Supply Activity Logger-

Software Team Project Closeout

May 24, 20201

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1. Design Impact Statement

1.1 Public Health, Safety, and Welfare Impacts

There are numerous adverse environmental impacts from technology that affect public health. For example, more than 45 million tons of electronic waste is disposed of around the world each year [1], and because of the chemical components of that electronic waste, there are very real risks to public health. However, using the SAL to minimize product loss should more than offset any adverse impact of the SAL device itself.

1.2 Cultural and Social Impacts

To use the web application, people must be tech savvy. Although that seems like a reasonable expectation, even in the US we cannot expect digital literacy throughout the country. Sixteen percent of adults in this country are not digitally literate, and five percent reported they had no computer experience at all [2]. Known as the "digital divide" or the "digital gap," rural Americans generally are less technically savvy than urban Americans [3]. There also is a technology gap – while most rural Americans have access to mobile telephones, ownership of laptop and desktop computers remains higher in urban areas than in rural areas [2] [3]. The digital divide also is an issue in developing countries where access to education and technology is far more limited than in the US [4]. Although it is likely that HP employees will be tech savvy and have access to the technology needed to access and use the SAL web app, that might not be true for all people on the receiving end of HP products or those in the shipping industry who might be impacted by what HP learns from information gathered by the SAL device.

1.3 Environmental Impacts

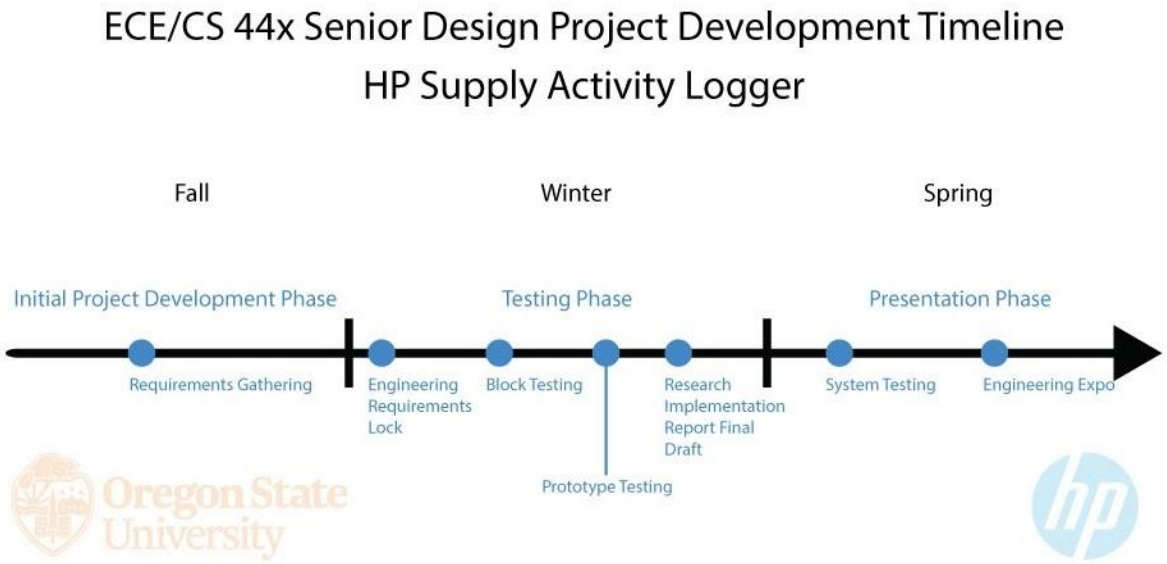
Most people are unaware of how web apps operate and their effect on the environment. Using a web hosting service requires the use of servers located around the world, usually at data centers, which operate 24-hours a day [5]. Unfortunately, 80 percent of data centers operate using electricity from fossil fuels [6]. Because they are not based on renewable resources, these data centers deplete resources without creating new ones. But today, new web hosting services are taking a green approach and using renewable resources – such as wind power – to run their systems. The ultimate goal is to reduce their carbon footprint because digital technologies are responsible for a growing proportion of global carbon emissions [7].

1.4 Economic Factors

The SAL device is relatively inexpensive to manufacture as it consists of only a few components. If the device were mass produced, labor and production costs would decrease further [8]. The software used to develop the SAL program is mostly open-source, limiting the need to purchase proprietary tools and software. Although mass production would lower costs of development, it could lead to excessive electronic waste in the future. However, it is not cost effective for HP to replace goods damaged during shipping. When evaluating the economic impact of the SAL device, it is apparent that the device could lower product waste, decrease shipping costs, and decrease the retail cost of goods. Thus, it appears there would be a market for these tracking devices, which indicates both an economic benefit to shipping companies, and a marketing opportunity for a company developing the SAL devices in the future [9].

