STEM Unit
Safe Transport in Adelaide’s Railway Network

In collaboration with

University of South Australia
Government of South Australia
Department of Planning, Transport and Infrastructure
Table of Contents

CONTEXT OF INDUSTRY ................................................. 3
BRAINSTORMING IDEAS ............................................... 3
SYSTEM .................................................................. 3
TEACHING PHILOSOPHY ............................................. 4
  PUBLIC PEDAGOGIES ............................................. 4
  INTELLECTUAL QUALITY ....................................... 4
  RELEVANCE .......................................................... 4
  CLASSROOM ENVIRONMENT .................................... 4
UNIT OVERVIEW ......................................................... 5
ACARA CONTENT DESCRIPTORS .................................. 6
DESIGN / ASSESSMENT BRIEF ..................................... 8
  PART 1 - FORMATIVE ASSESSMENT (INDIVIDUAL) ........ 8
  PART 2 - SUMMATIVE ASSESSMENT FOLIO (GROUP) .... 8
  DELIVERABLES ...................................................... 8
ASSESSMENT RUBRIC .................................................. 9
LESSON PLANS .......................................................... 10
  LESSON PLAN 1 ...................................................... 11
  LESSON PLAN 2 ...................................................... 12
  LESSON PLAN 3-4 .................................................... 13
  LESSON PLAN 5 ...................................................... 14
  LESSON PLAN 6 ...................................................... 15
  LESSON PLAN 7-8 .................................................... 17
  LESSON PLAN 9 ...................................................... 18
  LESSON PLAN 10 .................................................... 19
  LESSON PLAN 11-12 ............................................... 20
  LESSON PLAN 13-15 ............................................... 21
  LESSON 16-17 ....................................................... 22
  LESSON PLAN 18-19 ............................................... 23
  LESSON PLAN 20-21 ............................................... 24
  LESSON PLAN 22 .................................................... 25
  LESSON PLAN 23 .................................................... 26
  LESSON 24-25 ....................................................... 27
  LESSON PLAN 26-35 ............................................... 28
  LESSON PLAN 36-37 ............................................... 29
TEACHER RESOURCES ............................................... 30
  POWERPOINT Lesson 2 .......................................... 31
  POWERPOINT Lesson 5 .......................................... 33
  POWERPOINT Lesson 6 .......................................... 35
  POWERPOINT Lesson 23 ........................................ 37
This unit of work was designed in 2019 by
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Martin Oakley
Harrison Turner
Matthew Walsh
Context of Industry

The Department of Planning, Transport and Infrastructure (DPTI) serves the South Australian community by providing safe, effective and efficient planning, transport and infrastructure networks across the state and facilitating development of the State’s Infrastructure, in accordance with South Australia’s Strategic Plan and the State Infrastructure Plan.

While our industry visits were held through the Traffic Management Division, we had connections to both the Traffic Management Division and the Adelaide Rail Network, this meant that we could explore two different avenues to develop a unit of work. We decided to focus on the Rail Network as the Rail Network allows the safe transportation of 10000’s of commuters through numerous level crossing and other safety features which are found on the Rail Network.

Brainstorming Ideas

Before our first meeting going into DPTI, many ideas were formed on what we could base our project on, a few ideas were; Building a working intersection through the use of an Arduino program. Designing a modern-day boat ramp which included digital signals and parking locations. Both ideas would have been relevant to the topic but both had large complications attached to them.

After our first meeting, we went in a totally new path, because during our visit we were shown the complexities and design of the Adelaide Rail Network. This lead us to the idea of making a railway crossing so that the students could develop an understanding of the concepts which allows the safe travel of both trains and motorists through Adelaide. The system would have to be designed to react in real time of when a train was about to enter the intersection which would activate a boom gate. This idea could include other safety aspects of the intersection.

System

The STEM unit that we were creating would in a small way, duplicate what students see when traveling through Adelaide and allow them to understand how one of these complex systems work in providing a safe means of transport. Through this unit of work, students would have an opportunity to start to learn and understand code through an Arduino based system and to develop a system which would meet the design brief. This project would also involve the use of advanced manufacturing to develop the train which would be used for their model as well. Electronic skills would also be involved in wiring up the train by using a basic DC circuit as well as the connection of the Arduino circuit to motors, lights and buzzers. Students could further themselves though adding more sensors and outputs to the Arduino system to help further the model and create a more accurate representation of a real-world Scenario. The Science component of this STEM unit would include; electronics, circuits, current flow, resistance and Ohm's Law. The Technology component would include; laser cutting and Information Technology (Computer use). The
Engineering component would include; Arduino and coding. The Mathematics component would include; Using numbers in scientific notation, problem solving using rates and ratios and describing events using mathematical language.

Teaching Philosophy

Public pedagogies
In an ideal situation, it would be important and beneficial to include a field-trip to the Adelaide Rail Operations Centre at Dry Creek. However, having detailed information showing how the systems work and function would also allow students to see how the rail network operates in a real-world environment.

Intellectual Quality
It is important that students were encouraged to use higher order thinking skills throughout this unit of work. Students will be challenged the use these skills by learning code, understanding code and being able to troubleshoot it. Students will have to be able to provide evidence of this which will be assessed through both formative and summative assessments. It is important the use of metalanguage is used as educators so that students can be modelled on the technical language that is associated within this topic, so that they can convey ideas and problems clearly.

Relevance
Throughout this unit of work, students will demonstrate a high level of knowledge implemented across a broad range of learning capabilities due the STEM focus. This project fits the interdisciplinary definition as the content is pulled from different fields and disciplines. It allows students to connect to a real-life situation, i.e. understanding how a system in the rail network works, and how these systems allow the safe travel of all commuters.

Classroom Environment
As this is a group project this unit will eventually allow students to self-govern how they want to proceed with the project. Students will have to be able to plan their systems and self-regulate themselves to complete the tasks at hand. Because of the unit of work and the learning requirements the students have to undertake, it is important that as educators we create an environment which is supportive of their learning and will allow the students to be engaged within the classroom, while still being in a safe environment.
## Unit Overview

<table>
<thead>
<tr>
<th>Week</th>
<th>Lesson</th>
<th>Description of Lessons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Showcase of model and overview of course</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Looking at DPTI and the Rail Network</td>
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<tr>
<td></td>
<td>3</td>
<td>Excursion to DPTI</td>
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<td></td>
<td>4</td>
<td>Excursion to DPTI</td>
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<tr>
<td></td>
<td>5</td>
<td>Introducing Arduino code through TinkerCad,</td>
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<tr>
<td></td>
<td>6</td>
<td>Light and photo resistor task in TinkerCad</td>
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<tr>
<td></td>
<td>7</td>
<td>Arduino Introduction</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Light and photo resistor task with Arduino board</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Catch up lesson</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Assignment on the Adelaide Rail Network</td>
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<tr>
<td></td>
<td>11</td>
<td>Cont.</td>
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<tr>
<td></td>
<td>12</td>
<td>Cont.</td>
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<tr>
<td></td>
<td>13</td>
<td>TinkerCad diagrams</td>
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<td>14</td>
<td>Cont.</td>
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<td></td>
<td>15</td>
<td>Cont.</td>
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<td></td>
<td>16</td>
<td>Train – DC theory</td>
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<td>17</td>
<td>Cont.</td>
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<td></td>
<td>18</td>
<td>Refresher on soldering or learning to solder</td>
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<td></td>
<td>19</td>
<td>Soldering train kit together</td>
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<td></td>
<td>20</td>
<td>Assemble train Illustrator intro</td>
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<td></td>
<td>21</td>
<td>Assemble train laser cut parts</td>
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<tr>
<td></td>
<td>22</td>
<td>Intro to folio - Students get into assigned pairs for group project</td>
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<td></td>
<td>23</td>
<td>Start students on main project first on the light system component</td>
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<td>24</td>
<td>Cont.</td>
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<td></td>
<td>25</td>
<td>Cont.</td>
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<tr>
<td></td>
<td>26</td>
<td>Groups now work independently to develop all system components</td>
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<td>27</td>
<td>Cont.</td>
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<td></td>
<td>35</td>
<td>Cont.</td>
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<tr>
<td></td>
<td>36</td>
<td>Presentation of System and Hand-Up of Folio</td>
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<td>37</td>
<td>Cont.</td>
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</tbody>
</table>
## ACARA Content Descriptors

