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| **Title**  | **Programming in Theater** |
| **Introduction**  | Technology in theater began as early as theater.  Outside performances were common before the advent of indoor lighting using gas in the late 1700s.  With the invention of the incandescent lamp in 1879, almost all theaters used electric lighting by 1900.  Technology has been incorporated into all aspects of theater, including sets, props, and costumes.  Integration of technology into theater is the next generation of theater; a panel was conducted at the 2015 San Diego Comic-Con.  The panel focused on integration of technology for costuming in television and film. (<http://comiccon2015.sched.org/event/5345ff7a5915d39e101d2405d5817114?iframe=no&w=&sidebar=no&bg=no#.Vae5GvlViko>).  Professional theaters have used technology to create phenomenal costumes (<http://www.bryanbatt.com/images/LumiereTheatre-medium.jpg>).  Individuals are creating costumes for conventions and Halloween which utilize technology.<http://www.popularmechanics.com/technology/design/g209/13-high-tech-diy-halloween-costumes/?slide=13><http://glowyzoey.com/>It is time to integrate technology into costuming and props at the high school level. |
| **Real Science Application**  | The basic programming learned in the lesson will translate into many other disciplines. The C program is the most prevalent used programming language. It is used in system programming and almost all modern programming languages use it as their base. Students could apply C to multiple languages, such as C++, C#, and JavaScript. Programming is used in telecommunications, database constructions, networking, software design, and engineering. |

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| **Curriculum Alignment**  |

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| Content Area | Grade Level | North Carolina Essential Standards | Next Generation Science Standards  |
| Theater Arts | 11-12 | AE.1.1 Use technical knowledge and design skills to formulate designs.  | ETS1.COPTIMIZING THE DESIGN SOLUTION*How can the various proposed design solutions be compared and improved?* |
| Theater Arts | 11-12 | AE.1.2Use the major technical elements, such as sound, lights, set, and costumes, for formal or informal audiences. | ETS1.COPTIMIZING THE DESIGN SOLUTION*How can the various proposed design solutions be compared and improved?* |
| Apparel | 11-12 | FA32 1.02 Understand technical design and textile science.   | ETS1.COPTIMIZING THE DESIGN SOLUTION*How can the various proposed design solutions be compared and improved?* |

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| **Learning Outcomes**  | * Students will understand basic programming (turn lights on/off, blink, and change colors; create tones; and use sensors to drive lights).
* Students will learn sewing skills (hem, apply Velcro, seams, remove seams, use a sewing machine)
* Students will use the engineering design process to create unique costume and/or prop pieces.
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| **Time Required and Location**  | This lesson will require 6 days of 90 minute classes.Day 1:Introduce project, including engineering design process, programming, and construction. [45 minutes] Use engineering design process to create a unique costume piece or prop, teacher should circulate to answer student questions and provide feedback [45 minutes]Day 2:Programming [90 minutes]Day 3:Programming/Construction [90 minutes]Day 4: Construction [90 minutes]Day 5:Troubleshooting [90 minutes]Day 6:Peer Review [30 minutes]Final Revision [60 minutes]Submit by the end of the class period.    |

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| **Materials Needed**  | Teacher List* Presentations
	+ Engineering Design Process (Appendix A)
	+ Introduction to Programming (Appendix B)
	+ Technology in Costuming and Props (Appendix C)
* Fabric(multiple styles and lengths, remnants are fine)
* Sewing machine
* Velcro
* Buttons
* Thread (multiple colors)
* LilyPad Arduino Kits (1 per project)
* Access to computers with Arduino software

Student List* Notebook
* Pencil
* Ruler
* Creativity
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| **Safety**  | Teachers should be aware of understood risks while sewing. Needles are involved and should be used with caution. Sewing machines have the ability to damage fingers and should also be used with caution. |
| **Participant Prior Knowledge**  | This project is designed as a capstone project in an upper level theater arts class. Students should be familiar with all aspects of technical theater and understand its importance to performances. |
| **Facilitator Preparations**  | * Become familiar with Arduino programming. Have sample programs available to students for reference and use in the programming for the project.
* If necessary, reserve computers for this lesson.
* Become familiar with the operation of a sewing machine to facilitate student learning and ability to help students problem solve.
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| **Activities**  | Day 1:Direct the students to begin class by privately writing down the most memorable costume and or prop they have ever seen.  [5 minutes]Open class discussion by asking the students to describe their memorable piece.Toss a beach ball into the class and have students share their thinking after they have caught the ball.  Write down their responses on a surface that the whole class can see. [5 minutes]Ask the class what commonalities are found in their memorable pieces.  How do the students think the pieces could be made more impactful?  [5 minutes]Present introduction presentations to the students, which includes engineering design process, programming, and project instructions [30 minutes]Students should create a concept for a piece using the engineering design process.  Students should be encourage to collaborate with classmates, create sketches, and ask questions.  [45 minutes]Day 2:Log in to computers and open Arduino program. [10 minutes]Show and demonstrate sample programs to students.  Connect Arduino board to the computer using the USB cord.  Demonstrate editing and uploading code to a board.    Allow students to ask questions. [35 minutes]Create program for the piece, utilizing at least 2 different programming types.  For example: lights blink on/off, use sensors to determine light on/off, change LED color, or create tones.  Be sure to circulate to answer student questions. [45 minutes]Day 3:Students will explore workspace, while the teacher is showing the location of needed items, like fabric, machines, and computers. [10 minutes]Students design costume or prop piece using whatever medium they are most comfortable with including pencil and paper sketch, or 3D modeling software. [20 minutes]Students will finish the code needed to run their piece.  Program should be uploaded to the Arduino board. [60 minutes]Goal: Piece is designed, program completed and tested.Day 4:Students will construct piece and test programming. [90 minutes]Goal: Complete any construction and/or programming.  Students should test their piece to ensure it works as planned.  Make any needed adjustments.Day 5:Goal: Complete any construction and/or programming.  Students should test their piece to ensure it works as planned.  Make any needed adjustments. [90 minutes]Day 6:Have students complete a modified gallery walk to demonstrate pieces and receive feedback.  Students should present pieces 5 at a time with the other students visiting each piece, after an allotted time (5 minutes), presenters should change.  Complete walks until all students have presented and received feedback. [30 minutes]After the gallery walk students are to fix any issues that arose during the peer review session.  Students should be prepared to submit their final piece at the end of class. [60 minutes] |
| **Assessment**  | Rubrics will be used for assessing (1) engineering design process (2) programming, (3) construction, and (4) the final piece.Knowledge of the engineering design process, programming, and construction will be assessed by formative assessments (listening to group talk, designs, etc.) and by questions included on quiz (Appendix H).See the following rubrics at end of the unit plan: 1.  Rubric for Engineering Design Process (Appendix D)2.  Rubric for Programming (Appendix E)3.  Rubric for Construction (Appendix F)4.  Rubric for Final Product (Appendix G) |

