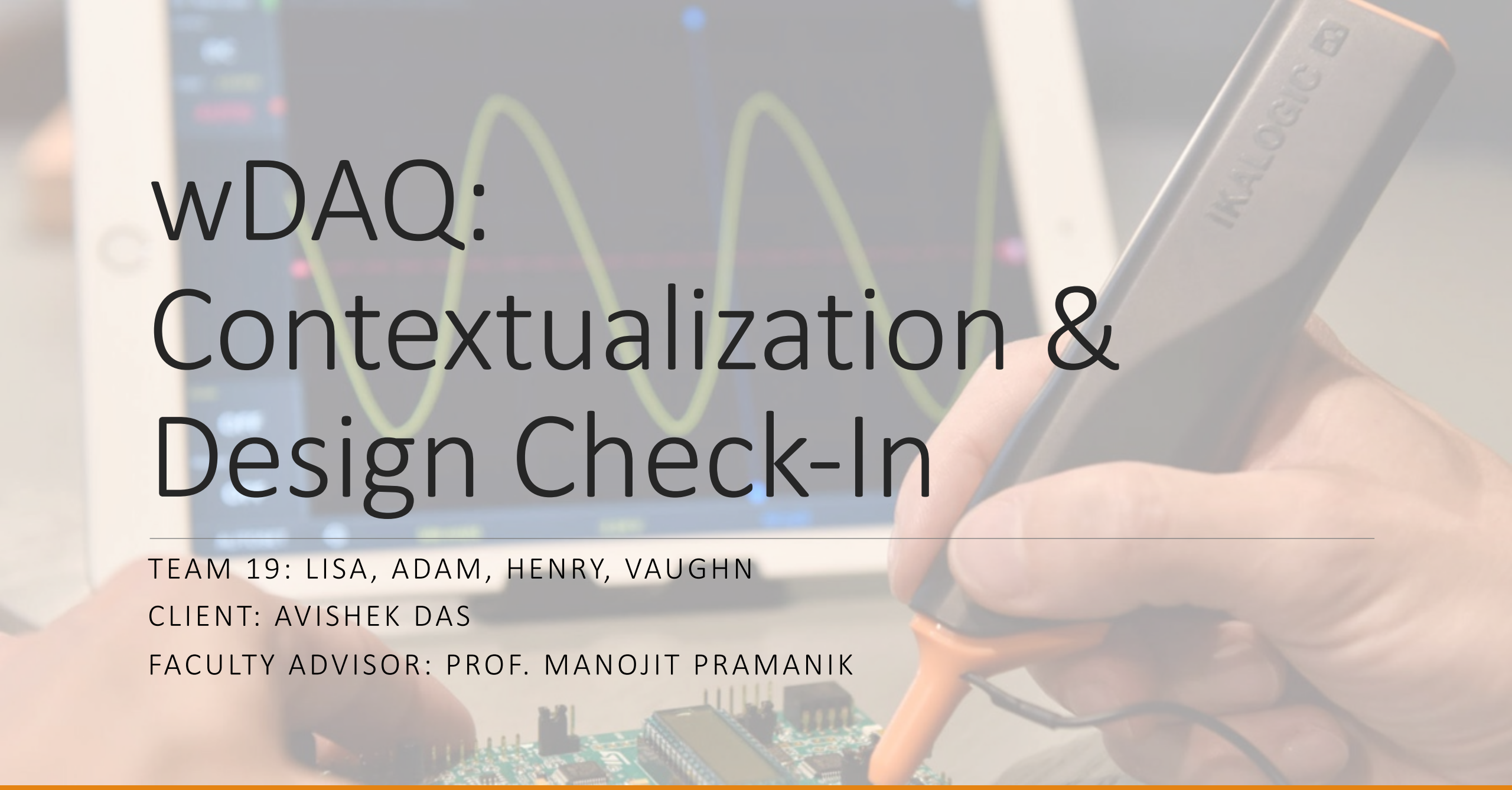


wDAQ: Contextualization & Design Check-In

TEAM 19: LISA, ADAM, HENRY, VAUGHN

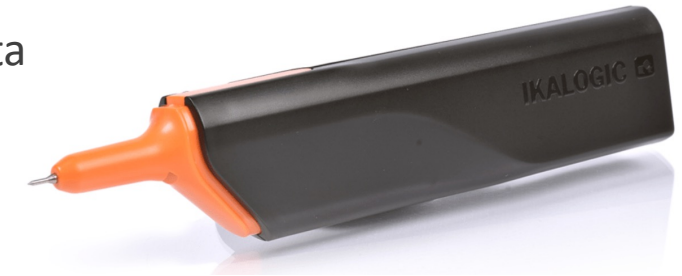
CLIENT: AVISHEK DAS

FACULTY ADVISOR: PROF. MANOJIT PRAMANIK

Project Overview

Project: Wireless Data Acquisition (wDAQ) system to capture/transmit high-frequency analog signals to a device in real time using Wi-Fi technology

- The DAQ will amplify a 1 mV analog input signal to approximately 1-2 V before digitizing it
  - ADC will have a 12-bit resolution
- Wi-Fi will be used to wirelessly transmit signals to a computer
  - Bluetooth can be used for signal transmission, but has a significantly lower data transfer rate than Wi-Fi
- The DAQ will be fabricated on a small PCB with surface-mount components
- A graphical user interface (GUI), written in LabVIEW, will be used to analyze data



Artifacts: Journey Map #1

Persona: Jane Jolly

Age: 30s

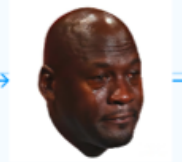
Occupation: Medical imaging lab tech for animal research facility

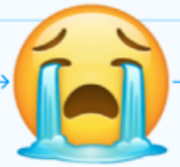
About: Jane is a medical imaging tech for an animal research lab in Ames, Iowa. She earned her Master's of Science and PhD in an animal science field about 8 years ago and now works full-time. She has experience using oscilloscopes and other related medical lab equipment, but the wireless data acquisition system is a new technology for her lab.

Jane Jolly

The next page shows a map of Jane's journey "as-is". Thoughts/pain points correspond to "experiences", actions, touchpoints, and opportunities do not. Pink thoughts are positive and purple thoughts are negative.

Key Experiences	Works as a lab imaging tech	Struggles to operate old oscilloscope	Loses power midway through analysis	Gets attacked by animals in the lab	Receives training for new equipment