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Students will:</th>
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</table>
| **Knowledge and Understanding:**  
  Investigate the role of hardware and software in managing, controlling and securing the movement of and access to data in networked digital systems (ACTDIK034) | Investigate programable hardware (Arduino) to control digital systems in level crossing. |
| **Processes and Production Skills**  
  Analyse and visualise data to create information and address complex problems, and model processes, entities and their relationships using structured data (ACTDIP037) | Analyse data surrounding train transport while focusing on safety, timing and complexity. |
  Define and decompose real-world problems precisely, taking into account functional and non-functional requirements and including interviewing stakeholders to identify needs (ACTDIP038) | Identifying the needs such as a safe passage for trains through level crossings while taking into account all road users. |
  Design algorithms represented diagrammatically and in structured English and validate algorithms and programs through tracing and test cases (ACTDIP040) | Design and structure clear code using C++ language that controls all systems sensors through an Arduino. |
  Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041) | Implement code using C++ language that controls all systems sensors through an Arduino. |
  Plan and manage projects using an iterative and collaborative approach, identifying risks and considering safety and sustainability (ACTDIP044) | Work in groups to achieve the outcome of a simulated level crossing that operates to allow safe passage for trains and other road users. |

<table>
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<tr>
<th>Science</th>
<th>Students will:</th>
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</table>
| **Use and Influence of Science:**  
  • Values and needs of contemporary society can influence the focus of scientific research (ACSHE228) | Students will gain appreciation into the need for safe public transport and how society influences research and advancement. |
| **Planning and Conducting:**  
  • Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACSIMS166) | Identify the correct equipment to use and code while maintaining an accurate record of data in a design folio. |
### Evaluating:
- Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems (ACSIS172)

### Mathematics

#### Chance:
Describe events using language of 'at least', exclusive 'or' (A or B but not both), inclusive 'or' (A or B or both) and 'and'. (ACMSP205)

#### Real numbers:
- Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

### Students will:
- Analyse information retrieved through research to complete minor assignment. Explore how DPTI has solved problems in regards to safe and sustainable public transport.

- Describe how all systems are dependent on train passing through and triggering first sensor and how this will affect the way its probability is calculated.

- Face, identify and solve a range of problems when: coding timing ratios, building train DC circuitry and adjusting the speed of the train using the potentiometer.
Design / Assessment Brief
Safety Systems involved within the Adelaide Rail Network

Part 1 - Formative Assessment (Individual)
You will be graded on the following throughout your individual work:
1. Class participation and contribution to tasks.
2. Problem solving abilities.
3. Engaging with enquiry activities and questions.
4. Understands theoretical concepts of code.
5. Digital skills involved with laser cutting and using Illustrator.
6. Completion of the Activities Booklet.

Part 2 - Summative Assessment Folio (group)
From your knowledge of electronics, programming with Arduino and DC theory, create a safe working railway crossing for both motorists and commuters.

Deliverables
You need to submit:

- A group folio that shows planning strategies and idea growth with an evaluation at the end discussing the overall success of your project (Investigate, Generate, Produce, Evaluate).
  - List showing group participation levels.
  - TinkerCad drawings showing correct Arduino circuits.
  - 4 sub-systems of code plus one main code of the whole system.
## Assessment Rubric

<table>
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<tr>
<th></th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TinkerCAD</strong></td>
<td>TinkerCAD circuit diagrams are very neat. Used correct pins on Arduino. Easy read code. Simulation of systems function as they should.</td>
<td>TinkerCAD circuit diagrams are set out well. Used correct pins on Arduino. Coded. Simulation of systems function as they should.</td>
<td>TinkerCAD circuit diagram set out is ok. Used correct pins on Arduino. Partially coded. Simulation of systems function sometimes.</td>
<td>TinkerCAD circuit diagrams are done. Used incorrect pins on Arduino. Not coded. Simulation of systems do not function.</td>
</tr>
<tr>
<td><strong>DC Circuit</strong></td>
<td>Well-ordered and clean wiring. Soldering is excellent. Functions without fault.</td>
<td>Neat and clean wiring. Soldering is good. Functions well.</td>
<td>Wiring is ok. Soldering is ok. Functions with some faults.</td>
<td>Wiring is messy. Too much solder/not enough. Does not function.</td>
</tr>
<tr>
<td><strong>Research Assignment</strong></td>
<td>Marks: 16/20 to 20/20</td>
<td>Marks: 11/20 to 15/20</td>
<td>Marks: 6/20 to 10/20</td>
<td>Marks: 0/20 to 5/20</td>
</tr>
<tr>
<td><strong>Arduino Systems Coding</strong></td>
<td>Code is correct. Explanation of code throughout.</td>
<td>Code is mostly correct. Explanation of code mostly throughout.</td>
<td>Code is partially correct. Little explanation of code throughout.</td>
<td>Code is ok. Little to no explanation of code throughout.</td>
</tr>
<tr>
<td><strong>Group Design Folio</strong></td>
<td>Folio follows template. All work recorded in folio. Pictures and explanations are excellent. All stages (Investigate, Generate, Produce, Evaluate) clearly recorded.</td>
<td>Folio follows template. Most of the work recorded in folio. Pictures and explanations are good. All stages (Investigate, Generate, Produce, Evaluate) clearly recorded.</td>
<td>Folio follows template mostly. Some work recorded in folio. Some pictures and explanations are in folio. Not all stages (Investigate, Generate, Produce, Evaluate) recorded.</td>
<td>Folio follows template in some parts. Little to no work recorded in folio. Little to no pictures with explanations. Not all stages (Investigate, Generate, Produce, Evaluate) recorded.</td>
</tr>
<tr>
<td><strong>Participation in group</strong></td>
<td>Workload evenly shared. All members equally contributed. Members contribution recorded in folio.</td>
<td>Most of the work evenly shared. Most members equally contributed. Most of the contribution recorded in folio.</td>
<td>Some of the work evenly shared. Some members equally contributed. Some members contribution recorded in folio.</td>
<td>Workload not evenly shared. Some members did not contribute. Members contribution not recorded in folio.</td>
</tr>
</tbody>
</table>
Lesson Plans

In collaboration with

University of South Australia

Government of South Australia
Department of Planning, Transport and Infrastructure
## Lesson Plan 1

**CONTEXTUAL DETAILS**

- **Year Level:** 9
- **No. of Students:** 26
- **Location:** Classroom

**Lesson:** 1 – Overview of topic  
**Estimated Duration of Activity:** 45 mins

**AREA OF LEARNING:** Technologies.

**BAND:** Digital Technologies

**TOPIC:** Safe Transportation in the Adelaide Railway Network

**BROAD OUTCOME**

For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

**SPECIFIC LEARNING OUTCOME/S**

To introduce students to the overall project and research specific components of the project.

**ACARA LINKS**

- **Design Technologies**
  - Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)
  - coding separate modules that perform discrete functions but collectively meet the needs of the solution
  - defining classes that represent the attributes and behaviour of objects in the real world or in a game
  - considering different algorithms and selecting the most appropriate based on the type of problem, for example choosing appropriate algorithms for particular problems
  - selecting different types of data structures such as an array, record and object to model structured data

**PREPARATION / ORGANISATION**

- Have the working model of the train and the railway track ready to be shown.
- Have a working example of a simple LED system operating to explain how arduino works.

