

# BME Design-Spring 2026 - ISABEL PLOESSL

## Complete Notebook

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Claudia Beckwith

on

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**Team contact Information**

ISABEL PLOESSL - Jan 26, 2026, 8:08 PM CST

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""		BPAG			



## Project description

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ISABEL PLOESSL - Jan 26, 2026, 8:14 PM CST

**Course Number: BME 301**

**Project Name: Wearable Glucose Alerting System**

**Short Name: wgas**

**Project description/problem statement:** Parents and caregivers of children with T1D often struggle to quickly see and interpret glucose readings, leading to stress and delayed decisions. The Wearing Glucose Alerting System aims to solve this problem by providing a clear, visible signal that instantly shows when a child's blood sugar needs attention.

**About the client:** Olive Cerniglia, Pharmacy Student, find contact information in team contact information page



## 2026/01/30 Advisor Meeting 1

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Claudia Beckwith - Jan 30, 2026, 11:02 AM CST

**Title: Advisor Meeting 1**

**Date:** 1/30/26

**Content by:** claudia

**Present:** 301s, dr p, izzy

**Goals:** We want to share with Izzy and Dr. P the research we have gotten done this first week. This is an existing project so we don't need as much introduction. Were ready to jump into the next steps, like app building and BLE connection.

**Content:**

Went over research of what we found for more impact

- talked about the price of insulin and the absurdity of the inflation when it should be going down
- comparing medical availability of insulin across different countries
  - high income countries have a much better rate of getting the access needed
- parents expressing concerns about others not understanding their child
- considerations of universal color understandings and option to customize this in the app
- child isolation concerns, not wanting it to look like a medical device to reduce sense of insulation
- exploring routes to get Flutter local app onto apple device
  - not looking to switch onto dexcom developer because it's too different from what we did
- XIAO ESP32 series microcontroller with on board wifi and bluetooth
- a child getting diagnosed is basically a diagnosis for the parents
- healthcare sector is 4.4% of global greenhouse gas emmissions
  - the electrical components are especially problematic

Talking about future goals:

- build app
- go wireless
  - new microcontroller should help

**Conclusions/action items:**

- order new microcontroller
- plug away at the programming
- look at BLE connections
- some AI tools to understand how to get the connection to work
- look into international color schemes
- look into an app builder



## 02/06/2026 Advisor Meeting 2

Claudia Beckwith - Feb 06, 2026, 11:02 AM CST

### Title: Advisor meeting 2, design matrix and updated research

Date: 2/6/2026

Content by: claudia

Present: whole team

**Goals:** We want to share the updates of our project this week, including the new parts ordered and code updates. We also want to talk about the design matrix because we're not entirely sure what to be evaluating. We'll also get a list of action items before new week and prelims.

### Content:

- PDS updates
  - not a ton of updates because we updated a ton throughout last semester
- new materials ordered
  - new LED has bigger holes for soldering
  - very streamlined data in and out
  - power consumption: pretty much the same as the one from last semester
    - ~16 mA per LED
  - microcontroller
    - going with the C6
      - C3 was supposed to be the most energy saving but it really wasn't different than the C6
      - C6 has largest wi-fi capacity
      - newest model
      - BLE5 connection, should be easier to update
      - cheaper with the pack of 3
      - able to charge the battery
  - battery from last sem still works
    - bought a bigger battery that can give us more run time
    - would be easy to swap out J pins if we need a different battery
    - goal to meet minimum specs, option to scale up in the future
- Runtime concerns
  - may need to revisit later, working on functionality first
- Software
  - Claudia rented a MAC!
  - figuring out how to deploy onto apple app for iPhone
  - may be limitations on how much I can code on a UW computer
- Design matrix
  - power consumption
  - distance/ranges
  - program complexity
  - accessibility (not everywhere has wifi)
  - replicability
  - comparing between wifi and bluetooth or both
- Functionality for status notifis
  - how to display a connectivity issue
  - show low battery
  - LED program, different LED, or app notification
  - look into power consumption, complexity of coding, power usage, etc
  - fitbit shows outdated data greyed out with a line
- Advertising
  - Kiera met with diagnostic advertisement rep from Abbott

- market of families, market of physicians, market of insurances
- 1 in 4 healthcare dollars are spent on diabetes
- price range, compare to Glowcose
- Lean startup, apps only available locally
- focus more on improving quality of life

**Conclusions/action items:**

We have a good idea of what to work on for the design matrix for next week. Claudia also has a lot of ground to cover for the iOS app now that she has a computer. Supplies should be shipped within the week so Isabel and Lauren can start fabricaton.

look into which patents exist for sugar pixel or glowcose



## 2026/02/13 Advisor Meeting 3

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Claudia Beckwith - Feb 13, 2026, 10:59 AM CST

**Title:** Advisor meeting 3, design matrix

**Date:** 2/13/2026

**Content by:** claudia

**Present:** whole team

**Goals:** We want to look into each of our criteria on the design matrix and talk about why we chose the scores we did. We also want to talk about next steps and things to get done before prelims next week. We want to communicate some of the details of our meeting with our clients from last week, including how we market the device.

**Content:**

sharing out design matrix, should look into how BLE and wifi give a little better range because if wifi drops still have the close range

\*change the connection ranges to be "connectivity"

wifi uses so much power that we couldn't meet PDS requirements

Marketing:

- pay attention to product market fit
- pitch focused on establishing the problem and showing the solution
- market to the payers, in our case, parents
- claims matrix
  - 6 biggest claims with description and evidence
  - ex. intended to display color signal consistent with glucose readings and show that it does that
  - helps for prove you can market the device

**Conclusions/action items:**

- need to update pictures to not include computer
- claudia still working on the app



## 2026/02/27 Advisor Meeting 4

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Claudia Beckwith - Feb 27, 2026, 11:12 AM CST

**Title:** Advisor meeting 4

**Date:** 2/27/2026

**Content by:** claudia

**Present:** whole team

**Goals:** We want to update Dr P on all our progress including... our app! We are excited on our progress and are ready to take this momentum into the next several weeks. We also want to get updates on where to invest our time in the coming weeks. Goal is to have a fully working prototype BEFORE show and tell.

**Content:**

Claudia app modifications:

- update backend to not be pulling through website
- use pydexcom code from Dr P
- option to keep login saved
- not pulling from website
- eventually getting settings to update the watch color ranges in the app

Other updates to focus on:

- work on connectivity packages
- update box and band connection
- looking into different leds that would operate in one dot vs the individual dots we have now
  - concerns with power consumption
  - Isabel to explore

**Conclusions/action items:**

This next week, we want to make a lot of continuing updates to our app. Right now our backend is extremely redundant and running off of a bme sharedlab website, adding an additional level of fragility and source for error. Dr P is going to send claudia a php file to help kickstart the process (including one that displays all of the metrics that pydexcom is able to display).



## 2026/03/06 Advisor Meeting 5

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Claudia Beckwith - Mar 06, 2026, 10:59 AM CST

**Title:** Avisor Meeting 5

**Date:** 3/6/26

**Content by:** claudia

**Present:** claudia isabel lauren

**Goals:** We want to update Dr. P and Izzy on our progress and difficulties. We've been having difficulties with the box redimensioning and the server. We can't be running everything on the phone but running on the computer isn't sustainable either. Looking at maybe deploying a cloud server that runs all the time.

**Content:**

Box is being very difficult to change dimensions, looking at just redoing the entire box with new dimensions.

Wants to pull from dexcom but only within flutter, have the I/o happening with the app not running on a server (Claudia is likely overcomplicating it)

how to change a php file to be readable in flutter

edit to hardcode isabel's credentials in for the time being and then develop a separate app page to handle credentials, not logging out automatically

printing box and band using the same strategies as before, having full physical build done next week with everything soldered, printed, attached, and have the light running and working

**Conclusions/action items:**

- Isabel redo the box on SolidWorks with the new dimesions
- app interface done in the next week
- show and tell focusing on getting help with the bluetooth connection



## 2026/03/13 Advisor Meeting 6

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Claudia Beckwith - Mar 13, 2026, 10:49 AM CDT

**Title:** Advisor Meeting 6

**Date:** Friday the 13th

**Content by:** Claudia Jennifer Beckwith

**Present:** 301 team

**Goals:** We want to update Dr P and Izzy on our app, box, and microcontroller from the past week.

**Content:**

Isabel redid the entire box on Solidworks, easy to redimension when we need to make changes.