Actions What does the user do?	Obtains data in imaging lab	Connects to computer or tablet to analyze data	Ensures proximity of oscilloscope to analysis device	Ensures stable, unbroken wiring connections	
Touchpoints What part of the product/service the user interacts with?	Cords & BNC Cables (old oscilloscope)	Local Wi-Fi connection with PC or mobile device	Computer/LCD	Charging dock/ power supply	
Thoughts What is the user thinking? Gain Pain	"I need to work inside so I have a wall outlet available."	"I need cords and additional devices to perform data analyses."	"Current oscilloscopes are vulnerable to power loss."	"Ouch"	"This new technology is much better!"
Feelings How is the user feeling?	Positive / Negative				
Pain points What problems does the user encounter?	Must do all work in lab due to the need for the power supply	Needs cables & cords to run simulations and analyses	Needs a constant power supply to use current oscilloscope		
Opportunities How can we improve the user's experience?	Increased mobility around and outside of the lab	Reduced clutter in work environment	Reduced setup & tear-down so more work can be done	Ease of access to data with computer software	





Journey Map #1: Jane Jolly

Artifacts: Journey Map #2

Persona: Big Lenny

Age: 70s

Occupation: Animal handler at Jane's medical research facility

About: Big Lenny is an older gentleman that is unfamiliar with technology. He struggles to understand what must be plugged into what and fears breaking the expensive tools that allow Jane to function in her day-to-day work. Big Lenny would like to diversify his skills and make himself a more valuable employee. With that, Lenny is a smaller fellow who feels that he exerts himself too much.

