

# Group 15 how.dance Smart Lights

## Executive Summary

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# 1 Original Design Problem

The purpose of the project is to design and prototype a smart light that will integrate with the how.dance online concert platform. The vision of the project is to make the online concert experience as immersive as possible for concert hosts and their audience. The how.dance Smart Lights will do this by synchronizing over a cloud server where the concert host can change the colors and animations of all lights in real-time. The lights will also have sound reactive animations using data from an onboard microphone to increase the immersive concert experience.

This project will help artists connect with their fans during the COVID-19 pandemic and beyond. Recently, online concerts through live streams have been growing in popularity since concerts traditionally feature large crowds. In order to make the how.dance Smart Lights as similar to the reactive lighting at an in-person venue as possible, all users in the same concert will be able to share the experience with identical LED patterns displayed in each of their own homes. This will be achieved by creating a network of devices that communicate with a host server using the PubNub real-time network API. The user will pair their lights to their wifi network and put the device in concert mode to begin communications with the network.

As with any project, it's important to imagine who this product is for. Our audience is anyone who wants to experience the immersive concert or club experience from the safety and comfort of their own home. Additionally, we want our product to appeal to anyone who would put an LED strip in their room for lighting or aesthetics. For this purpose, our smart light will also feature intuitive user controls and a variety of animation and color options so most users can have at least one favorite.

## 2 Management and Development Process

When teams were assigned, the project team met together to decide what roles each person would perform and to discuss the project. It was determined that the project would have one main hardware developer and one main software developer. Since the team was comprised of three individuals, the third individual would assist one of the leads. Knowing this, the hardware lead position was assigned to Aiden, the Software lead position was assigned to Chris, and the floater position was assigned to Oluwalana. The team also decided that Aiden would act as the team's project manager as he has had previous experience in that role. Once roles were established, the team contacted the project partner to discuss their vision for the project.

After meeting with the project partner, the project team determined that the project would be split into four main phases. The first phase concerned the research that needed to be done for the project. The second phase concerned the designing and development of a working prototype. The third phase concerned testing the different aspects of the prototype, and the fourth phase concerned finalizing the project. Each phase would be completed during a specified term when phase one would be completed in Fall Term, the second and third phases would be completed in Winter Term, and the fourth phase would be completed in Spring Term. After the completion of all four phases, the prototype and documentation created during the project would then be ready to hand off to the project partners.

Once the team established the phases that needed to be reached, the team decided on ten system blocks that would ensure that the system would function appropriately and assigned them to the specified team member. The Enclosure block, Light Display block, and the Power PCB would be assigned to Aiden because of his background in Fusion 360 and Solidworks. The Audio Processing block, Main Code block, Microphone block, and Wireless Host block would be assigned to Chris. The LED Animations block, Microcontroller block, and User Interface block would be assigned to Oluwalana.

At this time, the project has completed phase four, passed all system checkoffs, and all of the documentation is being finalized in order to be handed off to the project partner or the next team that will pick up where we left off.