2. Project Timeline

2.1 Timeline Overview



2.2 Detailed Timeline

Supply Activity Logger Timeline

	Assigned To	Status	Start Date
Fall 2020 (September 23rd - December 4th)			
Assignments and Documents			
Introductory Email and Initial Discovery Inquiry	Overall Team	Completed	Week 2
Executive Project Summary	Overall Team	Completed	Week 3
Team Protocols and Standards Document	Overall Team	Completed	Week 3
Engineering Requirements Draft	Overall Team	Completed	Week 4
Scope and Requirements Meeting	CS Team	Completed	Week 4
Risk Register	Individual	Completed	Week 4
Block Diagram Draft	CS Team	Completed	Week 6
Project Charter Assignment	CS Team	Completed	Week 7
Instructor System Architecture Meeting	CS Team	Completed	Week 8
Engineering Requirements	CS Team	Completed	Week 9
Block Diagram	CS Team	Completed	Week 9
Block Validation	Individual/CS Team	Completed	Week 10

Winter 2021 (January 4th - March 12th)			
Select Web Hosting Vendor	CS Team	Completed	Week 11
Begin Web Interface Prototype Development	CS Team	Completed	Week 11
Begin Database Development	CS Team	Completed	Week 11
Block Validation I	CS Team	Completed	Week 13
Meet with Project Partner	CS Team	Completed	Week13
Block Check-Off 1	CS Team	Completed	Week 14
RIR Paper Draft and Peer Review	Individual	Completed	Week 14
Research & Writing Studio Consultation and Feedback Summary Paragraph	Individual/CS Team	Completed	Week 14
Weekly Meeting Notes	Individual	Completed	Weekly
Technical Mentoring Meetings	Individual	Completed	Weekly
Block Validation 2	CS Team	Completed	Week 16
Meet with Project Partner	CS Team	Completed	Week16
Second Block Checkoff	CS Team	Completed	Week 17
Final Block Checkoff	CS Team	Completed	Week 20
Spring (March 29th - June 4th)			
Database Validation and Verification Testing	CS Team	Completed	Week 21
Begin Server Side Scripting Development	CS Team	Completed	Week 21
Schedule Meeting with ECE For Validation and Verification Testing (Hardware and Software)	Overall Team	Completed	Week 21
Elevator Speech Assignment	Individual	Completed	Week 22
Requirements Lock and Timeline Goals	CS Team	Completed	Week 22
Meet with Project Partner	CS Team	Completed	Week 23
Initial System Checkoff	CS Team	Completed	Week 25
System Beta Test	CS Team	Completed	Week 28
Final Requirement Checkoff	CS Team	Completed	Week 28
Project Closeout Draft	CS Team	Completed	Week 28
Project Summary Video	CS Team	Completed	Week 29
Project Closeout Final	CS Team	Completed	Week 29
Project Showcase Video	CS Team	Completed	Week 29

Legend
Items directly related to partner project
Personal goals and tasks
Items indirectly related to partner project

3. Scope and Engineering Requirements Summary

Name	CR	ER	Verification Method	Test Process	Test Pass Condition	Evidence Link"
Display data	Sensor data needs to be displayed graphically.	The system will display a line graph for temperature, orientation, impact, humidity, and atmospheric pressure sensor data to users via a web application.	Demonstra-tion	1. Have a user connect to the web application and navigate to a trip page. 2. Visually verify that the web application displays a line graph for temperature, orientation, impact, humidity, and atmospheric pressure sensor data.	If the system displays a line graph for temperature, orientation, impact, humidity, and atmospheric pressure sensor data to users via the web application, the requirement has been met.	https://www.youtube.com/watch?v=preW-rgj7i4
Filtering Data	Sensor data will be filterable on the web application.	9 out of 10 users will filter the type of sensor data the system displays in under 1 minute including display of data and report that the interface is intuitive.	Test	1. Select a focus group of 10 people to use the web application. 2. Explain to the users what the system does, so they have context for this test. 3. Have the 10 people connect to the web application and navigate to a sensor data set. 4. Ask the user to use the GUI to filter out every sensor data graph except for the temperature and orientation graphs. 5. Time how long it takes for each user to display only the temperature and orientation graphs. 6. Ask the users if they thought the interface was intuitive. 7. Verify that at least 9/10 users were able to filter the data in under a minute and that they reported that the user interface was intuitive.	If 9 out of 10 users filtered the type of sensor data system displays in under 1 minute (including display of data) and reported that the interface is intuitive, the requirement has been met.	https://media.oregonstate.edu/media/t/1_yl8l70u1

