# ECE4011/ECE 4012 Project Summary

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| **Project Title** | Coke Interactive Packaging |
| **Team Members** (names and majors) | Fan Chen (EE)<br>Alex Plager (CmpE)<br>Varun Malhotra (CmpE)<br>Hamim Nigena (EE)<br>Mitcham Tuell (EE) |
| **Advisor / Section** | Dr. Jasmeet Kaur, Dr. James Kenney |
| **Semester** | Fall 2017 ECE4012 |
| **Project Abstract** (250-300 words) | Objective: To design an interactive Coke bottle with onboard LEDs to enhance the consumer's experience, while modifying existing Coke bottle designs minimally and cost-effectively. The LEDs will light up based on NFC signals emitted from a cell phone operated by a user. The LEDs will light up in 3 different patterns based on input. Limitations to the design include maximizing cost-effectiveness, being able to withstand significant cooling, and finding optimum battery/power solutions.<br><br>Methods: The design consisted of 4 major components: NFC Detection, Computing System, Lighting and Power. The team used an NFC IC that converts NFC signals detected from an antenna to I2C signals (NFC Detection). These I2C signals were sent to a microcontroller to be decoded (Computing System). The microcontroller then lit up 9 LEDs in 3 different patterns based on the input (Lighting). The Microcontroller and the LEDs were powered by a common flexible lithium polymer battery (Power). The whole solution was mounted on a flexible PCB. The design required the following materials: resistors, capacitors, a microcontroller, LEDs, 1 lithium polymer battery and an IC that converts NFC signals to I2C (NTAG by NXP). |

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| List **codes** and | |

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| **standards** that significantly affect your project. Briefly describe how they influenced your design. | 1. **I2C:** The NFC IC communicated with the microcontroller using I2C. The team needed to understand I2C protocol to correctly decode messages.<br>2. **ISO 18092 (NFC):** The design allows a user to communicate with the bottle using NFC and hence the team needed to have a preliminary understanding of the standard and its capabilities. |
| List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design. | 1. **Cost:** The manufacturing cost of the design needed to be no more than approximately 10% to the manufacturing cost of a single PET or glass bottle but the team had decided to constraint the design to $10 at a production scale of 10000 bottles.<br>2. **Time:** The team had to figure out power issues, how to program a microcontroller that is not on an mbed or an arduino, and create a PCB layout to be milled on a flexible PCB. All these factors were accounted for to reach the goal of having a product ready by the design expo.<br>3. **Temperature:** The storage temperature of Coke is approximately -5˚C and the design had to be able to function after storage under that temperature for a period of time.<br>4. **Size/Weight:** The unit needed be small enough to fit on a Coke bottle and light enough to have negligible effect on distribution and consumption.<br>**5. Water Resistance:** The design had to be able to withstand condensation and minimum splashes of water. |
| Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen. | 1. **Microprocessor vs. Cost:** Using a microprocessor added more functionality to the interactive bottle but it also increased the cost. Without a microcontroller the design would just involve turning LEDs on/off based on energy harvesting capabilities of an NFC IC. The team thus decided to use a microcontroller to be able to flash the LEDs in different patterns based on NFC input from the user. This significantly raised the cost of the design but made this an an interesting project and allowed more interactions from a user.<br>2. **Battery Type vs. Form-Factor vs. Cost:** Power source consideration was a very important component of this design. The team could have ideally use a AAAA battery that could have the required current draw to drive LEDs but this would not allow the team to meet form factor |

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| | specifications and water resistance specs. There was a huge trade off between the capability of the design, form-factor and the cost. The team decided to give a higher priority to form-factor while still considering costs and capability and so the team looked into flexible lithium polymer batteries. |
| Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** tradeoffs, interfaces, and/or interactions.<br><br>*Complete if applicable; required if team includes CmpE majors.* | 1. Since the design used a microcontroller, a significant portion of the project involved writing the firmware for the microcontroller to interact with the NTAG IC (fetch data via I2C) and the LEDs. |

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| Leadership Roles (ECE4011 & Forecasted for ECE4012)<br>(NOTE: ECE4012 requires definition of additional leadership roles including:<br>1.Webmaster<br>2. Expo coordinator<br>3. Documentation | Admin Roles:<br><br>Team Leads: Varun and Hamim<br>Documentation Coordinator: Mitch<br>Webmaster: Fan<br>Coke Contact: Varun<br>Expo Coordinator: Alex<br>Parts Sourcing: Hamim<br><br>Technical Roles:<br><br>Flexible PCB Design: Fan , Mitch<br>Microcontroller Programming: Varun, Alex<br>NFC Antenna Design: Mitch, Hamim<br>Battery and Lighting: Alex, Hamim<br>Breadboard prototyping: Varun, Fan<br>Soldering: All |