### 3 Project Timeline

#### Board - Project Planning For Fall Term (by months)

	Start	End	Oct-2020				Nov-2020				Dec-2020				
			5	12	19	26	2	9	16	23	30	7	14	21	28
Owner - Team			Owner - Team												
ECE441: Biweekly Progress Videos (W 08-Oct-2020	03-Dec-2020		ECE441: Biweekly Progress Videos (Week 10) (08-Oct-20 - 03-Dec-20)												
Research Phase(Research Phase) 08-Oct-2020	31-Oct-2020		Research Phase (08-Oct-20 - 31-Oct-20)												
ECE441: Biweekly Progress Videos (W 08-Oct-2020	19-Nov-2020		ECE441: Biweekly Progress Videos (Week 8) (08-Oct-20 - 19-Nov-20)												
ECE441: Project Partner Update for V 08-Oct-2020	03-Dec-2020		ECE441: Project Partner Update for Week 10 (08-Oct-20 - 03-Dec-20)												
Fall Term Start and End Date(Fall Ter 08-Oct-2020	11-Dec-2020		Fall Term Start and End Date (08-Oct-20 - 11-Dec-20)												
Project Scope Meeting(Project Scope 13-Oct-2020	13-Oct-2020		Project Scope Meeting (13-Oct-20 - 13-Oct-20)												
Instructor Scope and Requirements Meeting 15-Oct-2020	16-Oct-2020		Instructor Scope and Requirements Meeting (15-Oct-20 - 16-Oct-20)												
Network Meeting(Network Meeting) 27-Oct-2020	27-Oct-2020		Network Meeting (27-Oct-20 - 27-Oct-20)												
Communication Evaluation with Rach 30-Oct-2020	30-Oct-2020		Communication Evaluation with Rachael (30-Oct-20 - 30-Oct-20)												
Prototype Phase(Prototype Phase) 01-Nov-2020	11-Dec-2020		Prototype Phase (01-Nov-20 - 11-Dec-20)												
Instructor Architecture Meeting(Instr 09-Nov-2020	09-Nov-2020		Instructor Architecture Meeting (09-Nov-20 - 09-Nov-20)												
Tech Demos(Tech Demos) 11-Dec-2020	11-Dec-2020		Tech Demos (11-Dec-20 - 11-Dec-20)												
Owner - Lana Popoola			Owner - Lana Popoola												
ECE 441: Team Protocols and Stand 08-Oct-2020	15-Oct-2020		ECE 441: Team Protocols and Standards Document (Group) (08-Oct-20 - 15-Oct-20)												
ECE441: Biweekly Progress Videos (W 08-Oct-2020	22-Oct-2020		ECE441: Biweekly Progress Videos (Week 4) (08-Oct-20 - 22-Oct-20)												
ECE441: Block Diagram Draft(ECE441 08-Oct-2020	05-Nov-2020		ECE441: Block Diagram Draft (08-Oct-20 - 05-Nov-20)												
ECE441: Project Executive Summary(I 08-Oct-2020	15-Oct-2020		ECE441: Project Executive Summary (08-Oct-20 - 15-Oct-20)												
ECE441: Research Implementation Re 08-Oct-2020	03-Dec-2020		ECE441: Research Implementation Report Draft (Individual) (08-Oct-20 - 03-Dec-20)												
ECE441: Teamwork Reflection Paper( 08-Oct-2020	19-Nov-2020		ECE441: Teamwork Reflection Paper (08-Oct-20 - 19-Nov-20)												
ECE441: Technical Demonstration(EC 08-Oct-2020	11-Dec-2020		ECE441: Technical Demonstration (08-Oct-20 - 11-Dec-20)												
Instructor System Architecture Meeti 08-Oct-2020	19-Nov-2020		Instructor System Architecture Meeting (08-Oct-20 - 19-Nov-20)												
Team Communication Evaluation(Te 08-Oct-2020	30-Oct-2020		Team Communication Evaluation (08-Oct-20 - 30-Oct-20)												
Prototype of Microcontroller PCB(Prc 11-Dec-2020	11-Dec-2020		Prototype of Microcontroller PCB (11-Dec-20 - 11-Dec-20)												
Owner - Aiden K Bahr			Owner - Aiden K Bahr												
Introductory Email & Initial Discovery 05-Oct-2020	08-Oct-2020		Introductory Email & Initial Discovery (05-Oct-20 - 08-Oct-20)												