Future changes to the box:

- take out push hole in the band sliders
- holes smaller for the slide bands
- usb-c hole moving 90 degrees

Claudia programmed the microcontroller to light up white

- look into module to ensure the battery is always outputting 5V (physical hardware)
- make sure we can forward charge from source

Claudia redid the entire backend for the app

- now process is direct from dexcom
- look into extending the sessionID (check into glance)
- fix UI
  - add tabs for educational videos
    - information (ranges)
    - set brightness
    - add disclaimer

**Conclusions/action items:**

- ordering new bands to start fresh
- add more for the UI
- fix box
- BLE connection?



## 04/10/2026 Advisor Meeting 7

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Claudia Beckwith - Apr 10, 2026, 10:56 AM CDT

**Title:** Advisor Meeting 7

**Date:** 4/10/26

**Content by:** claudia beckwith

**Present:** whole team

**Goals:** Update Dr. P and Isabel on all our updates from the past 4 weeks.

**Content:**

we shared with Dr. P that we won SHARx tank!!!! YAYAYYAYA!!! Go team!!!!

In terms of signing away our IP, we can't send anything away yet because we need WARF to look over what our funding came from because anything funded by the university

battery issue: microcontroller can't handle power through. needed to power the led with a powerbank for the competition, looking into new batteries but we can use a portable charger at the presentation if we needed

**Conclusions/action items:**

Working on testing next week to test our connectivity ranges and the error alerting light after 15 minutes

add off button to the app



## 2026/02/25 - In class ethics activity

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ISABEL PLOESSL - Feb 25, 2026, 1:54 PM CST

**Title:** Improving design

**Date:** 2/25/2026

**Content by:** Team

**Present:** 301's

**Goals:** To reflect on our design and what can be improved

**Content:**

### 4. Perceptible Information

Colors can mean different things to different countries; we can make downloaded packs per country to more intuitive colors for bad to good numbers, across more countries than just the US.

**Conclusions/action items:** Make different iOS app setting for different country set-ups.



## 2026/03/18 - Call to action

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Claudia Beckwith - Mar 20, 2026, 10:32 AM CDT

**Title:** Call to action

**Date:** 3/18/2026

**Content by:** Team

**Present:** 301's

**Goals:** Finish Call to action

**Content:**

- **Attention grabber:** I'm looking for help with CAD simulation
- **Introduction:** We are working on project X (very concise)
- **Value proposition:** that is trying to solve Y
  - Target customer
  - How the design/product/service solves a specific problem
  - Demonstrate what you already have - show the current CAD drawing
  - Don't waste time on unnecessary background
- **Benefits:** Unique features and benefits of your product
- **Call to action:** We are struggling to model Z, what are your suggestions?

We are looking for help with forward charging and maintaining Bluetooth connection to our microcontroller from an iPhone application. We are working on the Wearable Glucose Alerting Project that is trying to more easily communicate active blood glucose levels in a diabetic child. The device is marketed towards parents and caregivers of diabetic children in order to ease the everyday stresses associated with constant interpretation of blood glucose levels. Some benefits of our device as compared to other diabetic visual displays on the market is that it will be fully portable on the child and can move with them day-to-day. Our device features a resin circuit box with apple watch band connections, and our circuit uses a XIAO ESP32C-6 microcontroller, circle rainbow LED and Li-Po battery. We have a iOS application that can send glucose statuses via BLE to a microcontroller, but the connection times out if the app sleeps. Also, our battery won't charge through the microcontroller.

We are looking for help with Bluetooth connection to our XIAO ESP32-C6 microcontroller from an iPhone application. Currently, we have an iOS application that can receive values but does not self-transmit. We hope to receive feedback on how to transmit these values via a Bluetooth Low Energy connection.

**Conclusions/action items:** Use this pitch for Show and tell call to action.



## 03/20/26 - Show & Tell

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Lauren Klein - Mar 20, 2026, 12:57 PM CDT

**Title:** Show & Tell

**Date:** 03/20/26

**Content by:** Lauren

**Present:** Whole Team

**Goals:** To learn from seniors to solve our problems

**Content:**

- Showed our project to the prospective student Dr. P and Isabel talked to!!
- Raises the voltage and regulates it
- Unregulated voltage or current (look into buck converters to regulate it)
- Got suggested a PCB but explained why not
- Device could be pulling too much current to like reset the full charge
- Set up appointment w John
- Possible step down issue with battery (can step up to 5V)
- Need min/max current and voltage
- Battery isn't holding a charge? because of quality or something
- Lithium polymer battery?
- Test battery on other systems
- Priority on computer when plugged in?
- Server and
- extend period of time to every 30 seconds
- server is up but to be able to broadcast the server to devices and make findable by using Advertising
- Stops at set amount of time
- Might need to repeatedly advertise or make forever?
- Could conditionally run it
- Ty Bigger
- Computer going to sleep stops functioning XIAO
- Add something into loop to detect connection and if else start advertising
- Can advertise and connect at the same time but might not want to
- Can set up conditions to be what we want to
- Shitty battery could just not be able to hold the charge
- Krish said to buy a new battery that's detachable

**Conclusions/action items:** We have a potential fix for both issues but it's gonna be a fight against time.



## 2026/04/06- Ethics considerations

ISABEL PLOESSL - Apr 06, 2026, 12:19 PM CDT

**Title:** Ethics considerations

**Date:** 4/6/2026

**Content by:** Whole Team

**Present:** Wholes Team

**Goals:** To make ethical considerations about our device

**Content:**

1. **The Guidant VPs: Most of the VP's at Guidant are very much against reporting the data to the FDA. (a) How might they continue to justify their case? (b) What would be the moral foundations of their perspective?**
  1. **The product is still helping many people/ saving many lives, continue arguing that it is the surgeons fault and not theirs (shift the blame)**
  2. **Foundation that they would like to save more lives than are being taken, they didn't do the harm so they can continue on**
  
2. **Patients and doctors: Think about the position of those directly impacted: primarily patients who might be candidates for this surgery, and the doctors who use the device: (a) what arguments would those people want to ensure are considered by both the VPs and the design engineers about whether to report or not report the complications data? (b) What might be the ethical foundations of their perspective?**
  1. **Doctor: still helping patients, want to know if there have been other complications to approach the surgeries differently**
    1. **Patients: want to know the risks so they are able to make an informed decision about having the surgery**
  2. **Foundation that transparency and honesty is best for both patients and doctors, knowing the true complications and success rates are best for everyone**
  
3. **The design engineers: (a) What else can they say or do? (b) What arguments can they try to make, and to whom?**
  1. **They could go on strike/Could leak to the FDA or go above the VP's head/leak to the public**
  2. **They could make the argument to the VP's/public that they need to release it based on ethical standards of honesty**
  
4. **The design engineers: What options do they have? Generate a list of possible options (a minimum of 3 from the perspective of the design engineers), describe how each stakeholder is affected, then analyze them using the BME Code of Ethics (<https://www.bmes.org/2025/cmbconference/codeofconduct>) and a couple of tests from the [ethical decision-making system](#). Explain in detail the best option you would consider trying to act on.**
  1. Release to Public
  2. Release to FDA anonymously
  3. Go on strike
    1. Reversibility test: if it was yourself or your family would you want them to know what the true risks are
    2. Harm test: does the decision you make cause more harm than good long term?
    3. Publicity test: if the choice i choose to do was posted online would I still feel like i made the right decision
  4. Best option would be to send an anonymous tip to the FDA for their consideration

1. The VP's aren't listening or doing anything to help the cause, by tipping the FDA you are still making a choice that will affect change and help people, and it carries the most weight rather than just telling someone in the public and creating more fear, and potentially costing everyone at the company their jobs rather than just the specific people involved.