The next page shows a map of Lenny's journey "as-is". Thoughts/pain points correspond to "experiences", actions, touchpoints, and opportunities do not. Pink thoughts are positive and purple thoughts are negative.

Big Lenny

Key Experiences Describe 5 key experiences that the user goes through.	Preforms menial tasks and labor	Breaks an expensive lab tool	Accidentally releases an animal	Cannot reach the equipment	Afraid to ask for help with equipment
Actions	Handles animals	Performs work around lab/office	Performs manual labor for Jane		
Touchpoints	Animals	Lab techs			
Thoughts What is the user thinking?	"I can make more money and have a greater impact here"	"I have to work later than usual to fix problems I cause"	"F*** this"		"I don't know what to ask them"
Feelings	Positive / Negative				
Pain points	Animals needing food and waste cleanup				Tools that are difficult to use & understand
Opportunities	Concise instructions with consideration of problems	Opportunities for hands-on engagement and team collaboration	Inclusive environment that accommodates different skill levels		

Journey Map #2: Big Lenny

Artifacts: Journey Map #3

Persona: Big Al

Age: 35

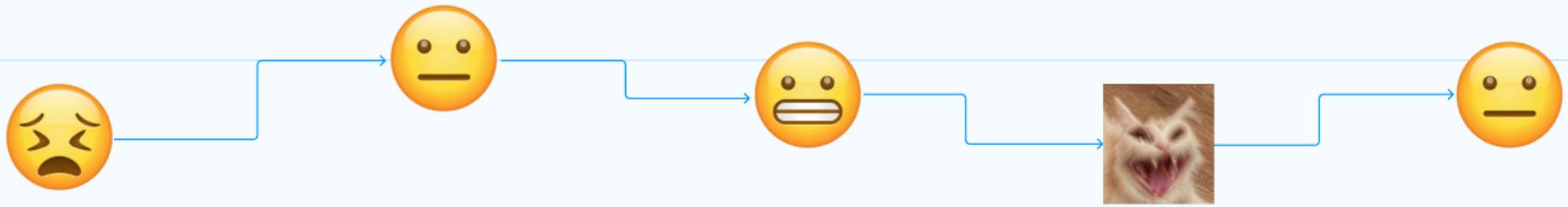
Occupation: Business owner with stakes in Jane's lab

About: Big Al is a business owner and professional looksmaxxer that has stakes in Jane's medical imaging lab. He works remotely most of the time due to the travel-oriented nature of his work. He is not a well-established business owner, because he recently acquired his wealth due to lucky stock bids from Andrew Tate's Hustlers University.

The next page shows a map of Al's journey "as-is". Thoughts/pain points correspond to certain "key experiences", while actions, user touchpoints, and opportunities for improvement do not. Pink thoughts are positive, and purple are negative.

Big Al

Key Experiences Describe 5 key experiences that the user goes through.	Research lab stock fluctuations	Budget costs	Micromanagement	Projects over budget	Angry Employees
Actions	Cuts budget to increase profits Manages employee schedules Gets distracted with small tasks Has stocks in Jane's research lab				
Touchpoints	Consumers, shareholders, and funding sources Leases for land Equipment vendors				
Thoughts	"I can earn profits from my stakes in the lab"		"I am losing money because I am poor at managing it"		"My employees hate me"
Feelings	Positive / Negative				
Pain points	Financial struggles		Poor time management		One star reviews on Indeed Intrusive thoughts
Opportunities	Increase reliability to reduce maintenance costs Make the device cutting-edge to eliminate competition Make the device easy to operate (so AI can work on other things)				



Journey Map #3: Big AI

Artifacts: Pros & Cons Table

Comparison of our device to other alternatives on the market (traditional oscilloscopes and USB-C powered oscilloscopes such as Digilent Analog Discovery)