ECE 441: Project Charter(ECE 441: Pr 08-Oct-2020	12-Nov-2020		ECE 441: Project Charter (08-Oct-20 - 12-Nov-20)												
ECE 441: Team Protocols and Stand 08-Oct-2020	15-Oct-2020		ECE 441: Team Protocols and Standards Document (Group) (08-Oct-20 - 15-Oct-20)												
ECE441: Block Diagram Draft(ECE441 08-Oct-2020	05-Nov-2020		ECE441: Block Diagram Draft (08-Oct-20 - 05-Nov-20)												
ECE441: Engineering Requirements D 08-Oct-2020	15-Oct-2020		ECE441: Engineering Requirements Draft (08-Oct-20 - 15-Oct-20)												
ECE441: Project Partner Update for V 08-Oct-2020	12-Nov-2020		ECE441: Project Partner Update for Week 7 (08-Oct-20 - 12-Nov-20)												
ECE441: Research Implementation Re 08-Oct-2020	03-Dec-2020		ECE441: Research Implementation Report Draft (Individual) (08-Oct-20 - 03-Dec-20)												
ECE441: Teamwork Reflection Paper( 08-Oct-2020	19-Nov-2020		ECE441: Teamwork Reflection Paper (08-Oct-20 - 19-Nov-20)												
ECE441: Technical Demonstration(EC 08-Oct-2020	11-Dec-2020		ECE441: Technical Demonstration (08-Oct-20 - 11-Dec-20)												
Instructor System Architecture Meeti 08-Oct-2020	19-Nov-2020		Instructor System Architecture Meeting (08-Oct-20 - 19-Nov-20)												
Project Partner Update (Week 4)(Pro 08-Oct-2020	22-Oct-2020		Project Partner Update (Week 4) (08-Oct-20 - 22-Oct-20)												
Team Communication Evaluation(Te 08-Oct-2020	30-Oct-2020		Team Communication Evaluation (08-Oct-20 - 30-Oct-20)												
Prototype of Power PCB(Prototype o 11-Dec-2020	11-Dec-2020		Prototype of Power PCB (11-Dec-20 - 11-Dec-20)												
Owner - Christopher Parker			Owner - Christopher Parker												
ECE 441: Project Charter(ECE 441: Pr 08-Oct-2020	12-Nov-2020		ECE 441: Project Charter (08-Oct-20 - 12-Nov-20)												
ECE 441: Team Protocols and Stand 08-Oct-2020	15-Oct-2020		ECE 441: Team Protocols and Standards Document (Group) (08-Oct-20 - 15-Oct-20)												
ECE441: Biweekly Progress Videos (W 08-Oct-2020	15-Oct-2020		ECE441: Biweekly Progress Videos (Week 3) (08-Oct-20 - 15-Oct-20)												
ECE441: Biweekly Progress Videos (W 08-Oct-2020	05-Nov-2020		ECE441: Biweekly Progress Videos (Week 6) (08-Oct-20 - 05-Nov-20)												
ECE441: Engineering Requirements D 08-Oct-2020	15-Oct-2020		ECE441: Engineering Requirements Draft (08-Oct-20 - 15-Oct-20)												
ECE441: Project Partner Update for V 08-Oct-2020	12-Nov-2020		ECE441: Project Partner Update for Week 7 (08-Oct-20 - 12-Nov-20)												
ECE441: Research Implementation Re 08-Oct-2020	03-Dec-2020		ECE441: Research Implementation Report Draft (Individual) (08-Oct-20 - 03-Dec-20)												
ECE441: Teamwork Reflection Paper( 08-Oct-2020	19-Nov-2020		ECE441: Teamwork Reflection Paper (08-Oct-20 - 19-Nov-20)												
ECE441: Technical Demonstration(EC 08-Oct-2020	11-Dec-2020		ECE441: Technical Demonstration (08-Oct-20 - 11-Dec-20)												
Instructor System Architecture Meeti 08-Oct-2020	19-Nov-2020		Instructor System Architecture Meeting (08-Oct-20 - 19-Nov-20)												
Team Communication Evaluation(Te 08-Oct-2020	30-Oct-2020		Team Communication Evaluation (08-Oct-20 - 30-Oct-20)												
Sever to Device communication Proti 11-Dec-2020	11-Dec-2020		Sever to Device communication Prototype (11-Dec-20 - 11-Dec-20)												