- In your design teams, identify components (at least 2) of your design that could face ethical dilemmas or have an ethical dimension (for example, safety is often a trade-off). **Answered below**
  - Consider the appropriate language in ABET Outcome 4: an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
  - Read through BME code of ethics: <https://www.bmes.org/2025/cmbeconference/codeofconduct>
  - Review the [Code of Ethics for Engineers and Ethical decision-making system](#)
  - Type up your answers and add to the case study answers (Q 1-4 above) – upload to Canvas. Copy and paste your design-specific ethics responses into your design notebook.
    - What components of your design have ethical dimensions (be specific and list at least 2)?
1. Children's Safety in regards to the internal circuitry (general safety/Rule of Practice I from Code of Ethics for Engineers)
  2. Data Breaching with the connection to each user's Dexcom Account (2.2.1 of BME code)
  3. Worldwide accessibility to the device (3.1.1 of BME code)
- How will your team address the ethical dimensions? (What is your action plan?)
1. The lid and box will serve as the shelter for the internal electric components but with the charging port on the side, we will need to include a warning statement that indicates the device cannot be completely submerged in water and can only withstand splashes from far distances (in accordance with IP 54).
  2. In order to avoid breach of confidentiality in regards to each individual's Dexcom Cloud data, we will have a disclaimer that logging in on unsafe Wi-Fi could lead to a breach of Dexcom Credentials. They will be told to always check with the Dexcom app before making treatment decisions as well in order to prevent usage of only our device.
  3. Driving down the costs will be the primary route to increase worldwide accessibility to the device as most families are already burdened with pharmaceutical costs of insulin, Continuous Glucose Monitors, and other necessary components.

**Conclusions/action items: To use these considerations and our given action plan to put them into place and ensure that our device is ethically sound.**



# 2026/02/05 Microcontroller Invoice

Claudia Beckwith - Feb 24, 2026, 4:07 PM CST

**Title:** Microcontroller Invoice (qty 3)

**Date:** 2/5/26

**Content by:** claudia

**Present:** claudia

**Goals:** Document purchases for our prototyping.

**Content:**

See attached pdf.

**Conclusions/action items:**

Attached in the invoice for the microcontroller. We will count this towards our total cost and update the purchase table.

Claudia Beckwith - Feb 24, 2026, 4:07 PM CST

8558, 10:47 AM Order # 4000480041

**seed studio**

**Invoice for Order #4000480041**

Seed Development Limited  
 5th floor, Building#17, Hengliang Industrial town, No.739 Zhouzhi Road, Hangcheng Street, Baoan District, Shenzhen 518055  
 ATTN: DENG  
 Tel: 00 86 755 36634826  
 Email: order@seed.io  
 Website: www.seedstudio.com  
 Invoice Date: 2026-02-05

Product Name	SKU	HS Code	COO	Price	Qty Invoiced	Subtotal
Seed Studio JMK ESP32-C6 (DFRCQ)	102010574	8542709900	CHINA	\$13.49	1	\$13.49
<b>Subtotal</b>						<b>\$13.49</b>
<b>Shipping</b>						<b>\$6.49</b>
<b>Grand Total</b>						<b>\$19.98</b>

**Order Information**

<p><b>Shipping Address</b></p> <p>Rachel Hoffman          777 Highland Ave          Madison, Wisconsin, 53705          United States          T: 6085205758 (tel:6085205758)</p>	<p><b>Shipping Method</b></p> <p>USLUNLROUND (5-10 working days)</p>
<p><b>Billing Address</b></p>	<p><b>Payment Terms</b></p> <p>100% In advance shipment controlled</p>
	<p><b>Payment Method</b> <input type="checkbox"/></p> <p>Credit Card <input type="checkbox"/> Leave a message</p>

File: /Users/seedstudio/Downloads/seedstudio.com/order/invoice\_4000480041.pdf 1/3

[Download](#)

**BME\_Student\_Order\_2.5\_x3.pdf (107 kB)**

# 2026/02/05 LED Invoice

Claudia Beckwith - Feb 24, 2026, 4:08 PM CST

**Title:** LED Invoice (qty 1)

**Date:** 2/5/26

**Content by:** claudia

**Present:** claudia

**Goals:** Document purchases for our prototyping.

**Content:**

See attached pdf.

**Conclusions/action items:**

Attached in the invoice for the LED. We will count this towards our total cost and update the purchase table.

Claudia Beckwith - Feb 24, 2026, 4:08 PM CST



[Download](#)

**BME\_Student\_Order\_2.5\_x2.pdf (137 kB)**



# 2026/02/05 Battery Invoice

Claudia Beckwith - Feb 24, 2026, 4:09 PM CST

**Title:** Battery Invoice (qty 1)

**Date:** 2/5/26

**Content by:** claudia

**Present:** claudia

**Goals:** Document purchases for our prototyping.

**Content:**

See attached pdf.

**Conclusions/action items:**

Attached in the invoice for the lithium-ion battery. We will count this towards our total cost and update the purchase table.

Claudia Beckwith - Feb 24, 2026, 4:09 PM CST



[Download](#)

**BME\_Student\_Order\_2.5.pdf (137 kB)**



# 2026/03/25 Electronic Component Invoice

Claudia Beckwith - Apr 08, 2026, 12:56 PM CDT

**Title:** Battery, Battery Forward Charger, and Pin Cable Invoice

**Date:** 3/25/26

**Content by:** claudia

**Present:** claudia

**Goals:** Document purchases for our prototyping.

**Content:**

See attached pdf.

**Conclusions/action items:**

Attached is the invoice for our most recent electronics order. We will count this towards our total cost and update the purchase table.

Claudia Beckwith - Apr 08, 2026, 12:56 PM CDT

Qty	Unit Price	Total Price
1	10.00	10.00
1	10.00	10.00
1	10.00	10.00
1	10.00	10.00
Subtotal		40.00
Tax		4.00
Grand Total		44.00

[Download](#)

**SALESORDER\_EMAIL98248612.pdf (61.4 kB)**

# 2026/04/15 LED Invoice

Claudia Beckwith - Apr 28, 2026, 12:42 PM CDT

**Title:** LED Invoice

**Date:** 4/15/26

**Content by:** claudia

**Present:** claudia

**Goals:** Document purchases for our prototyping.

**Content:**

See attached pdf.

**Conclusions/action items:**

Attached is the invoice for our most recent electronics order. We will count this towards our total cost and update the purchase table.

Claudia Beckwith - Apr 28, 2026, 12:44 PM CDT



[Download](#)

Ethridge\_Adafruit\_confirmation\_4.16.2026.pdf (95.3 kB)



## 2026/04/28 Final Cost Report

Claudia Beckwith - Apr 28, 2026, 12:16 PM CDT

**Title:** Final Cost Report

**Date:** 4/28/26

**Content by:** Claudia

**Present:** claudia

**Goals:** Record all the costs of good spent throughout the semester.

**Content:**

Category 1 - Appearance										
Item	Description	Manufacturer	Mft Pt#	Vendor	HS Code	Date	QTY	Cost Each	Total	Link
PLA Box Prototype	Box to fit new electronic components	UW Makerspace	N/A	UW Makerspace	N/A	3/11/2026	1	0.27	0.27	N/A
Resin Box Prototype	Resized box for electrical housing	UW Makerspace	N/A	UW Makerspace	N/A	3/17/2026	1	5.07	5.07	N/A
Watch Band	Apple watch compatible silicone band	PolyJoy	DBGJBZ001Q	Amazon	N/A	3/13/2026	2	4.99	9.99	<a href="#">Link</a>
PLA Box Prototype	Testing new dimensions	UW Makerspace	N/A	UW Makerspace	N/A	3/23/2026	1	0.27	0.27	N/A
Resin Box Prototype	Testing with new circuit components	UW Makerspace	N/A	UW Makerspace	N/A	3/24/2026	1	2.36	2.36	N/A
Resin Box Prototype	Updating power cord hole size	UW Makerspace	N/A	UW Makerspace	N/A	4/12/2026	1	2.36	3.57	N/A
Resin Box Prototype	Smaller size (no internal battery)	UW Makerspace	N/A	UW Makerspace	N/A	4/15/2026	1	2.36	3.30	N/A
Sports Arm	Holder for	YUNYILAN	N/A	Amazon	N/a	4/19/2026	2	7.99	15.98	<a href="#">arm band</a>