Name	CR	ER	Verification Method	Test Process	Test Pass Condition	Evidence Link"
Interactive Graphs	The system needs to let users interact with the sensor data graphs.	The system will provide users with sensor data graphs that can be zoomed inwards, panned, and display values for the data points.	Demonstra-tion	1. Have a user navigate to a trip page. 2. Visually verify that sensor data graphs are displayed for temperature, orientation, impact, humidity, and atmospheric pressure. 3. Have the user attempt get the sensor data value for a data point on the temperature graph. 4. Visually verify that the value for a data point was displayed. 5. Have the user attempt to zoom in on the temperature graph. 6. Visually verify that the graph zoomed inwards. 7. Have the user attempt to pan the temperature graph sideways. 8. Visually verify that the graph panned sideways.	If the system allows users to zoom inwards, pan, and display values for the data points in sensor data graphs, then this requirement is met.	https://www.youtube.com/watch?v=D_VUmguUoBA

Name	CR	ER	Verification Method	Test Process	Test Pass Condition	Evidence Link"
Multiple Users	Multiple users should be able to be logged into the system and use it at the same time.	The system will allow at least 10 authenticated users to interact with the system interface at the same time without slowing display times by more than 4 seconds.	Test	1. Have 10 users authenticate into the web server. 2. One at a time, have each user go to the same trip page and have them record how long it took for the page to fully load. 3. Have each user go back to the home page. 4. At the same time, have each user go to the same trip page and have them record how long it took for the page to fully load. 5. Verify with each user that the load times from step 4 were not more than 4 seconds longer than the load times from step 2.	If the system allows at least 10 authenticated users to interact with the system interface at the same time without slowing display times by more than 4 seconds, the requirement has been met.	https://www.youtube.com/watch?v=OFkAFqX0guc
Statistical Analysis	Unusually extreme sensor data will be flagged to the user.	The system will display which sensor data is outside a user selectable number of standard deviations of all sensor data of that type to the user.	Demonstra-tion	1. Input sensor data that contains extreme sensor readings. 2. Have a user navigate to the newly added data set in the web application and enter a number of standard deviations that will flag multiple data points as extreme values. 3. Visually verify that the correct extreme sensor data values are flagged to the user.	If the system displays which sensor data is outside a user selectable number of standard deviations of all sensor data of that type to the user, the requirement has been met.	https://www.youtube.com/watch?v=S-0pTRGFGiY

Name	CR	ER	Verification Method	Test Process	Test Pass Condition	Evidence Link"
Storing Data	Large amounts of sensor data needs to be stored.	The system will have the capacity to hold at least 1 million sets of sensor records.	Test	1. Put together a sensor data sets, altogether adding up to 1 million total records. 2. Send the sensor data from step 1 to the database. 3. Write a database query to count the amount of sensor data from step 1. 4. Run the query from step 3. 5. Verify that the system has 1 million records in the query results from step 4. 6. Have a user connect to the web application and attempt to navigate to the sensor data set from step 1 and then to another trip. 7. Visually verify that the web application functioned for both trips.	If the system has the capacity to hold at least 1 million sets of sensor records, the requirement has been met.	https://www.youtube.com/watch?v=_8VbJBKKPIE

Name	CR	ER	Verification Method	Test Process	Test Pass Condition	Evidence Link"
System Administra-tion	Only system administrat ors can remove sensor data and change other users' in-formation.	The system will allow only admin-istrative users to edit other users' information and delete sensor data sets.	Test	1. Have a non-administrator and an administrator log in to the web application. 2. Verify that the GUI does not allow the non-administrator to delete sensor data sets and that they cannot change other users' information. 3. Verify that the GUI allows the administrator to delete sensor data sets and that they can change other user's information. 4. Have the administrator attempt to delete a sensor data set. 5. Attempt to navigate to the sensor data set that was deleted and verify that it is no longer reachable. 6. Have the administrator attempt to edit the non-administrator's user permission to access the system. 7. Visually verify that the non-administrative user can no longer interact with the system (beyond logging in).	If the system allows only administrative users to edit other users' information and delete sensor data sets, the requirement has been met.	https://www.youtube.com/watch?v=FJ4yz1l9oNE