## Board - Project Planning For Winter (by months)

	Start	End	Jan-2021				Feb-2021				Mar-2021				
			4	11	18	25	1	8	15	22	1	8	15	22	29
Owner - Team			Owner - Team												
Winter Term Start and End Date(Winter Term)	04-Jan-2021	19-Mar-2021	Winter Term Start and End Date (04-Jan-21 - 19-Mar-21)												
Prototype and Development Phase(Prototype and Development Phase)	04-Jan-2021	01-Mar-2021	Prototype and Development Phase (04-Jan-21 - 01-Mar-21)												
Prototype Completion(Prototype Completion)	01-Mar-2021	01-Mar-2021	Prototype Completion (01-Mar-21 - 01-Mar-21)												
Testing Phase(Testing Phase)	02-Mar-2021	19-Mar-2021	Testing Phase (02-Mar-21 - 19-Mar-21)												
Owner - Lana Popoola			Owner - Lana Popoola												
ECE442: Progress Presentation Video 04-Jan-2021	18-Jan-2021		ECE442: Progress Presentation Video 1 Week 14 (04-Jan-21 - 18-Jan-21)												
ECE 442: Project Database Update Week 12(04-Jan-2021)	14-Jan-2021		ECE442: Project Database Update Week 12 (04-Jan-21 - 14-Jan-21)												
ECE44x: Block Check-Off 1 Week 14(ECE44x: Block Check-Off 1 Week 14)	04-Jan-2021	30-Jan-2021	ECE44x: Block Check-Off 1 Week 14 (04-Jan-21 - 30-Jan-21)												
ECE44x: Block Validation 1 Week 13(ECE44x: Block Validation 1 Week 13)	04-Jan-2021	21-Jan-2021	ECE44x: Block Validation 1 Week 13 (04-Jan-21 - 21-Jan-21)												
ECE 442: Research Implementation Report Final Version (Individual) (04-Jan-2021)	04-Jan-2021	04-Mar-2021	ECE 442: Research Implementation Report Final Version (Individual) (04-Jan-21 - 04-Mar-21)												
ECE 442: Progress Presentation Video 2 Week 18(19-Jan-2021)	19-Jan-2021	25-Feb-2021	ECE 442: Progress Presentation Video 2 Week 18 (19-Jan-21 - 25-Feb-21)												
ECE44x: Block Validation 2 Week 16(ECE44x: Block Validation 2 Week 16)	22-Jan-2021	11-Feb-2021	ECE44x: Block Validation 2 Week 16 (22-Jan-21 - 11-Feb-21)												
ECE44x: Block Check-Off 2 Week 17(ECE44x: Block Check-Off 2 Week 17)	31-Jan-2021	21-Feb-2021	ECE44x: Block Check-Off 2 Week 17 (31-Jan-21 - 21-Feb-21)												
ECE44x: Block Validation 3 Week 18(ECE44x: Block Validation 3 Week 18)	12-Feb-2021	28-Feb-2021	ECE44x: Block Validation 3 Week 18 (12-Feb-21 - 28-Feb-21)												
ECE44x: Block Check-Off 3 Week 20(ECE44x: Block Check-Off 3 Week 20)	22-Feb-2021	14-Mar-2021	ECE44x: Block Check-Off 3 Week 20 (22-Feb-21 - 14-Mar-21)												
Owner - Aiden K Bahr			Owner - Aiden K Bahr												
ECE442: Progress Presentation Video 04-Jan-2021	18-Jan-2021		ECE442: Progress Presentation Video 1 Week 14 (04-Jan-21 - 18-Jan-21)												
ECE 442: Project Database Update Week 12(04-Jan-2021)	14-Jan-2021		ECE442: Project Database Update Week 12 (04-Jan-21 - 14-Jan-21)												
ECE44x: Block Check-Off 1 Week 14(ECE44x: Block Check-Off 1 Week 14)	04-Jan-2021	30-Jan-2021	ECE44x: Block Check-Off 1 Week 14 (04-Jan-21 - 30-Jan-21)												