Band	portable charger									
Resin Box Final	Final Prototype for poster presentation	UW Makerspace	N/A	UW Makerspace	N/A	4/20/2026	2	2.46	4.92	
Resin Lid Final	Final Prototype for poster presentation	UW Makerspace	N/A	UW Makerspace	N/A	4/20/2026	2	1.05	2.10	
<b>Category 2 - Internal/Electronic Components</b>										
Item	Description	Manufacturer	Mft Pt#	Vendor	HS Code	Date	QTY	Cost Each	Total	Link
SeedStudioXIAO ESP32-C6 (3PCS)	Microcontroller for internal bracelet circuitry	SeedStudio	102010574	SeedStudio	8543709990	2/4/2026	1 (3 pack)	19.98	19.98	<a href="#">XIAO C6 microcontroller (3 pack)</a>
1 x NeoPixelJewel - 7 x 5050 RGB LED with Integrated Drivers [ID:2226] =	LED light for bracelet	Adafruit Industries	2226	Adafruit Industries	N/A	2/4/2026	1	20.39	20.39	<a href="#">NeoPixel Jewel - 7 x 5050 RGB LED with Integrated Drivers : Adafruit Industries, Unique &amp; fun DIY electronics and kits</a>
1 x Lithium Ion Polymer Battery - 3.7v 500mAh	Battery for bracelet	Adafruit Industries	1578	Adafruit Industries	N/A	2/4/2026	1	22.50	22.50	<a href="#">Lithium Ion Polymer Battery - 3.7v 500mAh : Adafruit Industries, Unique &amp; fun DIY electronics and kits</a>
1 x Lithium Ion Polymer Battery - 3.7v 500mAh	Battery for bracelet	Adafruit Industries	1578	Adafruit Industries	N/A	3/24/2026	1	7.95	7.95	<a href="#">Lithium Ion Polymer Battery - 3.7v 500mAh : Adafruit Industries, Unique &amp; fun DIY electronics and kits</a>
Adafruit Industries LLC LIPOLY BATTERY CHARGER W/USB C	Battery Forward Charger	Adafruit Industries	4410	Adafruit Industries	N/A	3/24/2026	1	5.95	5.95	<a href="https://www.digikey.com/en/products/detail/adafruit-industries-llc/4410/10673110">https://www.digikey.com/en/products/detail/adafruit-industries-llc/4410/10673110</a>
Pin Cable Male	Battery connector	Adafruit Industries	3814	Adafruit Industries	N/A	3/24/2026	2	0.75	1.5	<a href="https://www.digikey.com/en/products/detail/adafruit-industries-llc/3814/9380221">https://www.digikey.com/en/products/detail/adafruit-industries-llc/3814/9380221</a>

Header	cable									
1 x NeoPixel Jewel - 7 x 5050 RGB LED with Integrated Drivers [ID:2226] =	LED light for Dr. P's own personal bracelet	Adafruit Industries	2226	Adafruit Industries	N/A	4/15/2026	1	23.84	23.84	<a href="#">NeoPixel Jewel - 7 x 5050 RGB LED with Integrated Drivers : Adafruit Industries, Unique &amp; fun DIY electronics and kits</a>
VANYU ST S22 Portable Charger, 5000 mAh	Power bank for charging batteries	VANYU ST	N/A	Amazon	N/A	4/19/2026	2	9.99	19.98	<a href="#">charger link</a>
USB-C to USB right angle charger 1 ft	Cord to connect battery to band	SUNGU Y	N/A	Amazon	N/A	4/19/2026	2	7.99	15.98	<a href="#">charging cord link</a>
								<b>TOTAL:</b>	<b>167.55</b>	

**Conclusions/action items:**

**Total cost through this semester was \$167.55. The links and details of each transaction are outlined in the table above.**



## 2026/03/14 - Hardware Fabrication Protocol

---

Lauren Klein - Mar 14, 2026, 8:51 PM CDT

**Title:** Hardware (Circuitry) Fabrication Protocol

**Date:** 03/14/2026

**Content by:** Lauren

**Present:** Team

**Goals:** To create a Fabrication Protocol for our hardware/circuit side of the project

Content:

**Materials:**

1) XIAO ESP32-C6

Product Information: Seeed Studio Pt #102010574

Concentration/Amount/Dimensions: A single microcontroller

Function: Acts as the microcontroller and main processing unit of the device. It runs the app, manages input/output pins, and controls connected components such as the LEDs.

2) NeoPixel Jewel - 7 x 5050 RGB LED with Integrated Drivers

Product Information: Adafruit Industries Pt #2226

Concentration/Amount/Dimensions: A single Ring LED

Function: Provides visual output through programmable colored LEDs. Each LED can be individually controlled by the XIAO to display different colors and brightness levels, enabling status indicators, alerts, or lighting patterns controlled by the app.

3) Lithium Ion Polymer Battery - 3.7v 500mAh

Product Information: Adafruit Industries Pt #1578

Concentration/Amount/Dimensions: A single battery

Function: Supplies portable electrical power to the system, allowing the device to operate without being connected to a wired power source. The battery enables mobile or wearable operation and supports low-power embedded electronics such as the ESP32-C6 and LEDs.

4) 26 Gauge Connecting Wire

Product Information: Alpha Wire Hook-Up Wire, Pt #3049 BK005

Concentration/Amount/Dimensions: 9cm of wire

Function: Used for point-to-point electrical connections between electronic components in the circuit, including the microcontroller, LED, and the battery.

-Reference Expense Table for more information on each purchased material

**Equipment/External Materials (Makerspace):**

1) Adafruit Chip Quik Tack Flux 10cc Syringe with Plunger and Tip

Product Information: Adafruit Industries Pt #2667

Concentration/Amount/Dimensions: 0.1mL from the Syringe

Function: Improves the soldering process by cleaning metal surfaces and promoting solder flow. Flux removes oxidation from pads and component leads, allowing molten solder to properly wet and bond to the electrical contacts.

2) Stannol Wire, 0.5 mm Lead Free Solder, 227 °C

Product Information: Stannol #599100

Concentration/Amount/Dimensions: 12 inches or 0.5g of 0.5mm wire

Function: Used to create electrical and mechanical connections between electronic components and circuit boards. When melted by the soldering iron, the solder forms conductive joints that secure components such as the microcontroller and LEDs.

### 3) Orange Electrical Tape

Product Information: Uline #S-10520

Concentration/Amount/Dimensions: 20 x 20 mm square cut out

Function: Provides electrical insulation and mechanical protection for exposed wires and connections. It can also be used to secure components, bundle wires, and prevent short circuits in the assembled system.

### 4) Soldering Iron, 120 Watts 400-840F

Make & Model: Hakko FX-951-66

Function: To weld together items on our circuit.

### 5) Reflow oven

Make & Model: Reflow Ovens T962

Function: To redirect metal airflow from the soldering iron.

### 6) Wire Cutters

Function: To cut the adequate sized connecting wires for the circuit.

### 7) Wire Strippers

Function: To strip the ends of the connecting wires off.