**RESOURCES**

<table>
<thead>
<tr>
<th>Computers</th>
<th>Photo resistor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartboard or projector</td>
<td>Resistors</td>
</tr>
<tr>
<td>PowerPoint</td>
<td>Pin Wiring</td>
</tr>
<tr>
<td>Arduino Uno</td>
<td>Breadboards</td>
</tr>
<tr>
<td>Various other arduino modules</td>
<td></td>
</tr>
</tbody>
</table>

**PROCESS**

- Students will be introduced to the topic they will participate in the following 9 weeks by watching a working model of the train track being used and safety systems operating autonomously. – 10 minutes
- They will then be given a 8 week plan of the expected timeline – 5 minutes
- Students will then be introduced to Arduino and briefed on how the boards operate and function with other input and output components. This will be completed by using a simple LED light and showing the coding to operate it, mensioning features such as outputs and input, how the arduino is the brain of the system and how DC power needs to be a completed circuit. – 15 minutes
- Students are then given the remainder of the lesson to research and extend their understanding of Arduino and ask questions to the teacher. Giving students key words to google and suggested YouTube videos.
- Student debrief at the end of the lesson – 5 minutes
<table>
<thead>
<tr>
<th>Lesson Plan 2</th>
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</thead>
<tbody>
<tr>
<td><strong>CONTEXTUAL DETAILS</strong></td>
</tr>
<tr>
<td>Year Level: 9</td>
</tr>
<tr>
<td>No. of Students: 26</td>
</tr>
<tr>
<td>Location: Classroom</td>
</tr>
<tr>
<td>Lesson: 2 – Looking at DPTI</td>
</tr>
<tr>
<td>Estimated Duration of Activity: 45 mins</td>
</tr>
<tr>
<td><strong>AREA OF LEARNING:</strong> Technologies.</td>
</tr>
<tr>
<td><strong>BAND:</strong> Digital Technologies</td>
</tr>
<tr>
<td><strong>TOPIC:</strong> Safe Transportation in the Adelaide Railway Network</td>
</tr>
<tr>
<td><strong>BROAD OUTCOME</strong></td>
</tr>
<tr>
<td>For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.</td>
</tr>
<tr>
<td><strong>SPECIFIC LEARNING OUTCOME/S</strong></td>
</tr>
<tr>
<td>Students will research DPTI and gain an understanding of their role within the Adelaide Rail Network</td>
</tr>
<tr>
<td><strong>Design Technologies</strong></td>
</tr>
<tr>
<td>● Define and decompose real-world problems precisely, taking into account functional and non-functional requirements and including interviewing stakeholders to identify needs (ACTDIP038)</td>
</tr>
<tr>
<td><strong>PREPARATION / ORGANISATION</strong></td>
</tr>
<tr>
<td>Research DPTI and Adelaide Metro</td>
</tr>
<tr>
<td>Compile information into PowerPoint</td>
</tr>
<tr>
<td>Create summary sheet for digital handout to students</td>
</tr>
<tr>
<td>Check room has functioning smartboard/projector</td>
</tr>
<tr>
<td><strong>RESOURCES</strong></td>
</tr>
<tr>
<td>Teacher</td>
</tr>
<tr>
<td>Laptop/Computer</td>
</tr>
<tr>
<td>Smartboard or projector</td>
</tr>
<tr>
<td>Intro PowerPoint</td>
</tr>
<tr>
<td>Internet</td>
</tr>
<tr>
<td>Students</td>
</tr>
<tr>
<td>Laptops</td>
</tr>
<tr>
<td><strong>PROCESS</strong></td>
</tr>
<tr>
<td>Students will sit at their desks, with their devices away. Mark the roll. – 5 minutes</td>
</tr>
<tr>
<td>Teacher will present the PowerPoint on the course introduction. Ensure to read the room, clarifying any queries as the presentation is shown. Students will take notes as necessary. – 20 minutes</td>
</tr>
<tr>
<td>Students will then research DTPI’s website, and record three facts about the department into their activity book. – 15 minutes</td>
</tr>
<tr>
<td>If time permitting, lead a class discussion about what safety measures they think are present in a train station crossing.</td>
</tr>
<tr>
<td>Advise students about the next lesson’s excursion to DPTI before they leave. – 5 minutes</td>
</tr>
</tbody>
</table>
## Lesson Plan 3-4

### CONTEXTUAL DETAILS
- **Year Level:** 9
- **No. of Students:** 26
- **Location:** Classroom
- **Lesson:** 3 + 4 – Excursion to DPTI
- **Estimated Duration of Activity:** 90 mins

### AREA OF LEARNING:
- Technologies.

### BAND:
- Digital Technologies

### TOPIC:
- Safe Transportation in the Adelaide Railway Network

### BROAD OUTCOME
For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

### SPECIFIC LEARNING OUTCOME/S
For students to visit DPTI and gain more of a general insight to their role in public transport in Adelaide

#### Design Technologies
- Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)
- Coding separate modules that perform discrete functions but collectively meet the needs of the solution
- Defining classes that represent the attributes and behaviour of objects in the real world or in a game
- Considering different algorithms and selecting the most appropriate based on the type of problem, for example choosing appropriate algorithms for particular problems
- Selecting different types of data structures such as an array, record and object to model structured data

#### PREPARATION / ORGANISATION
- Have a bus booked ready for students to leave ASAP.
- First aid kit.
- Ensure DPTI are prepared for our visit.

#### RESOURCES
- Students are to have some kind or recording device ie pen and paper

#### PROCESS
- Students will board the bus and travel to Norwood to visit Steve. (15mins)
- From here Steve will provide students with a tour of the building and also present his PowerPoint presentation on the Adelaide Railway system. (60mins)
- Student will catch the bus back to school while teacher leads a discussion of what everyone learned (15mins)
## Lesson Plan 5

### Contextual Details

<table>
<thead>
<tr>
<th>Year Level: 9</th>
<th>Lesson: 5 TinkerCad Coding</th>
</tr>
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<tbody>
<tr>
<td>No. of Students: 26</td>
<td>Estimated Duration of Activity: 45 mins</td>
</tr>
<tr>
<td>Location: Classroom</td>
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</tr>
</tbody>
</table>

### Area of Learning:

- **Band:** Digital Technologies
- **Topic:** Safe Transportation in the Adelaide Railway Network

### Broad Outcome

For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

### Specific Learning Outcome/S

For student to start gaining and understanding of the code, and how an Arduino is coded.

### ACARA Links

**Design Technologies**

Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)

- coding separate modules that perform discrete functions but collectively meet the needs of the solution
- defining classes that represent the attributes and behaviour of objects in the real world or in a game
- considering different algorithms and selecting the most appropriate based on the type of problem, for example choosing appropriate algorithms for particular problems
- selecting different types of data structures such as an array, record and object to model structured data

### Preparation / Organisation

- Have a PowerPoint which shows how Arduino code works.
- Have an Arduino Program open and ready to go with notes on pins and programming etc…
- Also have some copies of wiring diagrams

### Resources

- Computers for each student and teacher
- Smartboard or projector
- PowerPoint
- Copy of code to use

### Process

- Have students sit down at their desks, mark the roll – 5 minutes
- Run though the students on how to Code with an Arduino as a walkthrough (have notes on pins and a copy of the code etc…) – 10 minutes
- Have students open TinkerCad and create an account – 10 minutes
- The students should then try and recreate the code which you have shown them (leave the code on the board, if they start to struggle) – 15 minutes
- After they finish they should then discuss with the person next to them how the code works and if they don’t understand something refer to the teacher. – 5 minutes
- Encourage them to start changing the values so they gather a deeper knowledge of the code.
## Lesson Plan 6

<table>
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<th>CONTEXTUAL DETAILS</th>
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<tr>
<td>Year Level: 9</td>
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<tr>
<td>No. of Students: 26</td>
</tr>
<tr>
<td>Location: Classroom</td>
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</table>

| AREA OF LEARNING: Technologies. |
| BAND: Digital Technologies |
| TOPIC: Safe Transportation in the Adelaide Railway Network |

<table>
<thead>
<tr>
<th>BROAD OUTCOME</th>
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<tbody>
<tr>
<td>For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIFIC LEARNING OUTCOME/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>For students to learn how to code a photoresistor in Tinkercad</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACARA LINKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Technologies</td>
</tr>
<tr>
<td>Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)</td>
</tr>
</tbody>
</table>
  - coding separate modules that perform discrete functions but collectively meet the needs of the solution |
  - defining classes that represent the attributes and behaviour of objects in the real world or in a game |
  - considering different algorithms and selecting the most appropriate based on the type of problem, for example choosing appropriate algorithms for particular problems |
  - selecting different types of data structures such as an array, record and object to model structured data |

