation Station labyrinth alternative:

You have the ability to see a directional choice option a or option b and you have a temperature sensor that will help lead you. The warmer you are the closer you are to the exit

- 1) You can go forward or turn left you are at 72 degrees
- 2) You can go back or turn right you are at 72 degrees
- 3) You can go forward or go back - you are at 70 degrees
- 4) you can go right or go back - you are at 65 degrees
- 5) you can go right or go back - you are at 72 degrees
- 6) you can go left or go back - you are at 72 degrees
- 7) you can go right or go back - you are at 72 degrees
- 8) you can go forward, go right, or go back - you are at 72 degrees
- 9) you can go left or go back - you are at 65 degrees
- 10) you can go left or go back - you are at 40 degrees
- 11) you can only go back - you are at 32 degrees
- 12) you can go right or go back - you are at 60 degrees
- 13) you can go left or go back - you are at 40 degrees
- 14) you can only go back - you are at 32 degrees
- 15) you can go left or go forward - you are at 80 degrees
- 16) you can only go back - you are at 72 degrees
- 17) you have made it out - you are at 85 degrees ↑



## Exit Ticket

Fill in your answers for the worksheet below:

- Enter the class of fire described for each question below
  - 1) Enter the class of fire that fits each description:
  - 2) It involves common combustibles such as wood, paper, cloth, rubber, trash and plastics
  - 3) Water is very dangerous to use with this this class of fire
  - 4) This fire can only be put out with very large amounts of water and sand.
  - 5) Dry-chemical extinguishers will put this fire out but should not be used on it.
  - 6) This fire requires a special wet chemical agent
  
- List the extinguishing agent that will put out each fire
  - 1) A fire that is fueled by a pile of wood
  - 2) A fire caused by a short circuit.
  - 3) A fire that is fueled magnesium.
  - 4) A fire that is fueled by tar
  - 5) A fire that is fueled by rubber.

### Design Packet

You are to use what you have learned to design a robot capable of fighting fires on a ship. You should draw a sketch of your robot including description bubbles as modeled on the SAFFiR robot picture from Session 1. You may also use a drawing program on the computer to sketch the robot and a presentation application (PowerPoint, Prezi, Powtoon, slideshare.) to display your design. You will have to come up with a 1 min presentation on the robot. This will be presented to the class. You may use paper slides or a presentation application of your choice.

### **The Team Members (4 - 5):**

---

*List your team members here*

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## The Design

The engineering design process involves a series of steps that lead to the development of a new product or system. In this design challenge, students are to complete each step and document their work as they develop their robot to fight fires.

Your robot must have 3 of the following specifications:

- Bipedal locomotion in all directions
- Balancing in sea state conditions
- Stepping over obstacles
- Absorbing shocks
- Navigating shipboard terrain (stairs, ladders, etc)
- Manipulating of fire suppression equipment
- Surviving high heat situations
- Sensing through smoke
- Operating fire suppression equipment
- Launching propelled extinguishing agent technology (PEAT)

Your team has 35 min to work through the design process below.

<p><b>Define the Problem</b>-State the challenge problem in your own words. Ex. How can I design a _____ that will _____?</p>
<p><b>Identify Criteria and Constraints</b> -- Specify the design requirements (criteria). Example: Our growth chamber must have a growing surface of 10 square feet and a delivery volume of 3 cubic feet or less. List the limits on the design due to available resources and the environment (constraints). Example: Our growth chamber must be accessible to astronauts without the need for leaving the spacecraft.</p>
<p><b>Brainstorm Possible Solutions</b> -- Each student in the team should sketch his or her own ideas as the team discusses ways to solve the problem. Labels and arrows should be included. These drawings should be quick and brief.</p>
<p><b>Generate Ideas</b> -- In this step, each student should develop two or three ideas more thoroughly.</p>
<p><b>Explore Possibilities</b> -- The developed ideas should be shared and discussed among the team members. Students should record pros and cons of each design idea directly on the paper next to the drawings.</p>
<p><b>Select an Approach</b> -- Students should work with the team and identify the design that appears to solve the problem best. Students should write a statement that describes why they chose the solution. This should include some reference to the criteria and constraints identified above.</p>
<p><b>Design the Model or Prototype</b> -- Students will design a model based on the sketch drawings. Students should create new drawings that are multiple views showing the top, front and one side, and three-dimensional depiction drawings. These are to be drawn neatly, using rulers to draw straight lines and to make parts proportional. Parts and measurements should be labeled clearly. <u>These drawings can also be done on a computer.</u></p>
<p><b>Presentation</b> - Students are to create a 1 min presentation based on their work. They should use their drawings in the presentation. If a computer is used for the presentation students can take pictures of their drawings with a camera (phone) and send them to an email so the pictures may be include in the presentation.</p>

Students in their design teams will evaluate the designs from the other teams

Evaluation of team number #

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**Rubric**

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A. Does the robot meet the requirements of having 3 of the following?

- 1) Bipedal locomotion in all directions
- 2) Balancing in sea state conditions
- 3) Stepping over obstacles
- 4) Absorbing shocks
- 5) Navigating shipboard terrain (stairs, ladders, etc)
- 6) Manipulating of fire suppression equipment
- 7) Surviving high heat situations
- 8) Sensing through smoke
- 9) Operating fire suppression equipment
- 10) Launching propelled extinguishing agent technology (PEAT)

Score on a 1 - 10 rating \_\_\_\_\_

B. Rate on a 1 - 10 rating the chances of success of this robot fighting a fire aboard ship \_\_\_\_\_

C. List any possible suggestions for future improvement on the back of this sheet.



A M E R I C A ' S  
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Discovery  
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NOTES FOR IMPROVEMENT

**Students in their design teams will evaluate their designs to determine redesign options  
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**Teams are to reconvene and reevaluate their calculations to determine the following:**

- **If you were missing requirements discuss how to add them.**
- **Discuss the possible success or failure of your design based on the input from the other teams.**
- **Discuss which suggestions you would implement and what you would do differently.**