-See Makerspace Website (<https://making.engr.wisc.edu/equipment/electronics/>) & Staff for more information

## **Method/Procedure:**

1. Prepare the workspace by clearing any debris and gathering all required materials/tools listed above.
2. Power on the soldering iron and allow it to heat to 750 °F for proper melting of the solder.
3. Clean the soldering iron tip using a brass wool.
4. Cut three pieces of 26 gauge insulated wire approximately 3 cm long.
5. Strip approximately 5 mm of insulation from each end of the cut wires, ensuring the stripped copper strands remain intact.
6. Gently twist the copper strands using fingers to prevent fraying.
7. Apply a small amount of flux (approximately 0.02mL) to the GND, DIN, and VOUT pins on the Ring LED (the DOUT will not be used) and the ESP32-C6 microcontroller.
8. Tin the stripped wire ends by touching the heated soldering iron tip to the exposed copper while feeding a small amount of solder until the strands are lightly coated and cool.
9. Position the ESP32-C6 and the NeoPixel LED so that the needed pins can be easily connected using the prepared wires, securing the boards if necessary to prevent movement.
10. Place one tinned wire between the VOUT of the Ring LED and the 5V pin on the ESP32-C6, then heat the joint with the soldering iron for 1–2 seconds until the solder melts and bonds to both the pad and the wire before removing the iron and allowing the joint to cool.
11. Repeat Step 10 for the GND pin of the Ring LED and GND of the ESP32-C6.
12. Repeat Step 10 for the DIN of the Ring LED and the D2 pin on the ESP32-C6.
13. Strip approximately 3 mm of insulation from the ends of the battery leads.
14. Tin the battery leads by briefly heating the exposed wire and applying a small amount of solder until the copper is lightly coated.
15. Solder the positive battery lead to the 3.3V pin on the ESP32-C6 by heating the pad and wire simultaneously until the solder melts and bonds the connection.

16. Solder the negative battery lead to a ground pin on the ESP32-C6 using the same heating procedure as Step 15.
17. Inspect all solder joints to ensure smooth solder fillets and no loose connections are present. If needed, fix any that aren't sufficiently bonded.
18. Cut 10 2cm pieces of electrical tape using the wire cutters and wrap them around any exposed solder joints or unused pins to prevent accidental contact.
19. Ensure the microcontroller light is blinking due to a stable connection to the battery and insert combined elements into the resin box.

**Conclusions/action items:** I need to submit the protocol to canvas. Claudia and Isabel will review order it to make sure it's sound and straightforward.



## 2026/04/28 Final App Deployment Fabrication

---

Claudia Beckwith - Apr 28, 2026, 11:48 AM CDT

**Title:** Final App deployment fabrication

**Date:** 4/28/26

**Content by:** claudia beckwith

**Present:** claudia

**Goals:** I want to outline the steps for deploying the iOS app so that anyone can replicate on their own device

**Content:**

GitHub repo containing all final files:

[https://github.com/cjbeckwith2-cyber/dexcom\\_project.git](https://github.com/cjbeckwith2-cyber/dexcom_project.git)

Steps for deploying personally:

- 1. Copy the Repository URL:**
  - Navigate to the GitHub repository on your hosting service
  - Click the **Code** button.
  - Ensure the **HTTPS** tab is selected and copy the provided URL
- 2. Open Your Terminal:**
  - Open your command-line interface, such as Terminal (Mac/Linux), Command Prompt, or [Git Bash](#) (Windows).
- 3. Navigate to the Destination:**
  - Use the `cd` command to move into the directory where you want the project folder to be created.
  - Example: `cd Documents/Projects`
- 4. Run the Clone Command:**
  - Type `git clone`, followed by a space, and paste the URL you copied earlier.
  - **Command:** `git clone https://github.com`
  - Press **Enter** to start the process.
- 5. Authenticate (If Prompted):**
  - If the repository is private, you will be asked for your credentials.
  - **Note:** Modern services like GitHub no longer accept account passwords for command-line authentication; you must use a [Personal Access Token \(PAT\)](#) or a credential manager.
- 6. Verify the Clone:**
  - Once the process finishes, navigate into the new directory: `cd [repository-name]`.
  - List the files to ensure everything downloaded correctly: `ls` (or `dir` on Windows).

Once all files are on local device, upload to VS Code

to deploy on iPhone follow the following steps:

**For iPhone:**

1. Open the project in Xcode by opening the `ios/Runner.xcworkspace` file.
2. Connect the iPhone to the computer via USB and trust the computer on the phone when prompted.
3. In Xcode, select the connected iPhone as the target device in the top toolbar.
4. Sign the app — go to the Runner target > Signing & Capabilities > select a Team (requires a free or paid Apple Developer account).
5. Click the Run (▶) button in Xcode, or run `flutter run` in the terminal with the phone connected.
6. On the phone, go to Settings > General > VPN & Device Management > trust the developer certificate so the app can open.

**General tips:**

- Make sure Flutter is installed and `flutter doctor` shows no critical errors before starting.
- For Android, the USB cable must support data transfer (not charge-only).

- The iPhone method requires a Mac; Windows/Linux cannot deploy to iOS.

**Conclusions/action items:**

Outlined above are all the steps needed to deploy our flutter app on any phone. The git hub repo contains all the latest files for the final version of the software.



# 2026/04/28 Final Microcontroller Programming

Claudia Beckwith - Apr 28, 2026, 11:52 AM CDT

## Title: Final Microcontroller Programming

Date: 4/28/26

Content by: claudia

Present: claudia

Goals: I want to outline the steps to program the microcontroller using our most recent code.

## Content:

1. **Install Arduino IDE** Download and install the latest Arduino IDE from <https://www.arduino.cc/en/software>

### 2. Add ESP32 Board Package URL

- Open Arduino IDE > go to **File > Preferences**
- In the "Additional Boards Manager URLs" field, paste: `https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json`
- Click OK

### 3. Install the ESP32 Board Package

- Go to **Tools > Board > Boards Manager**
- Search for esp32
- Install "**esp32 by Espressif Systems**" (version 3.0.0 or later, which includes C6 support)
- Wait for installation to complete

### 4. Install Required Libraries

- Go to **Sketch > Include Library > Manage Libraries**
- Install any libraries your project uses — common ones for the C6 include:
  - **WiFi** (built into ESP32 package)
  - **Wire** (built in, for I2C)
  - **ArduinoJSON** if parsing JSON
  - Any other project-specific libraries

### 5. Select the Correct Board

- Go to **Tools > Board > esp32 > XIAO\_ESP32C6**
- If it doesn't appear, search for "XIAO" in the board list

### 6. Configure Board Settings

 Under the **Tools** menu, set:

- **Port:** (leave for now, set after connecting)
- **USB CDC On Boot:** Enabled
- **Flash Size:** 4MB (default)
- **Partition Scheme:** Default 4MB

### 7. Connect the XIAO ESP32-C6

- Plug the board into the computer via USB-C
- If it's the first time, Windows may need a driver — install the **CH343 driver** from <https://www.wch-ic.com/products/CH343.html> (Mac/Linux usually detect it automatically)

### 8. Put the Board in Boot Mode (if needed)

 If the port doesn't appear or upload fails:

- Hold the **BOOT** button

- Press and release **RESET** while holding **BOOT**
- Release **BOOT** — the board is now in bootloader mode

### 9. Select the Port

- Go to **Tools > Port**
- Select the COM port (Windows: COM3, COM4, etc. / Mac: /dev/cu.usbmodem... / Linux: /dev/ttyACM0)

### 10. Open Your Project

- Open the .ino project file in Arduino IDE

### 11. Verify/Compile the Code

- Click the **checkmark (✓)** button to compile and check for errors
- Fix any missing library errors by going back to step 4

### 12. Upload the Code

- Click the **right arrow (→) Upload** button
- The IDE will compile and flash the board
- You should see Done uploading in the output console