<table>
<thead>
<tr>
<th>PREPARATION / ORGANISATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have a PowerPoint to do a quick refresher on last lesson, example code etc. Last slide of the PowerPoint will be what they need for this lesson(with pictures) and task.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RESOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers for each student and teacher</td>
</tr>
<tr>
<td>Smartboard or projector</td>
</tr>
<tr>
<td>PowerPoint</td>
</tr>
<tr>
<td>Copy of code to use</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have the students come in and sit down at their desks away from the computers</td>
</tr>
<tr>
<td>Quickly go over the PowerPoint emphasising the code which was used last lesson and how it worked, and give a few pointers on where things might go in the code if they start to use sensors.</td>
</tr>
<tr>
<td>Get the students to move towards their computers and get them to open Tinkercad</td>
</tr>
<tr>
<td>Get the Students to copy the layout of the Arduino board setup from the PowerPoint and use that to start programing in Tinkercad (show resistors and the breadboard)</td>
</tr>
<tr>
<td>From here students should be able to build off what they learned, if they have trouble with this direct them to the website below to see the code, <a href="https://www.instructables.com/id/How-to-use-a-photoresistor-or-photocell-Arduino-Tu/">https://www.instructables.com/id/How-to-use-a-photoresistor-or-photocell-Arduino-Tu/</a></td>
</tr>
</tbody>
</table>
- During the lesson, once they start to understand how the photoresistor works, start to highlight the importance of using maths to get the correct timing in the code, and the correct brightness level, and get them to play around with adjusting the code.
- With 5 minutes to go in the lesson, get the students to start saving their work so that it will be saved by the end of the lesson.
### Lesson Plan 7-8

#### CONTEXTUAL DETAILS
- **Year Level:** 9
- **No. of Students:** 26
- **Location:** Classroom

Lesson: Lesson 7-8 – Tinkercad Light and Photo resistor task Arduino

Estimated Duration of Activity: 90 mins

#### AREA OF LEARNING:
Technologies.

**BAND:** Digital Technologies

**TOPIC:** Safe Transportation in the Adelaide Railway Network

#### BROAD OUTCOME
For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

#### SPECIFIC LEARNING OUTCOME/S
For students to learn how to setup, use and code with an Arduino and the Arduino software.

#### ACARA LINKS
**Design Technologies**

Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)

- coding separate modules that perform discrete functions but collectively meet the needs of the solution
- defining classes that represent the attributes and behaviour of objects in the real world or in a game
- considering different algorithms and selecting the most appropriate based on the type of problem, such as an array, record and object to model structured data
- selecting different types of data structures such as an array, record and object to model structured data

#### PREPARATION / ORGANISATION
- Arduino kits for the class including all modules.
- Testing station to ensure that components are all working
- Classroom with computers/laptop

#### RESOURCES
- Computers
- Arduino Uno’s
- Male to female wires
- Servos
- Lasers
- Photo resistors
- Sound modules
- Light modules

#### PROCESS
- Students will be given their Arduino Uno’s along with a sufficient amount of wires and modules. – 5 minutes
- Students are to simply recreate their Tinker Cad Models into physical models. – 20 minutes
- Once completed, students will move onto the servo circuit referring to the sample code that they have been given in their booklets. – 20 minutes

Once students have completed all of the modules they need to save all of their code to use for their final project.
## Lesson Plan 9

### CONTEXTUAL DETAILS
- **Year Level:** 9
- **No. of Students:** 26
- **Location:** Classroom

### Lesson: Lesson 9 – Coding catchup/review
- **Estimated Duration of Activity:** 45 mins

### AREA OF LEARNING:
- **Technologies.

### BAND:
- **Digital Technologies

### TOPIC:
- Safe Transportation in the Adelaide Railway Network

### BROAD OUTCOME
- For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

### SPECIFIC LEARNING OUTCOME/S
- For Students to catch up on previous tasks, or extend their learning with TinkerCad

### Design Technologies
- Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)
  - coding separate modules that perform discrete functions but collectively meet the needs of the solution
  - defining classes that represent the attributes and behaviour of objects in the real world or in a game
  - considering different algorithms and selecting the most appropriate based on the type of problem, for example choosing appropriate algorithms for particular problems
  - selecting different types of data structures such as an array, record and object to model structured data

### PREPARATION / ORGANISATION
- Arduino kits for the class including all modules.
- testing station to ensure that components are all working
- Classroom with computers/laptop

### RESOURCES
- Computers
- Arduino Uno’s
- Male to female wires
- Servos
- Lasers
- Photo resistors
- Sound modules
- Light modules

### PROCESS
- Students will be catching up on their work with the assistance of the teacher or working independently on Tinker Cad to extend their learning. Other activities will be allowed such as watching YouTube Videos provided they are on task and the content is relevant.

Make clear that all students at the end of this lesson will be expected to be up to date.
# Lesson Plan 10

## CONTEXTUAL DETAILS
- **Year Level:** 9
- **No. of Students:** 26
- **Location:** Classroom
- **Lesson:** Lesson 10 – Research project
- **Estimated Duration of Activity:** 45 mins

## AREA OF LEARNING:
- Technologies.

## BAND:
- Digital Technologies

## TOPIC:
- Safe Transportation in the Adelaide Railway Network

## BROAD OUTCOME
For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

## SPECIFIC LEARNING OUTCOME/S
Students to extend their knowledge on DPTI, the Adelaide Rail Network and Arduino.

## ACARA LINKS
- **Design Technologies**
  - Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (ACTDEK041)

## PREPARATION / ORGANISATION
- Research DPTI and Adelaide Metro
- Compile information and make a question sheet
- Create an answer sheet for teacher
- Check room has functioning smartboard/projector

## RESOURCES
### Teacher
- Laptop/Computer
- Question Sheet
- Answer Sheet
- Internet

### Students
- Laptops
- Internet

## PROCESS
- Students to sit at a bench with their devices away. Mark the roll and Introduction the lesson – 5 minutes
- Explain the research assignment, constantly refer back to the activity booklet on where relevant content can be found – 20 minutes

Students have the rest of the lesson to work through questions. Enforce the fact that this and the following lesson will be the only allocated class times to do so, the remainder will have to be done for homework.
## Lesson Plan 11-12

<table>
<thead>
<tr>
<th>CONTEXTUAL DETAILS</th>
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<tbody>
<tr>
<td>Year Level: 9</td>
<td>Lesson: Lesson 11-12 – Research project and review of coding basics.</td>
</tr>
<tr>
<td>No. of Students: 26</td>
<td>Estimated Duration of Activity: 90 mins</td>
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<tr>
<td>Location: Classroom</td>
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<td>Digital Technologies</td>
</tr>
<tr>
<td>TOPIC:</td>
<td>Safe Transportation in the Adelaide Railway Network</td>
</tr>
</tbody>
</table>

| BROAD OUTCOME | For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network. |

| SPECIFIC LEARNING OUTCOME/S | For students to continue to gain an insight to Adelaide Rail Network and DPTI |

<table>
<thead>
<tr>
<th>ACARA LINKS</th>
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<tbody>
<tr>
<td></td>
<td>Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (ACTDEK041)</td>
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<table>
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<tr>
<th>PREPARATION / ORGANISATION</th>
<th>Research DPTI and Adelaide Metro</th>
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<tbody>
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<td></td>
<td>Compile information and make a question sheet</td>
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<tr>
<td></td>
<td>Create an answer sheet for teacher</td>
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<td></td>
<td>Check room has functioning smartboard/projector</td>
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<th>Teacher</th>
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<tbody>
<tr>
<td></td>
<td>Laptop/Computer</td>
</tr>
<tr>
<td></td>
<td>Question Sheet</td>
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<tr>
<td></td>
<td>Answer Sheet</td>
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<tr>
<td></td>
<td>Internet</td>
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<table>
<thead>
<tr>
<th></th>
<th>Students</th>
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<tbody>
<tr>
<td></td>
<td>Laptops</td>
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<tr>
<td></td>
<td>Internet</td>
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<table>
<thead>
<tr>
<th>PROCESS</th>
<th>Students to sit at a bench with their devices away. Mark the roll and clarify the lesson outcomes – 5 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students have the rest of the lesson to work through questions. Enforce the fact that this will be the only allocated class time to do so, the remainder will have to be done for homework. Students who finish the research assignment may wish to review their past TinkerCad designs in preparation for the next lesson.</td>
</tr>
</tbody>
</table>
## Lesson Plan 13-15