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| **Critical Vocabulary**  | Costume piece: small part of a costume that adds to the overall designProp piece: small items designed to be carried or held by an actor that add to the designArduino LilyPad: small programmable circuit boardConstraints: limitations of a project which can include materials and power source.Criteria: parameters of a project which can include size and weight. [Sew Electric Glossary](http://sewelectric.org/references/glossary/) |
| **Community Engagement**  | Students could work with the drama department to create costume or prop pieces for current productions.Students could learn about new materials being used and created at NC State’s Textile College through a site visit and hypothesize use in theatre costuming and props.Students could work with local theatre groups, such as Raleigh Little Theatre, to create costume or prop pieces for current productions. |
| **Extension Activities**  | If time allows, larger props and more intricate costumes could be created. |

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| **Modifications**  | Create a small group of students who struggle with comprehension and, particularly, have a limited vocabulary. Guide a read-aloud session, discussing small sections of reading at a time to aid comprehension and talking through decoding of difficult words. If it is not possible to oversee this in this manner, a student assistant could be used. Many classes will have a student proficient in English and another language. Ask these students to volunteer as translators for English language learners. This is especially helpful in lab situations.Ask students who understand the concepts and technology to act as class experts. They can help struggling students, explain concepts in another way, and help with programming and construction. This can be a great way to involve AIG students. Provide simple programs students can use to build their needed piece. This will save time if students are struggling with programming. An example of a sample program can be found in Appendix I; it includes coding necessary to make the light sensor turn on and off the lights, changes the LED color due to temperature change, plays the beginning of Beethoven’s 5th using different frequencies when a button is pushed, and vibration when a switch is turned on. Provide sample costume patterns for reference with design. |
| **Alternative Assessments**  | Students could finish a pre-started piece, or work in teams to complete one project to decrease the amount of work needed from each student. Alternative assessment will be based on student’s ability and needs. |
| **References** | NC Theater Arts Standards<http://www.dpi.state.nc.us/docs/acre/standards/new-standards/arts/theatre/9-12.pdf>NC Apparel and Textile Production Standards<http://www.ncpublicschools.org/cte/program-areas/family/programs>[A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas ( 2012 )](http://www.nap.edu/catalog.php?record_id=13165)<http://www.nextgenscience.org/hsets1-engineering-design>Arduino Programming<http://playground.arduino.cc/uploads/Main/arduino_notebook_v1-1.pdf>A Brief History of Theatre Architecture and Stage Technology<http://teachers.sduhsd.net/rpierce/ROP%20Class%20Documents/A%20Brief%20History%20of%20Theatre%20Architecture%20and%20Stage.pdf>A Guide to Studying the Relationship Between Engineering and Theatre<http://www.fa.mtu.edu/~dlbruch/>Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards.<http://www.iteaconnect.org/File.aspx?id=78445&v=1476043b>Standards for Technological Literacy Content for the Study of Technology<http://www.iteaconnect.org/File.aspx?id=67767&v=691d2353>Buechley, L., Qiu, K., & de Boer, S. (2013). *Sew Electric: A collection of DIY projects that combine fabric, electronics, and programming.*<http://sewelectric.org/> |
| **Appendices** | Appendix A: Engineering Design ProcessAppendix B: Introduction to ProgrammingAppendix C: Technology in Costuming and Props Appendix D: Rubric for Engineering Design Process Appendix E: Rubric for ProgrammingAppendix F: Rubric for ConstructionAppendix G: Rubric for Final ProductAppendix H: Programming in Theater QuizAppendix I: Sample Arduino Code |
| **Supplemental Information** | Technology enhanced costumes[*http://www.popularmechanics.com/technology/design/g209/13-high-tech-diy-halloween-costumes/*](http://www.popularmechanics.com/technology/design/g209/13-high-tech-diy-halloween-costumes/)Arduino Website[*https://www.arduino.cc/*](https://www.arduino.cc/)LilyPad Website[*http://lilypadarduino.org/*](http://lilypadarduino.org/) |
| **Comments**  | Students will explore much of the content on their own, students must be self-motivated to complete the project.Students should be proficient using sewing machines and multiple type of fabric. Students should have created unique pieces prior to the project, and are comfortable creating a piece from scratch. Students should be comfortable working individually and independently.Students should be aware that programming can be difficult, and they need to take their time to work through it step-by-step. |
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