### 13. Verify It's Working

- Open **Tools > Serial Monitor**
- Set baud rate to match your code (commonly 115200)
- Press the **RESET** button on the board
- You should see your program's serial output confirming it's running

project file pasted below:

```
#include <BLEDevice.h>

#include <BLEUtils.h>

#include <BLEServer.h>

#include <Adafruit_NeoPixel.h>

#define SERVICE_UUID "4fafc201-1fb5-459e-8fcc-c5c9c331914b"

#define CHARACTERISTIC_UUID "beb5483e-36e1-4688-b7f5-ea07361b26a8"

#define PIN D3

#define NUMPIXELS 7

#define TIMEOUT_MS 720000 // 12 minutes
```

```
Adafruit_NeoPixel jewel(NUMPIXELS, PIN, NEO_GRB + NEO_KHZ800);
```

```
BLECharacteristic *pCharacteristic;
```

```
bool deviceConnected = false;
```

```
unsigned long lastDataTime = 0;
```

```
bool timeoutActive = false;
```

```
// — Helpers —————
```

```
void setAllPixels(uint32_t color) {
```

```
for (int i = 0; i < NUMPIXELS; i++) {
```

```
    jewel.setPixelColor(i, color);
```

```
}
```

```
    jewel.show();
```

```
}
```

```
uint32_t getColorForValue(int val) {
```

```
    if (val < 55) return jewel.Color(255, 0, 0);
```

```
    else if (val < 65) return jewel.Color(255, 65, 0);
```

```
    else if (val < 80) return jewel.Color(255, 255, 0);
```

```
    else if (val < 139) return jewel.Color(0, 255, 0);
```

```
    else if (val < 200) return jewel.Color(0, 0, 255);
```

```
    else return jewel.Color(180, 0, 180);
```

```
}
```

```
// New: color index helper for test mode

uint32_t getColorFromIndex(int idx) {

switch (idx) {

case 0: return jewel.Color(255, 0, 0); // Red

case 1: return jewel.Color(255, 65, 0); // Orange

case 2: return jewel.Color(255, 255, 0); // Yellow

case 3: return jewel.Color(0, 255, 0); // Green

case 4: return jewel.Color(0, 0, 255); // Blue

case 5: return jewel.Color(180, 0, 180); // Purple

case 6: return jewel.Color(255, 255, 255); // White

default: return jewel.Color(0, 0, 0); // Off

}

}

// — Pulse Animation —————

void pulsewhite() {

static int brightness = 0;

static int fadeAmount = 5;

brightness += fadeAmount;

if (brightness <= 0 || brightness >= 230) {

fadeAmount = -fadeAmount;
```

```
}
```

```
uint32_t color = jewel.Color(brightness, brightness, brightness);
```

```
setAllPixels(color);
```

```
delay(30);
```

```
}
```

```
// — BLE Characteristic Callback —————
```

```
class MyCallbacks : public BLECharacteristicCallbacks {
```

```
void onWrite(BLECharacteristic *pCharacteristic) {
```

```
String value = pCharacteristic->getValue().c_str();
```

```
if (value.length() == 0) return;
```

```
// Reset timeout timer
```

```
lastDataTime = millis();
```

```
timeoutActive = false;
```

```
// — TEST COMMAND (T0-T6) —————
```

```
if (value[0] == 'T' && value.length() > 1) {
```

```
int idx = value[1] - '0';
```

```
Serial.print("Test color index: ");
```

```
Serial.println(idx);
```

```
setAllPixels(getColorFromIndex(idx));
```

```
return; // stop here
```

```
}
```

```
// — BRIGHTNESS COMMAND —————
```

```
if (value.startsWith("B")) {
```

```
int brightness = value.substring(1).toInt();
```

```
int mapped = map(brightness, 0, 100, 0, 255);
```

```
jewel.setBrightness(mapped);
```

```
jewel.show();
```

```
Serial.print("Brightness set to: ");
```

```
Serial.print(brightness);
```

```
Serial.println("%");
```

```
return;
```

```
}
```

```
// — GLUCOSE VALUE —————
```

```
int glucose = value.toInt();
```

```
Serial.print("Glucose received: ");
```

```
Serial.println(glucose);
```

```
setAllPixels(getColorForValue(glucose));
```

```
}
```

```
};
```

```
// — BLE Server Callbacks —————  
  
class MyServerCallbacks : public BLEServerCallbacks {  
  
void onConnect(BLEServer* pServer) {  
  
deviceConnected = true;  
  
Serial.println("Client connected");  
  
}  
  
void onDisconnect(BLEServer* pServer) {  
  
deviceConnected = false;  
  
Serial.println("Client disconnected");  
  
BLEDevice::startAdvertising();  
  
Serial.println("Advertising restarted");  
  
}  
  
};  
  
  
// — Setup —————  
  
void setup() {  
  
Serial.begin(115200);  
  
jewel.begin();  
  
jewel.setBrightness(100);  
  
jewel.show();  
  
}
```

```
lastDataTime = millis();

BLEDevice::init("XIAO_ESP32C6");

BLEServer *pServer = BLEDevice::createServer();

pServer->setCallbacks(new MyServerCallbacks());

BLEService *pService = pServer->createService(SERVICE_UUID);

pCharacteristic = pService->createCharacteristic(
CHARACTERISTIC_UUID,
BLECharacteristic::PROPERTY_READ |
BLECharacteristic::PROPERTY_WRITE
);

pCharacteristic->setCallbacks(new MyCallbacks());

pCharacteristic->setValue("Waiting...");

pService->start();

BLEAdvertising *pAdvertising = BLEDevice::getAdvertising();

pAdvertising->addServiceUUID(SERVICE_UUID);

pAdvertising->setScanResponse(true);

pAdvertising->setMinPreferred(0x06);

pAdvertising->setMinPreferred(0x12);
```

```
BLEDevice::startAdvertising();

Serial.println("BLE ready – waiting for glucose values.");

}

// — Loop —————

void loop() {

unsigned long currentTime = millis();

if ((currentTime - lastDataTime) > TIMEOUT_MS) {

timeoutActive = true;

}

if (timeoutActive) {

pulseWhite();

} else {

delay(100);

}

}
```

**Conclusions/action items:**

Final code and steps to deploy are outlined above. Anyone could use these steps to replicate the microcontroller code that works with the app.



[Download](#)

**BLE\_with\_failure\_detection.ino (6.04 kB)**



## 2026/04/28 - Fabrication of Band

ISABEL PLOESSL - Apr 28, 2026, 12:51 PM CDT

**Title:** Fabrication of band

**Date:** 4/28/2026

**Content by:** Isabel

**Present:** N/A

**Goals:** Create a fabrication of the band

**Content:** Attached in pdf below

**Conclusions/action items:** Use this fabrication for final deliverables

ISABEL PLOESSL - Apr 28, 2026, 12:50 PM CDT

### Fabrication Procedure: Box and Lid

#### 1. CAD Creation (SolidWorks)

- Sketch base rectangle (31 x 28 mm) → Extrude to form outer case
- Use Shell to create internal cavity (~1.5-2 mm wall thickness)
- Add internal ledge for lid using Extrude Cut / O-Block
- Create snap slots and USB-C opening with Cut-Extrude
- Apply Fillets (R1.5-1.7) to edges for comfort and stress reduction
- Model lid separately: sketch rectangle → Extrude, then a pply Dome/Fillet (R15) for curvature
- Add snap-fit features using angle extrusion/cut features along side walls

#### 2. CAD Finalization

- Verify all critical dimensions in SolidWorks
  - Case outer dimensions (31 x 28 mm)
  - Internal cavity (~25-27 mm range)
  - Lid curvature (R15) and thickness (~3 mm)
- Confirm tolerances for snap-fit interfaces (recommended: 0.1-0.2 mm clearance)
- Ensure snap-slots and USB-C opening are dimensioned correctly for fit

#### 3. File Preparation

- Export both box and lid as .stl files
- Import into slicing software (PrusaMM for resin)
- Set print orientation:
  - Box: open side facing upward (minimize internal supports)
  - Lid: curved surface facing upward for best finish

#### 4. 3D Printing

- Printer type: MakeSpace mini printer for black and clear
- Material: Tough or ABS-like resin (for durability + snap-fit performance)
- Suggested settings:
  - Layer height: 0.05-0.1 mm
  - Infill: solid (post-cure)
  - Supports:
    - Minimal on outer surfaces
    - Focus on underside edges and overhangs

#### 5. Post-Processing (done by makerspace)

[Download](#)

3D\_print\_fabrication\_.pdf (71.1 kB)



## 2026/04/28 Connectivity Testing Protocol and Results

---

Claudia Beckwith - Apr 28, 2026, 12:27 PM CDT

### **Title: Connectivity Testing Protocol and Results**

**Date:** 04/28/2026

**Content by:** Lauren

**Present:** Lauren & Claudia

**Goals:** In order to test the effectiveness of the BLE, we want to perform a test over varying distances to observe the LED color and transmitted microcontroller blood glucose values. We want to ensure that the led can update on its own and consistently. We are using Isabel's blood glucose values for the purposes of these tests.