### CONTEXTUAL DETAILS
- **Year Level:** 9
- **No. of Students:** 26
- **Location:** Classroom
- **Lesson:** Lesson 13-15 – Final TinkerCad and code design
- **Estimated Duration of Activity:** 135 mins

### AREA OF LEARNING:
Technologies.

### BAND:
Digital Technologies

### TOPIC:
Safe Transportation in the Adelaide Railway Network

### BROAD OUTCOME
For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

### SPECIFIC LEARNING OUTCOME/S
Students to build circuit diagrams in TinkerCad for their major project.

### ACARA LINKS
**Design Technologies**
- Design algorithms represented diagrammatically and in structured English and validate algorithms and programs through tracing and test cases (ACTDIP040)
- Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)

### PREPARATION / ORGANISATION
- Create all the TinkerCad diagrams for reference
- Check room has functioning smartboard/projector

### RESOURCES
- **Teacher**
  - Laptop/Computer
  - TinkerCAD
  - Internet
- **Students**
  - Laptops
  - TinkerCAD
  - Internet

### PROCESS
- Students to sit at a bench with their devices away. Mark the roll – 5 minutes
- Using TinkerCAD, students will build their final train models digitally. – 30 minutes
- The final code will then be generated to emulate and test a final model. – 100 minutes

Throughout the coding process, reinforce the resources of multiple component how-to’s in the activity booklet.
**Lesson 16-17**

**CONTEXTUAL DETAILS**

Name: Lesson 16-17  
Year Level: 9  
No. of Students: Whole class  
Location: Classroom  
Estimated Duration of Activity: 90 mins

**AREA OF LEARNING:** Technologies.  
**BAND:** Digital Technologies  
**TOPIC:** Safe Transportation in the Adelaide Railway Network

**BROAD OUTCOME**

For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

**SPECIFIC LEARNING OUTCOME/S**

Students will be introduced to electrical theory and how to solder

**ACARA LINKS**

Design Technologies

Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)

coding separate modules that perform discrete functions but collectively meet the needs of the solution

defining classes that represent the attributes and behaviour of objects in the real world or in a game

considering different algorithms and selecting the most appropriate based on the type of problem, for example choosing appropriate algorithms for particular problems

selecting different types of data structures such as an array, record and object to model structured data

**PREPARATION / ORGANISATION**

The PowerPoint presentation will need to be ready to play.

A classroom with enough soldering kits will also need to be booked and ready to use. A pre-made DC motor with switch to be made.

**RESOURCES**

Smartboard or projector  
Pre-soldered DC motor with switch to use as example to show class  
PowerPoint presentation  
Soldering Kit (enough for 1 kit per person)  
Safety glasses

**PROCESS**

- Explain to students the direction of power followed by what a resistor is (This is best explained using the water theory where:
  - Voltage is amount in Litres  
  - Amperage is pressure  
  - Resistance is size of pipe. (40mins)
  - Teacher then explains the 3 electrical symbols presented in the diagram.
- Then teacher explains to students what a DC motor is and how it works. (10 mins)
- Teacher then performs a demonstration on how to solder including information such as:
  - The temperature of the soldering iron  
  - How solder runs to towards the heat  
  - All safety involved i.e. hair, glasses, sleeves up, extractor always on. (15 mins)
- Will then be given some soldier and wire and have some practice turns at soldiering them together. (25 mins)
<table>
<thead>
<tr>
<th><strong>Lesson Plan 18-19</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONTEXTUAL DETAILS</strong></td>
</tr>
<tr>
<td>Year Level: 9</td>
</tr>
<tr>
<td>No. of Students: 26</td>
</tr>
<tr>
<td>Location: Classroom</td>
</tr>
<tr>
<td>Lesson: Lesson 18-19 – Electronics and soldering</td>
</tr>
<tr>
<td>Estimated Duration of Activity: 90 mins</td>
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</tbody>
</table>

| **AREA OF LEARNING:** Technologies. |
| **BAND:** Digital Technologies |
| **TOPIC:** Safe Transportation in the Adelaide Railway Network |

| **BROAD OUTCOME** |
| For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network. |

| **SPECIFIC LEARNING OUTCOME/S** |
| For students to develop their soldering skills and create a DC circuit. |

| **ACARA LINKS** |
| **Design Technologies** |
| Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041) coding separate modules that perform discrete functions but collectively meet the needs of the solution defining classes that represent the attributes and behaviour of objects in the real world or in a game considering different algorithms and selecting the most appropriate based on the type of problem, for example choosing appropriate algorithms for particular problems selecting different types of data structures such as an array, record and object to model structured data |

| **PREPARATION / ORGANISATION** |
| The PowerPoint presentation will need to be ready to play. |
| A classroom with enough soldering kits will also need to be booked and ready to use. A pre made DC motor with switch to be made. |

| **RESOURCES** |
| Smartboard or projector |
| Pre-soldered DC motor with switch to use as example to show class |
| PowerPoint presentation |
| Soldering Kit (enough for 1 kit per person) |
| Safety glasses |

<p>| <strong>PROCESS</strong> |
| Students sit at their soldering stations, allow them to warm up. Mark Roll while waiting. |
| Everyone to continue practicing soldering until they feel confident. Students will be required to show teacher their soldering skills. |
| Once individually approved, students will be given the remainder of the double to solder their train electronic components together. |
| If students then exceed past this mark they can glue together their train frame components made from 3mm MDF and 3mm Acrylic. |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Year Level: 9</td>
</tr>
<tr>
<td>No. of Students: 26</td>
</tr>
<tr>
<td>Location: Classroom</td>
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<tr>
<td>Lesson: 20-21</td>
</tr>
<tr>
<td>Estimated Duration of Activity: 90 minutes</td>
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<tbody>
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<table>
<thead>
<tr>
<th>SPECIFIC LEARNING OUTCOME/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students learn how to use illustrator and the laser cutter to create their model train.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>ACARA LINKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Technologies</td>
</tr>
<tr>
<td>Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques (ACTDEP036)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PREPARATION / ORGANISATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students to prepare image</td>
</tr>
<tr>
<td>Distribute Maker case file to students</td>
</tr>
<tr>
<td>Create Illustrator tutorial for students</td>
</tr>
<tr>
<td>Cut and prepare 3mm MDF sheets to fit in the laser bed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RESOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers for students and teacher</td>
</tr>
<tr>
<td>Smartboard or Projector</td>
</tr>
<tr>
<td>Adobe Illustrator</td>
</tr>
<tr>
<td>Laser Cutter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get Students seated at tables.</td>
</tr>
<tr>
<td>Walkthrough Illustrator on Projector, while students are following on their own laptops. (20 minutes)</td>
</tr>
<tr>
<td>Laser cut each students train. (30 Minutes)</td>
</tr>
<tr>
<td>Take students to the workshop where they can assemble train. (30 Minutes)</td>
</tr>
<tr>
<td>Insert DC circuit into train. (10 Minutes)</td>
</tr>
</tbody>
</table>
# Lesson Plan 22

**CONTEXTUAL DETAILS**

<table>
<thead>
<tr>
<th>Year Level: 9</th>
<th>Lesson: 22</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Students: 26</td>
<td>Estimated Duration of Activity: 45 minutes</td>
</tr>
<tr>
<td>Location: Classroom</td>
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</tbody>
</table>

**AREA OF LEARNING:** Technologies.  
**BAND:** Digital Technologies  
**TOPIC:** Safe Transportation in the Adelaide Railway Network

**BROAD OUTCOME**

For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

**SPECIFIC LEARNING OUTCOME/S**

Introduce students to Design Folio and give a refresher with Arduino code

**ACARA LINKS**

Design Technologies  

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (ACTDEK041)