Name	CR	ER	Verification Method	Test Process	Test Pass Condition	Evidence Link"
Web application navigation	The sensor data sets will be navigable on the web application.	9 out of 10 users will navigate between different sensor data sets in under 1 minute and report that the interface is intuitive.	Test	1. Select a focus group of 10 people to use the web application (who have never seen it before). 2. Explain to the users what the system does, so they have context for this test. 3. Have the 10 people connect to the web application and attempt to navigate to a sensor data set. 4. Time how long it takes for each user to find the data set. 5. Ask the users if they thought the interface was intuitive. 6. Verify that at least 9/10 users were able to find sensor data in under a minute and that they reported that the user interface was intuitive.	If 9 out of 10 users navigated between different sensor data sets in under 1 minute and reported that the interface is intuitive, the requirement has been met.	https://www.youtube.com/watch?v=U-EBWz899ZY

4. Risk Register

Risk ID	Risk Description	Risk Category, Probability, & Impact	Performance indicator	Responsible party	Action Plan	Lessons Learned
R1	The sensor data format changes.	Technical 80% Moderate	The parsed sensor data is not accepted by the database, or the web app displays corrupt information.	Nolan	Retain/adapt project	Develop a data format to use internally in the web app – and stick with it. That way only the parser needs to be adjusted when changes to the format occur.
R2	We identify potential system features to add.	Technical 75% High	A team member notices an opportunity to include additional features.	Dustin	Retain	Try to anticipate features up front, but implement the critical features before extra features, and avoid "feature creep."

Risk ID	Risk Description	Risk Category, Probability, & Impact	Performance indicator	Responsible party	Action Plan	Lessons Learned
R3	The project cost exceeds the budget.	Cost 50% High	The project runs low or out of funds before the project is completed.	Nolan	Reduce	We thought we had budgeted all that we needed, so we used our funds to help the ECE team with their expenses. But then we ran into an unexpected expense and had to use our personal funds.
R4	We encounter shipping regulations issues, which would prohibit collection of data for the web app.	Legal 30% High	Team members learn of regulations that prohibit the sensor device from being shipped.	Dustin	Avoid	Team chose our battery type based on which type posed the fewest issues with shipping regulations, thus ensuring our ability to collect the data for our web app to display.

Risk ID	Risk Description	Risk Category, Probability, & Impact	Performance indicator	Responsible party	Action Plan	Lessons Learned
R5	The project falls behind schedule.	Timeline 60% Moderate	The software development fails or nearly fails to meet the timeline benchmarks.	Nolan	Reduce	We faced challenges with the timeline when we lost a team member and had only two people to do the work planned for three. We should have planned ahead for this contingency.
R6	The project fails to meet project-partner's expectations	Technical 20% High	The project partner expresses dissatisfaction with designs or end product.	Dustin	Avoid	We met the project partner's expectations.

5. Future Recommendations

Recommendation	Reason and Starting Point
1. Optimize Query Handling	**Reason**: Currently, the system makes numerous database queries – 1 for each graph and table. This causes a lot of excess data transmission that does not need to occur and that slows response times. **Starting Point**: Refactor the code to pull all data in one query and then process it all at once server-side. This should avoid the redundant data transmission.
2. Develop method for displaying user-requested GPS map locations for data points	**Reason**: Currently, the system displays up to five GPS locations with Google Maps. The system does not allow functionality to select just any data point and view it on the map. This additional functionality would allow users to better visualize where problems occur. **Starting Point**: Investigate whether the Plotly graphing library has a functionality to turn data points in the graph into links. If not, research for a different graphing library and convert the system to use that library.
3. Improve data visualization for orientation sensor data	**Reason**: Currently, the system displays a single line graph that shows the *x*, *y*, and *z* orientation component vectors together. Even with color coding, this is challenging for users to interpret. **Starting Point**: We recommend keeping the line graph as an additional visualization tool. However, we recommend implementing a separate line graph that displays the angle off-set from the sensor being in an upright position.
4. Allow users to download data from the database	**Reason**: Currently, users can view stored data graphically or in tables, but they cannot export the formatted data to their personal computers. This makes it more challenging for individuals to write reports concerning the results of their analysis of product losses. **Starting Point**: Investigate efficient ways to extract the data from the database and generate a downloadable report.