	Alternative 1: Traditional Oscilloscope	**Alternative 2:** Digilent Analog Discovery 2	**Alternative 3:** Our Design
Pros	- Highly accurate - Data sent in real time - Wide bandwidth - Can read most signals - Safe to operate - Support functions like math - Established documentation	- Compatibility with multiple types of software - NI WaveForms app - Many functionalities and capabilities for data analysis	- Precise high-frequency data - Portable and user-friendly - Small size - Minimizes use of equipment - Likely very inexpensive compared to similar market options
Cons	- Fairly costly to acquire outside of a university setting - Bulky device - Requires technical training or exposure to the device - Requires tuning - Uses probes (hardwired connection) - Requires corded power connection	- Requires USB-C for power supply and software connection (not fully wireless) - Larger size than our device	- Small footprint comes at the cost of lower battery capacity and potentially inferior performance - Not as fast as high-end portable oscilloscopes - No established brand reputation or marketplace presence - No customer support or professionally evaluated documentation

Human Considerations

- **Mobility:**
  - Lack of BNC cables allows movement with a wireless connection to the scope
  - Lithium-Ion Batteries removes the need to be hardwired into a power outlet
  - Wi-Fi connection allows user to stay connected within 100 feet of the device
- **Size:**
  - Components on both sides of the PCB decrease the size and weight
  - Using small footprints creates a compacted device
- **Device accuracy, speed, and interface:**
  - Using high-end components facilitates the device accuracy and speed that is critical to the user's needs
  - LabVIEW is an easy-to-use program that can relay information to the highest degree

Economic Considerations

- **Use of high-end components:**
  - Drawbacks: In the short term, there is a higher capital cost
  - Benefits: In the long term, this saves money on replacement due to the device's longevity
- **Software:** LabVIEW, which will be what the user interfaces with, is a free-to-use program renowned for its wide range of capabilities
- **Production**: a dozen or so of the devices will need to be fabricated for the client upon test completion
  - Drawback: Must have access to soldering equipment or pay for JLCPCB to assemble PCBs
  - Benefits: Anyone with minor hardware skills can assemble the device at a low cost

Technical Considerations

- **Internal Complexity:**
  - Our design incorporates six interconnected components: a transducer, low-noise amplifier, analog-to-digital converter (ADC), microcontroller, Wi-Fi module & connection, and graphical user interface (GUI)
  - The amplifier and ADC leverage electrical and some computer engineering principles
    - The amplifier manipulates analog signals, using passive components and integrated circuits (ICs) to amplify them
    - The ADC circuit uses IC amplifiers and passive components to convert the single-ended signal to a differential (double-ended) one
    - The ADC circuit incorporates a linear voltage regulator and DC-DC buck converter that steps down the power supply voltage
    - The ADC has a specific bit resolution and sampling rate that must be considered in relation to other parts of the design
  - The microcontroller and Wi-Fi module incorporate a mix of electrical, computer, & software aspects
    - The microcontroller and Wi-Fi modules are Systems-on-Chip that are biased and controlled by a larger circuit
    - The Wi-Fi module transmits data from the microcontroller to the GUI at a fast data transfer rate
    - The Wi-Fi chip is tested on an Arduino evaluation board on a breadboard
  - The GUI makes use of mostly software & computer engineering principles
    - The GUI is written in LabVIEW software and connects to the device with Wi-Fi

Technical Considerations

- **External Complexity:**
  - Numerous aspects of our device match or surpass cutting-edge technology in the industry
  - The use of a rechargeable battery to power an oscilloscope is a novelty
    - Only a few other devices on the market utilize a rechargeable battery rather than a corded power supply
  - The compact size of our device beats the size of most oscilloscopes on the market
    - Our device will be approximately 1"x5"x1", making it much smaller than traditional box oscilloscopes
  - The use of Wi-Fi to communicate data makes our device one of the fastest in industry
    - Wi-Fi connection enables data transfer at a rate of up to 150 Mbps (megabits per second)
    - Other devices that utilize Bluetooth communication are limited to a data transfer rate closer to 10-20 Mbps
  - The ability to directly "probe" real-world physical signals is a cutting-edge technology
    - Our device is directly compatible with transducers (via SMA connection), which quickly translate physical signals to electrical signals