**PREPARATION / ORGANISATION**

Design Folio Template Arduino  
refresher PowerPoint

**RESOURCES**

Computers for students and teacher  
Smartboard or Projector  
Design Folio documents and handout

**PROCESS**

- Get Students seated at tables.  
- Refresh students on Arduino Code using PowerPoint (10 minutes)  
- Walkthrough Design Folio template on projector (20 minutes)  
- Split class into pairs for folio and system assessment (5 minutes)  
- Students start working on Folio (10 minutes)
## Lesson Plan 23

### CONTEXTUAL DETAILS
- **Year Level:** 9
- **Lesson:** 23
- **No. of Students:** 26
- **Location:** Classroom
- **Estimated Duration of Activity:** 45 minutes

### AREA OF LEARNING:
- Technologies.

### BAND:
- Digital Technologies

### TOPIC:
- Safe Transportation in the Adelaide Railway Network

### BROAD OUTCOME
For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

### SPECIFIC LEARNING OUTCOME/S
For students to learn one of the sub-systems involved within their Arduino code.

### ACARA LINKS
**Design Technologies**
- Design algorithms represented diagrammatically and in structured English and validate algorithms and programs through tracing and test cases (ACTDIP040)
- Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)
- Plan and manage projects using an iterative and collaborative approach, identifying risks and considering safety and sustainability (ACTDIP044)

**Science**
- Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACISIS166)
- Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

**Mathematics**
- Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

### PREPARATION / ORGANISATION
- Classroom
- Students with laptops
- Projector Screen
- Teacher computer

### RESOURCES
- PowerPoint from Lesson 22 regarding folio
- Code for Light Sub System

### PROCESS
- Get students to sit at their tables, and have the PowerPoint ready to go.
- Quickly recap the folio and make sure that every student understands what they should do. (10 minutes)
- Open Arduino programs and walkthrough the code that they should create for the light sub system. (15 minutes)
- Get students to open their computers and start working on recreating what you have shown them. (20 minutes)
## Lesson 24-25

### CONTEXTUAL DETAILS
- **Year Level:** 9
- **No. of Students:** 26
- **Location:** Classroom
- **Estimated Duration of Activity:** 90 minutes

### AREA OF LEARNING:
- **Band:** Digital Technologies
- **Topic:** Safe Transportation in the Adelaide Railway Network

### BROAD OUTCOME
For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

### SPECIFIC LEARNING OUTCOME/S
For students to continue to develop their first sub-system

### ACARA LINKS
**Design Technologies**
- Design algorithms represented diagrammatically and in structured English and validate algorithms and programs through tracing and test cases (ACTDIP040)
- Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)
- Plan and manage projects using an iterative and collaborative approach, identifying risks and considering safety and sustainability (ACTDIP044)

**Science**
- Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACSIS166)
- Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

**Mathematics**
- Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

### PREPARATION / ORGANISATION
- **Classroom**
- Students with laptops
- Projector Screen
- Teacher computer

### RESOURCES
- Code for Light Sub System

### PROCESS
- Students are to keep working on developing the flashing lights subsystem
<table>
<thead>
<tr>
<th>CONTEXTUAL DETAILS</th>
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<tbody>
<tr>
<td>Year Level: 9</td>
<td>Lesson: 26-35</td>
</tr>
<tr>
<td>No. of Students: 26</td>
<td>Estimated Duration of Activity: 6 ½ hours</td>
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<tr>
<td>Location: Classroom</td>
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<tbody>
<tr>
<td>For students to continue working on all the sub-systems and design folio</td>
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</tr>
</tbody>
</table>

**Design Technologies**
- Design algorithms represented diagrammatically and in structured English and validate algorithms and programs through tracing and test cases (ACTDIP040)
- Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)
- Plan and manage projects using an iterative and collaborative approach, identifying risks and considering safety and sustainability (ACTDIP044)

**Science**
- Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACYSIS166)
- Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

**Mathematics**
- Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

<table>
<thead>
<tr>
<th>PREPARATION / ORGANISATION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom</td>
<td></td>
</tr>
<tr>
<td>Students with laptops</td>
<td></td>
</tr>
<tr>
<td>Projector Screen</td>
<td></td>
</tr>
<tr>
<td>Teacher computer</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RESOURCES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Code for all sub systems</td>
<td></td>
</tr>
<tr>
<td>Folio template</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROCESS</th>
<th></th>
</tr>
</thead>
</table>
- Students can now work on all their sub-systems and folio (up to their discretion and self-management). |
## Lesson Plan 36-37

### CONTEXTUAL DETAILS
- **Year Level:** 9
- **No. of Students:** 26
- **Location:** Classroom

- **Lesson:** 36-37
- **Estimated Duration of Activity:** 90 minutes

### AREA OF LEARNING:
- Technologies.

### BAND:
- Digital Technologies

### TOPIC:
- Safe Transportation in the Adelaide Railway Network

### BROAD OUTCOME
- For students to gain an understanding of the automated safety systems which occur within the Adelaide Railway Network.

### SPECIFIC LEARNING OUTCOME/S
- For students to present their project to the teacher and hand up all their relevant work.

### ACARA LINKS

**Design Technologies**
- Analyse and visualise data to create information and address complex problems, and model processes, entities and their relationships using structured data (ACTDIP037)
- Investigate the role of hardware and software in managing, controlling and securing the movement of and access to data in networked digital systems (ACTDIK034)
- Plan and manage projects using an iterative and collaborative approach, identifying risks and considering safety and sustainability (ACTDIP044)
- Design algorithms represented diagrammatically and in structured English and validate algorithms and programs through tracing and test cases (ACTDIP040)

**Science**
- Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)
- Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems (ACISIS172)

**Mathematics**
- Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

### PREPARATION / ORGANISATION
- **Classroom**
- **Working Model for students to upload code to (allow connection to laptop)**
- **Assessment rubrics to mark against for presentation**
- **Create a digital submission for folio**

### RESOURCES
- Code for all sub systems
- Folio template

### PROCESS
- Get the class to sit down at their desks. (5 minutes)
- Explain how the presentations will work. (5 minutes)
- Call up the first group to present to the teacher (where the working model will be), while the groups are presenting students can be working on their activity booklets to make sure they are all completed. (80 minutes)
- Each presentation is 5 minutes.
- After each presentation make sure folio is submitted into the digital submission folder.
- Collect activity booklets at end of lesson for assessment. (5 minutes)
TEACHING FOR TOMORROW

Teacher Resources

In collaboration with

University of South Australia

Government of South Australia
Department of Planning, Transport and Infrastructure
PowerPoint Lesson 2

KEY POINTS FROM THE VIDEO

- Community focus
- Constantly improving how we move around South Australia
- Road and rail upgrades to improve commercial movement of freight
- Planning for efficiency
- Constantly updating and upgrading public transport for the future
- Safety improvements to preserve life
- Freight, Public Transport, Transport, Safety, Growth and Community

DPTI

Values
- Collaboration
- Honesty
- Excellence
- Enjoyment
- Respect

Approach
- Listen
- Partner
- Innovate

Customer Service Principles
- Listen and Engage
- Integrate and Empower
- Simplify and Be Open
- Partner and Perform
Areas/services of DPTI
- Planning & Land Use Services, Policy
- Strategy and Program Development
- Road and Marine Services
- Across Government Services
- Transport Project Delivery
- People and Corporate Services

And:
- Public Transport Services
  Adelaide Metro, under DPTI, provides bus, tram and train service to Adelaide.

Adelaide Metro Facts
- 89 railway stations
- 125.9km of rail
- 6 railway lines: Belair, Gawler, Grange, Outer Harbor, Seaford, and Tonsley.