ECE44x: Block Validation 1 Week 13(ECE44x: Block Validation 1 Week 13)	04-Jan-2021	21-Jan-2021	ECE44x: Block Validation 1 Week 13 (04-Jan-21 - 21-Jan-21)												
ECE 442: Research Implementation Report Final Version (Individual) (04-Jan-2021)	04-Jan-2021	04-Mar-2021	ECE 442: Research Implementation Report Final Version (Individual) (04-Jan-21 - 04-Mar-21)												
ECE 442: Progress Presentation Video 2 Week 18(19-Jan-2021)	19-Jan-2021	25-Feb-2021	ECE 442: Progress Presentation Video 2 Week 18 (19-Jan-21 - 25-Feb-21)												
ECE44x: Block Validation 2 Week 16(ECE44x: Block Validation 2 Week 16)	22-Jan-2021	11-Feb-2021	ECE44x: Block Validation 2 Week 16 (22-Jan-21 - 11-Feb-21)												
ECE44x: Block Check-Off 2 Week 17(ECE44x: Block Check-Off 2 Week 17)	31-Jan-2021	21-Feb-2021	ECE44x: Block Check-Off 2 Week 17 (31-Jan-21 - 21-Feb-21)												
ECE44x: Block Validation 3 Week 18(ECE44x: Block Validation 3 Week 18)	12-Feb-2021	28-Feb-2021	ECE44x: Block Validation 3 Week 18 (12-Feb-21 - 28-Feb-21)												
ECE44x: Block Check-Off 3 Week 20(ECE44x: Block Check-Off 3 Week 20)	22-Feb-2021	14-Mar-2021	ECE44x: Block Check-Off 3 Week 20 (22-Feb-21 - 14-Mar-21)												
Owner - Christopher Parker			Owner - Christopher Parker												
ECE442: Progress Presentation Video 04-Jan-2021	18-Jan-2021		ECE442: Progress Presentation Video 1 Week 14 (04-Jan-21 - 18-Jan-21)												
ECE 442: Project Database Update Week 12(04-Jan-2021)	14-Jan-2021		ECE442: Project Database Update Week 12 (04-Jan-21 - 14-Jan-21)												
ECE44x: Block Check-Off 1 Week 14(ECE44x: Block Check-Off 1 Week 14)	04-Jan-2021	30-Jan-2021	ECE44x: Block Check-Off 1 Week 14 (04-Jan-21 - 30-Jan-21)												
ECE44x: Block Validation 1 Week 13(ECE44x: Block Validation 1 Week 13)	04-Jan-2021	21-Jan-2021	ECE44x: Block Validation 1 Week 13 (04-Jan-21 - 21-Jan-21)												
ECE 442: Research Implementation Report Final Version (Individual) (04-Jan-2021)	04-Jan-2021	04-Mar-2021	ECE 442: Research Implementation Report Final Version (Individual) (04-Jan-21 - 04-Mar-21)												
ECE 442: Progress Presentation Video 2 Week 18(19-Jan-2021)	19-Jan-2021	25-Feb-2021	ECE 442: Progress Presentation Video 2 Week 18 (19-Jan-21 - 25-Feb-21)												
ECE44x: Block Validation 2 Week 16(ECE44x: Block Validation 2 Week 16)	22-Jan-2021	11-Feb-2021	ECE44x: Block Validation 2 Week 16 (22-Jan-21 - 11-Feb-21)												
ECE44x: Block Check-Off 2 Week 17(ECE44x: Block Check-Off 2 Week 17)	31-Jan-2021	21-Feb-2021	ECE44x: Block Check-Off 2 Week 17 (31-Jan-21 - 21-Feb-21)												
ECE44x: Block Validation 3 Week 18(ECE44x: Block Validation 3 Week 18)	12-Feb-2021	28-Feb-2021	ECE44x: Block Validation 3 Week 18 (12-Feb-21 - 28-Feb-21)												
ECE44x: Block Check-Off 3 Week 20(ECE44x: Block Check-Off 3 Week 20)	22-Feb-2021	14-Mar-2021	ECE44x: Block Check-Off 3 Week 20 (22-Feb-21 - 14-Mar-21)												