Recommendation	Reason and Starting Point
5. Switch to a green web hosting service	**Reason**: Currently, we are using a non-green web hosting service because we needed a host that is reliable, secure, inexpensive, and has good technical support. However, we recognize that within the industry, hosting services have developed that are green (*i.e.*, they use renewable energy). We feel it is important to acknowledge the increasing environmental impact web applications have today. **Starting Point**: Investigate green web hosting services to locate one that is secure, reliable, and has good technical support. It must fit within whatever budget is established for hosting.
6. Create a back-up plan for what happens if one of your team-members is unable to continue with the project	**Reason**: During the development of our project, one of our team members became very ill and was unable to continue. We had developed a project plan and assigned tasks for a 3-person team. We had plans for many different risks, but this was not one we had considered. This made the project more challenging and required us to completely redevelop our requirements, timeline, and task allocation. Further, our roles were too compartmentalized, which meant we lost his accumulated knowledge, as well as his work. **Starting Point**: When developing your project plan, make sure that any work done by one team member is available to, and understood by, at least one other team member. All work for the project must be saved in a group repository, such as GitHub.
7. Allow users to compare two trips side-by-side	**Reason**: Currently, the web application is designed so that users are able to view all the information about a single trip on one webpage. But that means they can view the information about only one trip at a time. When trying to determine where product damage is occurring, it would be useful to be able to compare the data from two similar trips side-by-side. **Starting Point**: Develop a smooth user interface that allows the different sensor graphs to viewed either side-by-side or on the same graph, using color coding. Note that Plotly supports this color-coding feature already.
8. Convert the Map to OpenStreetMaps api	**Reason**: Currently, the system is set up to use Google Maps. However, we learned that Google Maps incurs a charge once you reach a certain usage threshold. To avoid this cost, we looked for a different app to use. **Starting Point**: We located a different api – OpenStreetMaps – that does not incur a charge when usage reaches the level where Google Maps imposes a charge.

6. References

[1] Leestma, David. “Electronic Waste Study Finds $65 Billion in Raw Materials Discarded in Just One Year.” https://www.ecowatch.com/electronic-waste-united-nations-2517390624.html (accessed Apr. 8, 2021).

[2] Mamedova, Saida and Emily Pawlowski. “A Description of U.S. Adults Who Are Not Digitally Literate.” *Stats in Brief, National Center for Education Statistics*. https://nces.ed.gov/pubs2018/2018161.pdf (accessed Apr. 5, 2021).

[3] Perrin, Andrew. “Digital Gap Between Rural and Nonrural America Persists.” *FactTank – News in the Numbers*. https://www.pewresearch.org/fact-tank/2019/05/31/digital-gap-between-rural-and-nonrural-america-persists/ (accessed Apr. 8, 2021)

[4] “Understanding the Negative Social Impacts of Technology-Driven Education.” The European Business Review. https://www.europeanbusinessreview.com/understanding-the-negative-social-impacts-of-technology-driven-education/ (accessed Apr. 15, 2021).

[5] The Environmental Impact of Web Hosting, And Why I Switched To Wind Power.” *Ethical Unicorn.com*. https://ethicalunicorn.com/2017/07/21/the-environmental-impact-of-web-hosting-and-why-i-switched-to-wind-power/ (accessed Apr. 8, 2021).

[6] Clifford, Ben. “The Alarming Environmental Impact of the Internet and How You can Help.” *We Don’t Have Time*. https://medium.com/wedonthavetime/guest-blog-post-the-alarming-environmental-impact-of-the-internet-and-how-you-can-help-6ff89138730d (accessed Apr. 10, 2021).

[7] “The Internet’s Environmental Impact and How You Can Help.” *Erjjio Studios*. https://erjjiostudios.com/environment/the-internets-environmental-impact-how-you-can-help/ (accessed Apr. 8, 2021).

[8] H. Peterson, “Missing wages, grueling shifts, and bottles of urine: The disturbing accounts of Amazon delivery drivers may reveal the true human cost of 'free' shipping,” *Business Insider*, 11-Sep-2018. [Online]. Available: https://www.businessinsider.com/amazon-delivery-drivers-reveal-claims-of-disturbing-work-conditions-2018-8. [Accessed: 14-Apr-2021].

[9] “Home,” *Tive*, 17-Nov-2020. [Online]. Available: https://tive.co/. [Accessed: 14-Apr-2021].