- [Adelaide rail network map](https://www.transport.sa.gov.au/)
**Arduino Code Overview**

```c
// the setup function runs once when you pass reset or power the board
void setup() {  
  // Initialize digital pin LED_BUILTIN as an output
  pinMode(LED_BUILTIN, OUTPUT);
}
```

```c
// the loop function runs over and over again forever
void loop() {  
  digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(2000); // wait for a second
  digitalWrite(LED_BUILTIN, LOW);  // turn the LED off by making the voltage low
  delay(2000); // wait for a second
}
```

**Breakdown of Code - Setup**

```c
// the setup function runs once when you pass reset or power the board
void setup() {  
  // Initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}
```

- The setup function runs only once when the Arduino enters the program. The pins are defined by using the `pinMode` command, and some pins are defined as either input or output by setting the `PORT_DIR`.
- It is important to use `void` to specify the start and end of the coding process. This can be seen above.
- It is important to `pinMode` to define what the pins do.
- From this we can see that the `pinMode` is to be led on LED and set as an output.
Breakdown of Code - Loop

```c
// The loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000); // wait for a second
  digitalWrite(LED_BUILTIN, LOW); // turn the LED off by making the voltage LOW
  delay(1000); // wait for a second
}
```

- pinMode is used to define pins and set as input or output.
- digitalWrite is used to write a high or low output to a pin, as long as that pin is defined as an output.
- delay is measured in milliseconds and is used to delay the next function of the code as seen above.

Useful tips:

- Remember the brackets {} ()
- Use pinMode to define pins and set as an input/output.
- digitalWrite is a command which is used to write a high or low output to a pin, as long as that pin is defined as an output.
- delay is measured in milliseconds and is used to delay the next function of the code.
Your task is to create a code which will turn the led on when it is dark and turn it off once it becomes light.
In Void Loop define value using the following:

```
const int photoresistor = 0;  
const int led = 9;  
```

Use the value above Void Setup to define the value of the photoresistor.

Set the photoresistor as an input.

In Void Loop define value using the following:

```
value = analogRead(photoresistor);  
```

Lower the photoresistor's brightness by adding the following:

```
brightness = 30;  
```

If the value is higher, then decrease the brightness. If the value is lower, then decrease the brightness.
**What is an Arduino?**

Open Source electronic prototyping platform based on flexible easy to use hardware and software.

---

**Bare minimum code**

```c
void setup() {  
  // put your setup code here, to run once:
}
void loop() {  
  //putyourmaincodehere, to run repeatedly:
}
```

**What is an Arduino?**

Open Source electronic prototyping platform based on flexible easy to use hardware and software.

---

**Bare minimum code**

```c
void setup() {  
  // It is called only when the Arduino is powered on or reset. It is used to initialise variables and pin modes
}
void loop() {  
  // The loop functions runs continuously till the device is powered off. The main logic of the code goes here. Similar to while (1) for micro-controller programming.
```

---
PinMode

- A pin on Arduino can be set as input or output by using pinMode function.
- pinMode(13, OUTPUT);  // sets pin 13 as output pin
- pinMode(13, INPUT);  // sets pin 13 as input pin

Reading/writing digital values

- digitalWrite(13, LOW);  // Makes the output voltage on pin 13, 0V
- digitalWrite(13, HIGH);  // Makes the output voltage on pin 13, 5V
- int buttonState = digitalRead(2);  // reads the value of pin 2 in buttonState

ADC in Arduino Uno

ADC in Arduino

- The Arduino Uno board contains 6 pins for ADC
- 10-bit analog to digital converter
- This means that it will map input voltages between 0 and 5 volts into integer values between 0 and 1023
Reading/Writing Analog Values

```c
analogRead(A0); // used to read the analog value from the pin A0

analogWrite(2, 128);
```

ADC Example

```c
// These must be connected to ground. They're used to give hysteresis to the analogPin's. e.g., if analogPin's output is above or below the analogPin's voltage range, it will be delayed in switching to another channel.
// Example:
// 1. Turn on the analogPin's output at channel 1 (A0)
// 2. Switch to channel 2 (A1)
// 3. Switch to channel 3 (A2)
// 4. Switch to channel 4 (A3)

// AnalogWrite arguments are in range 0-255
```

---

Page 39 of 58
Public transport by train has advanced rapidly in Adelaide since its induction in 1856. It now has a multitude of automated systems and technology that have been programmed to allow the trains to run with minimal human input.

Your task is to code an Arduino level crossing system that will allow a DC powered train to pass safely through the crossing. The crossing contains 4 subsystems that need to be coded to operate simultaneously.

The systems include:
- Buzzer (warning bell), LEDs (warning light), servo (boom gate) and 2 lasers with 2 photoresistor sensors (pressure sensors) which act as the trigger for the rest of the systems.
- These are to be made and coded individually in and then combined and coded. Run in Tinkercad before doing the real product.

When making your combined systems circuit, in Tinkercad and physically, you MUST use these pins on the Arduino:
**GENERATE**

- Identify new ideas
- Develop new products
- Conduct market research
- Analyze data
- Brainstorm

**PRODUCE**

- Create prototypes
- Develop design concepts
- Define project scope
- Establish deadlines
- Allocate resources

**EVALUATE**

- Evaluate prototypes
- Conduct user testing
- Analyze feedback
- Make changes
- Adjust design

**DATE DUE:**
Public Transport and Automated Safety Systems - Research Assignment

Due: 
Mark: /20

The Department of Planning, Transport and Infrastructure (DPTI) is a large and complex government organisation. They are responsible for, but not limited to, road and rail in South Australia.

Use the links provided, and the PowerPoint presentation from Week 1, to conduct research and answer the following questions to gain a better understanding of the DPTI, the Adelaide Metro rail network and Arduino.


DPTI

1. **What title does the head of the DPTI have?**
   
   Chief Executive.

2. **What are the 7 areas/services DPTI are responsible for?**

   Planning & Land Use Services,
   
   Policy, Strategy and Program Development, Road and Marine Services,
   
   Public Transport Services,
   
   Across Government Services,
   
   Transport Project Delivery,
   
   People and Corporate Services.

3. **What are the 4 social media accounts held by DPTI?**

   Facebook
   
   Twitter
   
   LinkedIn
   
   YouTube
4. **What are the 4 customer service principles at DPTI?**

Listen and Engage
Integrate and
Empower Simplify
and Be Open
Partner and
Perform

5. **What are DPTI's values?**

Collaboration
Honesty
Excellence
Enjoyment
Respect

6. **What is DPTI's approach?**

Listen
Partner
Innovate

**Adelaide Metro**

7. **Where does Adelaide Metro service?**

Adelaide Metro provides public transport services around metropolitan Adelaide. They do not provide interstate or regional services.

8. **What is the name of Adelaide Metro's app?**

metroMATE

9. **What 3 transport services does Adelaide Metro provide?**

Bus, train, tram.

10. **How many train stations are operated by Adelaide Metro?**

89
11. How many railway lines are there in Adelaide and what are their names?
6 lines. Belair, Gawler, Grange, Outer Harbor, Seaford and Tonsley.

12. If you were to catch a Citybound train at Lynton Railway Station, what would be the next stop?
Torrens Park Railway Station

13. What foundation does DPTI and Adelaide Metro support?
TrackSAFE Foundation

14. How many kilometres of rail in Adelaide?
125.9km

15. Who were the original starters of Arduino?
Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino and David Mellis.

16. When was the first Arduino board introduced?
2005.

17. What are some of the innovative ways Arduino is being used? (name 3)
Music, games, toys, smart homes, farming, autonomous vehicles etc.

18. Why was Arduino initially created?
To help design students who had no previous experience in electronics or microcontroller programming, to create working prototypes connecting the physical world to the digital world.

19. What is Arduino’s market value estimated to be by 2021?
$6 trillion.

20. Name an Arduino microcontroller?
Uno, Mega, Leonardo, Due
Laser Diode Module

The laser diode module brings a controllable laser to your Duinotech Main Board. The laser can be driven directly from a Duinotech IO pin. As with all lasers, be careful that the laser is not aimed in anyone’s eyes.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Main Board</th>
<th>Function</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>D13</td>
<td>5V supply</td>
<td>Put 5V on this pin to turn the module on</td>
</tr>
<tr>
<td>-</td>
<td>GND</td>
<td>Ground connection</td>
<td>Ground connection</td>
</tr>
</tbody>
</table>

In the above example, S is connected to pin 13 on the Duinotech Main Board and – is connected to GND, and the ‘Blink’ sketch is uploaded from the Arduino IDE (from Examples/Basics under the file menu). This blinks the laser on and off.