### **Content:**

#### Objective:

To verify that the wearable device's LED correctly changes colors based on programmed conditions, reaches the connectivity range requirement, and the microcontroller is getting the correct updated values at increasing distance intervals to reduce delays.

#### Equipment and Materials:

- Prototype wearable device with controllable LED
- Phone running iOS Flutter app, logged into Isabel's Dexcom
- Meter measuring stick

#### Setup:

1. log into Isabel's Dexcom account on the iOS Flutter app
2. Connect via BLE to powered on band device
3. Set up starting distance

#### Procedure:

1. Repeat the following steps 3 times at each ~10m interval (increasing for each successful trial)
  1. Record distance from individual wearing device to phone using the iOS app
  2. Run "Test Connectivity" program from manual initiation on the SugarSafe app
  3. Record if any colors of program were skipped or if all 6 successfully cycled
    1. If all 6 cycled, BLE connection was actively established and distance increment is considered successful (pass)
    2. If any skipped or the cycle did not run, the BLE connection was not successful (fail)
    3. Note any delays in light color changes
  4. Record any other observation of device/LEDs or environment blockages

#### Success Standard:

Goal is to maintain the MARD of <8.5% that Dexcom aims to maintain with their CGM. This means that microcontroller/software flow doesn't reduce the accuracy of the CGM. For the "Test Connectivity" to run, the iPhone app must be in range of the microcontroller, meaning that the LED can only cycle through the test program if a successful connection is actively established. Also, per client requests, we need to have a visibility and connectivity range of at least 50 meters to simulate that of an average playground.

### **Conclusions/action items:**

We performed testing based on the listed procedure. Test was very successful and actually reached 3x the distance required by the clients (161m) for visibility and connectivity ranges! There were also no delays recorded.



## 2026/04/28 - Activity Testing Protocol and Results

ISABEL PLOESSL - Apr 28, 2026, 12:23 PM CDT

**Title:** Activity testing protocol and results

**Date:** 4/28/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To design a testing protocol for the activity testing

**Content:** Attached as pdf below

**Conclusions/action items:** Perform test based on procedure and use results

ISABEL PLOESSL - Apr 28, 2026, 12:24 PM CDT

### Testing Protocol: SugarSafe Band Rotation During Activity

#### Objective:

To measure the percent rotation of the band around the wrist after different physical activities.

#### Materials:

Wristband prototype, marker or tape, liner, measuring tape or angle guide, dial table.

#### Procedure:

1. Place the band securely on the participant's wrist in the starting position.
2. Mark the starting position of the band on the wrist using tape or a skin-safe marker.
3. Have the participant perform one activity for 60 seconds.
4. After 60 seconds, record how far the band shifted around the wrist.
5. Calculate the percent rotation using:

$$\text{Percent Rotation} = \frac{\text{Distance shifted around wrist}}{\text{Wrist circumference}} \times 100$$

- a. Repeat the same activity for 3 trials.
7. Repeat steps 3-6 for each activity:
    - o Walking
    - o Running
    - o Jumping
    - o Jumping jacks
  8. Average the 3 trials for each activity.
  9. Compare the average percent rotation between activities to determine which motions caused the most band shifting.

#### Acceptance Criteria:

The wristband should remain securely positioned with minimal rotation during activities. Lower percent rotation indicates better stability and fit.

[Download](#)

activity\_protocol\_.pdf (127 kB)



## 2026/04/28 Accuracy Testing Protocol and Results

Claudia Beckwith - Apr 28, 2026, 12:35 PM CDT

### Title: Accuracy Testing Protocol and Results

**Date:** 04/28/2026

**Content by:** Claudia

**Present:** Claudia

**Goals:** In order to test the effectiveness of the app backend code, we want to perform a test over 5 hours to observe the app updated value and LED color in relation to the actual Dexcom reading. We want to ensure that the app can update correctly. We are using Isabel's blood glucose values for the purposes of these tests.

### Content:

#### Objective:

To verify that the app and wearable device's LED correctly update and changes colors based on programmed conditions.

#### Equipment and Materials:

- Prototype wearable device with controllable LED
- Phone running iOS Flutter app, logged into Isabel's Dexcom
- Dexcom account also logged into Isabel's readings as a control

#### Setup:

1. log into Isabel's Dexcom account on the iOS Flutter app
2. log in on Dexcom Share
3. Connect via BLE to powered on band device

#### Procedure:

1. Record starting Dexcom reading, app reading, and LED color
2. after 5 minutes, record the values again

#### Success Standard:

Testing was performed across different dates to ensure test values encompassed the spectrum of ranges, both low and high. Results demonstrated that the SugarSafe app and band displayed the correct expected values and colors, respectively, with 100% accuracy. Plotting expected values against observed shows a perfect linear slope with an  $R^2$  of 1. This test meets the PDS requirements of maintaining at least 95% accuracy with transmitted test results as well as the client requirement stating delay time should not exceed 5 minutes, as data is updated continuously

#### Raw Data of Results:

Table 1: Accuracy Data and Color Mapping

Time	PyDexcomReading	Microcontroller reading	Expected color	Actual color
9:20	160	160	Blue	Blue
9:25	158	158	Blue	Blue

9:30	154	154	Blue	Blue
9:36	146	146	Blue	Blue
9:41	149	149	Blue	Blue
9:45	157	157	Blue	Blue
9:50	165	165	Blue	Blue
9:55	175	175	Blue	Blue
10:01	182	182	Blue	Blue
10:08	190	190	Blue	Blue
10:09	200	200	Purple	Purple
10:16	208	208	Purple	Purple
10:19	214	214	Purple	Purple
10:26	220	220	Purple	Purple
4:19	74	74	Yellow	Yellow
4:27	62	62	Orange	Orange
4:32	62	62	Orange	Orange
4:39	84	84	Green	Green
4:44	98	98	Green	Green
4:50	108	108	Green	Green
4:58	122	122	Green	Green
5:03	117	117	Green	Green
5:08	119	119	Green	Green
5:16	148	148	Blue	Blue
5:22	166	166	Blue	Blue
8:42	223	223	Purple	Purple
8:48	214	214	Purple	Purple

8:54	205	205	Purple	Purple
9:02	197	197	Blue	Blue
1:32	150	150	Blue	Blue
1:33	151	151	Blue	Blue
1:38	158	158	Blue	Blue
1:45	142	142	Blue	Blue
1:50	138	138	Green	Green
2:13	66	66	Yellow	Yellow
2:18	69	69	Yellow	Yellow
2:23	68	68	Yellow	Yellow
2:29	72	72	Yellow	Yellow
2:35	74	74	Yellow	Yellow
2:42	82	82	Green	Green
2:47	81	81	Green	Green
2:52	84	84	Green	Green
5:00	144	144	Blue	Blue
5:05	151	151	Blue	Blue
5:10	155	155	Blue	Blue
5:15	157	157	Blue	Blue
5:20	159	159	Blue	Blue
5:25	162	162	Blue	Blue
5:30	163	163	Blue	Blue
5:35	165	165	Blue	Blue
5:40	171	171	Blue	Blue
5:45	163	163	Blue	Blue