## Board - Project Planning For Spring (by months)

	Start	End	Mar-2021		Apr-2021		May-2021				Jun-2021			
			29	5	12	19	26	3	10	17	24	31	7	14
<b>Owner - Team</b>			<b>Owner - Team</b>											
Spring Term Start and End Date(Sprin			Spring Term Start and End Date (29-Mar-21 - 11-Jun-21)											
Testing Phase(Testing Phase)			Testing Phase (29-Mar-21 - 11-Apr-21)											
Presentation and Showcase Phase(Pr			Presentation and Showcase Phase (12-Apr-21 - 11-Jun-21)											
System Checkoff(System Checkoff)			System Checkoff (13-May-21 - 13-May-21)											
<b>Owner - Lana Popoola</b>			<b>Owner - Lana Popoola</b>											
ECE 443: Design Impact Assessment (			ECE 443: Design Impact Assessment (Individual) Week 23 (29-Mar-21 - 16-Apr-21)											
ECE 443: Project Closeout Week 28(E			ECE 443: Project Closeout Week 28 (29-Mar-21 - 20-May-21)											
ECE443: Project Showcase Week 28(E			ECE443: Project Showcase Week 28 (29-Mar-21 - 20-May-21)											
ECE443: Initial System Testing Week :			ECE443: Initial System Testing Week 24 (29-Mar-21 - 22-Apr-21)											
ECE443: Final System Testing Week 2			ECE443: Final System Testing Week 27 (23-Apr-21 - 13-May-21)											
<b>Owner - Aiden K Bahr</b>			<b>Owner - Aiden K Bahr</b>											
ECE 443: Design Impact Assessment (			ECE 443: Design Impact Assessment (Individual) Week 23 (29-Mar-21 - 16-Apr-21)											
ECE 443: Project Closeout Week 28(E			ECE 443: Project Closeout Week 28 (29-Mar-21 - 20-May-21)											
ECE443: Project Showcase Week 28(E			ECE443: Project Showcase Week 28 (29-Mar-21 - 20-May-21)											
ECE443: Initial System Testing Week :			ECE443: Initial System Testing Week 24 (29-Mar-21 - 22-Apr-21)											
ECE443: Final System Testing Week 2			ECE443: Final System Testing Week 27 (23-Apr-21 - 13-May-21)											
<b>Owner - Christopher Parker</b>			<b>Owner - Christopher Parker</b>											
ECE 443: Design Impact Assessment (			ECE 443: Design Impact Assessment (Individual) Week 23 (29-Mar-21 - 16-Apr-21)											
ECE 443: Project Closeout Week 28(E			ECE 443: Project Closeout Week 28 (29-Mar-21 - 20-May-21)											
ECE443: Project Showcase Week 28(E			ECE443: Project Showcase Week 28 (29-Mar-21 - 20-May-21)											
ECE443: Initial System Testing Week :			ECE443: Initial System Testing Week 24 (29-Mar-21 - 22-Apr-21)											
ECE443: Final System Testing Week 2			ECE443: Final System Testing Week 27 (23-Apr-21 - 13-May-21)											

## 4 Project Reflection

This project taught all of us how to deal with the challenge of remote collaboration. In the corporate world, even after the pandemic, it is likely you will have to work with people in other parts of the world. Large companies often have multiple branches and projects can be collaborations between them. We learned to use a shared drive and constant communication to keep track of roles and deadlines. This made sure every assignment was completed promptly.

We also learned how to work with wireless communication, specifically minimizing overhead to get the lowest possible latency. Our interfaces encode the color and mode information as hexadecimal values that only require 1 byte each to transmit. Working with this has prepared us for jobs that involve network communication and real time applications.

The final takeaway our team received was the ability to work around constraints. Since we had to make our engineering requirements before we even started the engineering of our capstone, we had to figure out how to manage ambitious requirements. Due to the maximum budget, we ended up running out of money before we could make enough parts to meet one of the constraints we initially set. Our team met to discuss what approach we needed to take and eventually decided that reducing the number of parts we needed to demo didn't affect the end product. We ended up changing the requirement from 5 LED bars down to only 3 and were still able to demonstrate the modularity of the device.