Sample Code:

/*
 * Blink
 * Turns on an LED on for one second, then off for one second, repeatedly.
 *
 * Most Arduinos have an on-board LED you can control. On the Uno and Leonardo, it is attached to digital pin 13. If you’re unsure what pin the on-board LED is connected to on your Arduino model, check the documentation at http://arduino.cc

 * This example code is in the public domain. Modified 8 May 2014 by Scott Fitzgerald
 */

// the setup function runs once when you press reset or power the board
void setup()
{
  // initialize digital pin 13 as output. pinMode(13, OUTPUT);
}

// the loop function runs over and over again forever
void loop()
{
  digitalWrite(13, HIGH);  // turn the LED on (HIGH is the voltage level)
  delay(1000);  // wait for a second
  digitalWrite(13, LOW);  // turn the LED off by making the voltage LOW
  delay(1000);  // wait for a second
}
digitalWrite(13, HIGH);  // turn the LED on (HIGH is the voltage level)  
delay(1000);  // wait for a second  
digitalWrite(13, LOW);  // turn the LED off by making the voltage LOW  
delay(1000);  // wait for a second  
}
Project 6: Photocell sensor

Introduction:
Photocell is commonly seen in our daily life and is mainly used in intelligent switch, also in common electronic design. To make it easier and more effective, we supply corresponding modules.
Photocell is a semiconductor. It has features of high sensitivity, quick response, spectral characteristic, and R-value consistence, maintaining high stability and reliability in environment extremes such as high temperature, high humidity. It’s widely used in automatic control switch fields like cameras, garden solar lights, lawn lamps, money detectors, quartz clocks, music cups, gift boxes, mini night lights, sound and light control switches, etc.

Specification:
Interface type: analog
Working voltage: 5V
Size: 30*20mm
Weight: 3g

Connection Diagram:
Sample Code

```c
int sensorPin = A0; int value = 0;
void setup()
{
  Serial.begin(9600); } void
loop()
{
  value =
  analogRead(sensorPin);
  Serial.println(value, DEC);
  delay(50); }
```
Code for Flashing Lights

```c
int light1 = 9; // Defining that light 1 is coming from port 9
int light2 = 10; // Defining that light 2 is coming from port 10

void setup()
{
  pinMode(9, OUTPUT); // Declaring that light 1 is an output
  pinMode(10, OUTPUT); // Declaring that light 2 is an output
}

void loop() // this section repeats itself non stop
{
  digitalWrite(light1, HIGH); // turn on light 1
  digitalWrite(light2, LOW); // turn off light 2
  delay(500); // wait 50ms
  digitalWrite(light1, LOW); // turn off light 1
  digitalWrite(light2, HIGH); // turn on light 2
  delay(500); // wait 50ms
}
```
Passive Buzzer module

Introduction:
We can use Arduino to make many interactive works of which the most commonly used is acoustic-optic display. All the previous experiment has something to do with LED. However, the circuit in this experiment can produce sound. Normally, the experiment is done with a buzzer or a speaker while buzzer is simpler and easier to use. The buzzer we introduced here is a passive buzzer. It cannot be actuated by itself, but by external pulse frequencies. Different frequencies produce different sounds. We can use Arduino to code the melody of a song, which is actually quite fun and simple.

Specification:
Working voltage: 3.3-5v
Interface type: digital
Size: 30*20mm Weight: 4g
Connection Diagram:
Sample Code

```c
int buzzer=8; // set digital IO pin of the buzzer

void setup()
{
  pinMode(buzzer,OUTPUT); // set digital IO pin pattern, OUTPUT to be output
}

void loop()
{
  unsigned char i,j; // define variable
  while(1)
  {
    for(i=0;i<80;i++) // output a frequency sound
      {
        digitalWrite(buzzer,HIGH); // sound
        delay(1); // delay 1ms
        digitalWrite(buzzer,LOW); // not sound
        delay(1); // ms delay
      }
    for(i=0;i<100;i++) // output a frequency sound
      {
        digitalWrite(buzzer,HIGH); // sound
        digitalWrite(buzzer,LOW); // not sound
      }
  }
```

```
Buzzer and 2 lights in sync running with photo resistor.

Note: Code is exactly the same for individual components, just need to delete the code for the component not being used.

```c
int sensorValueIn = 0;
int sensorValueOut = 0;
int light1 = 9;
int light2 = 10; int In = 0;
int buzzer = 11;

void setup()
{
  pinMode(A0, INPUT);
  pinMode(A1, INPUT);
  Serial.begin(9600);

  pinMode(9, OUTPUT);
  pinMode(10, OUTPUT);
  pinMode(11, OUTPUT);
}

void loop()
{
  // read the value from the sensor sensorValueIn = analogRead(A0);
  sensorValueOut = analogRead(A1);
  // print the sensor reading so you know its range
  Serial.println(sensorValueIn);
  Serial.println(sensorValueOut);
  Serial.println(In);
  if (sensorValueIn < 300) { In = 1;
    Serial.println("In"); delay (100);
  }

  if (sensorValueOut < 300) {
    In = 0;
    Serial.println("Out");
    delay(100); In == 0;
}
```
if (In == 1) { Serial.println("Train In"); digitalWrite(light1, HIGH);
    digitalWrite(light2, LOW); tone(buzzer, 2000); delay(500);
    digitalWrite(light1, LOW); digitalWrite(light2, HIGH);
    noTone(buzzer); delay(500); } }
LED Light Module

Introduction:
This LED light module has a shiny color, ideal for Arduino starters. It can be easily connected to IO/Sensor shield.

Specification:
Type: Digital
PH2.54 socket
White LED light module
Enables interaction with light-related works
Size: 30*20mm
Weight: 3g

Connection Diagram:
Sample Code

```c
int led = 3; void
setup()
{
    pinMode(led, OUTPUT); //Set Pin3 as output
}
void loop()
{
    digitalWrite(led, HIGH);  //Turn
    on led delay(2000);
    digitalWrite(led, LOW); //Turn off led
    delay(2000);
}
```
Servo motors have three wires: power, ground, and signal. The power wire is typically red, and should be connected to the 5V pin on the Arduino or Genuino board. The ground wire is typically black or brown and should be connected to a ground pin on the board. The signal pin is typically yellow, orange or white and should be connected to pin 9 on the board.

Sample Code 1
/* Sweep */

#include <Servo.h>

Servo myservo; // create servo object to control a servo
// twelve servo objects can be created on most boards

int pos = 0; // variable to store the servo position

void setup() {
  myservo.attach(9); // attaches the servo on pin 9 to the servo object
void loop() {
    for (pos = 0; pos <= 180; pos += 1) {
        // goes from 0 degrees to 180 degrees
        // in steps of 1 degree
        myservo.write(pos); // tell servo to go to position in variable 'pos'
        delay(15); // waits 15ms for the servo to reach the position
    }
    for (pos = 180; pos >= 0; pos -= 1) {
        // goes from 180 degrees to 0 degrees
        myservo.write(pos); // tell servo to go to position in variable 'pos'
        delay(15); // waits 15ms for the servo to reach the position
    }
}
}
Sample Code 2

```c
#include <Servo.h>

Servo servo;

int ldr1PinA0 = A4; // Open Boom
int ldr2PinA1 = A5; // Close Boom
const int servoPin = 8; // Servo/Boom
int ldr1ValueA0 = 0; // Open Boom
int ldr2ValueA1 = 0; // Close Boom

void setup() {
  Serial.begin(9600);
  servo.attach(8); //8
  servo.write(0);
  delay(2000);
}

void loop() {
  int ldr1Status = analogRead(ldr1PinA0); if
  (ldr1Status <= 300) {
    servo.write(0);
    delay(1000);
    Serial.println("Servo Closed");
  }

  else {
    int ldr2Status = analogRead(ldr2PinA1); if
    (ldr2Status <= 300) {
      servo.write(100); delay(1000);
      Serial.println("Servo open");
    }
  }
}```