5:50	168	168	Blue	Blue
5:55	165	165	Blue	Blue
6:00	220	220	Purple	Purple
6:05	235	235	Purple	Purple
6:10	229	229	Purple	Purple
6:15	240	240	Purple	Purple
6:33	199	199	Blue	Blue
6:38	189	189	Blue	Blue
11:12	100	100	Green	Green
11:17	108	108	Green	Green
11:23	112	112	Green	Green
11:28	118	118	Green	Green
11:35	117	117	Green	Green
11:42	116	116	Green	Green
11:47	121	121	Green	Green
11:55	124	124	Green	Green
12:00	143	143	Blue	Blue
12:05	148	148	Blue	Blue
12:10	147	147	Blue	Blue
12:15	149	149	Blue	Blue
12:20	139	139	Green	Green
12:25	138	138	Green	Green
12:30	136	136	Green	Green
12:35	129	129	Green	Green
8:22	62	62	Orange	Orange

8:27	59	59	Orange	Orange
8:36	55	55	Red	Red
1:30	89	89	Green	Green
1:35	92	92	Green	Green
1:40	95	95	Green	Green

**Conclusions/action items:**

We performed testing based on the listed procedure. Test was very successful with 100% success observed over every point. This leads us to conclude our device and app work correctly and can be used for our prototype.



## 2026/04/28 Fail Light Detection Testing Protocol and Results

---

Claudia Beckwith - Apr 28, 2026, 12:39 PM CDT

### **Title: Accuracy Testing Protocol and Results**

**Date:** 04/28/2026

**Content by:** Claudia

**Present:** Claudia

**Goals:** In order to test the effectiveness of the fail light feature, we want to forceably disconnect the ble connection and make sure it happens at exactly 12 minutes.

### **Content:**

#### Objective:

To verify that the LED fail light code deploys correctly.

#### Equipment and Materials:

- Prototype wearable device with controllable LED
- Phone running iOS Flutter app, logged into Isabel's Dexcom
- timer

#### Setup:

1. log into Isabel's Dexcom account on the iOS Flutter app
2. Connect via BLE to powered on band device

#### Procedure:

1. Start with a connected BLE microcontroller
2. drop the connection on the app and start the timer
3. Record how long it takes to show the white blinking light

#### Success Standard:

A successful test was denoted by the observance of the pulsing white alert light after exactly 12 minutes from the time of the dropped connection. The test was performed 5 times, and results demonstrated 100% accuracy with initiating the alert light feature.

#### **Conclusions/action items:**

We performed testing based on the listed procedure. Test was very successful with 100% success observed at each trial. This leads us to conclude our device will correctly deploy the white blink light after exactly 12 minutes, showing the caregivers of a dropped connection.

# 2026/02/13 Design Matrix

Claudia Beckwith - Feb 17, 2026, 4:21 PM CST

**Title:** Design Matrix

**Date:** 2/13/2026

**Content by:** claudia, isabel, lauren

**Present:** all

**Goals:** We want to evaluate the 3 different designs based on our established criteria. This will help us make an informed decision on what the smartest choice will be moving forward when considering what the client wants and what we have researched. Our 3 designs are BLE only, Wi-Fi only, and a combo.

**Content:**

Table 1: Design Matrix ranking competing designs of data transmission from iOS application to microcontroller on 6 different criteria.

Designs	BLE 5.0	Wi-Fi 6	Both Wi-Fi 6 and BLE 5.0
Power Consumption (25)	5/5 (25 pts)	3/5 (15 pts)	2/5 (10 pts)
Connection Ranges (25)	3/5 (15 pts)	4/5 (20 pts)	4/5 (20 pts)
Ease of Use (20)	4/5 (16 pts)	2/5 (8 pts)	3/5 (12 pts)
Accessibility (15)	3/5 (9 pts)	4/5 (12 pts)	5/5 (15 pts)
Feasibility (10)	5/5 (10 pts)	3/5 (6 pts)	2/5 (4 pts)
Replicability (5)	4/5 (4 pts)	3/5 (3 pts)	1/5 (1 pt)
Total (100)	79 pts	64 pts	62 pts

**Power Consumption:**

When rating the power consumption category, BLE had by far the lowest usage of the three options. BLE is typically <0.01 W since it is specifically designed for low-energy operation. Wi-Fi has a much larger typical consumption range (about 0.5-

2 W), making it the next best option for the alerting system but still significantly higher than BLE [1]. When both Wi-Fi 6 and BLE 5.0 are used together, however, power consumption can become more complicated. In our chosen microcontroller, the Seeed Studio XIAO ESP32-C6, both protocols operate on the same 2.4 GHz frequency band, which can create signal interference and lead to increased power draw and faster battery drain, making this design the lowest rating [2].

#### Connection Ranges:

The alerting system must maintain a reliable wireless link to the connection device at all times to ensure accuracy in LED signals. While BLE 5.0 is extremely power-efficient, it is highly sensitive to walls, metal, and environmental interference, though long-range modes can extend coverage to roughly 40-50 meters on medium power and 100 meters on high power [3]. The Wi-Fi 6 2.4 GHz frequency band offers substantially greater and more consistent coverage, about 46 meters indoors and 91 meters outdoors [4]. The hybrid BLE and Wi-Fi approach would take on that of the Wi-Fi since it doesn't require different power modes and is more reliable. Overall, all three options do meet the client requirement of a range of 50 meters which is comparable to that of an average playground diameter.

#### Ease of Use:

Ease of use was analyzed as the user's ability to set up the program with moderate simplicity and no extensive technical knowledge. BLE 5.0 is generally very easy to set up from a user perspective using simple device pairing. As seen in most smart devices, BLE uses automatic discovery and minimal network configuration, which makes it most intuitive for users [5]. Wi-Fi 6 2.4 GHz offers strong performance but requires more involved setup steps, such as network selection, password entry, and router configuration. This would increase user burden and the likelihood of setup errors. The combined BLE 5.0 and Wi-Fi 6 approach introduces additional complexity as the individual set up of both paths is needed.

#### Accessibility:

Accessibility was evaluated using both United States metrics and global availability. Wi-Fi, measured by the percentage of people with internet access, had the highest overall accessibility: over 90% in the U.S. and about 70% globally [6]. These values were slightly higher than Bluetooth device availability, which is approximately 82% in the U.S. and 63% worldwide [7]. While both connectivity options are widely accessible, allowing the device to switch between pairing methods provides the greatest accessibility overall, giving it the highest rating.

#### Feasibility:

Between the three designs, implementing BLE 5.0 connectivity is the most straightforward. It does not require a backend, and iOS provides native BLE support through CoreBluetooth, making device discovery and Generic Attribute Profile (GATT) communication well-defined and standardized. A Wi-Fi 6 design increases complexity because the microcontroller must first be provisioned with network credentials and then maintain a reliable IP connection. It may also encounter issues on managed networks that use captive portals or client isolation policies, where embedded devices are often blocked [5][8]. The hybrid model is the most complex, requiring both BLE and Wi-Fi implementation plus connection-state management logic to allow the system to seamlessly jump between BLE and Wi-Fi, adding more edge cases and testing.

#### Replicability:

In terms of replication, a BLE 5.0 system is the most scalable when deploying many XIAO microcontrollers, each paired to its own iPhone. Because BLE does not rely on shared network infrastructure or backend coordination, each device/phone pair operates independently. Additionally, by assigning each microcontroller with a unique BLE identifier, the iOS app can easily scan, select, and store the device for easy reconnection. In contrast, a Wi-Fi 6 system makes replication much more difficult, as each device must be configured to the local network. A hybrid model further complicates replication because both communication stacks must be maintained and tested across multiple units [9].

#### References:

[1] Noman, "WiFi vs Bluetooth: Understanding Power and Bandwidth Use," Archer IT Solutions, Jan. 11, 2026. [Online]. Available: <https://www.archer-its.com/wifi-vs-bluetooth-which-uses-more-power-and-bandwidth/>. [Accessed: Feb. 9, 2026].

[2] Espressif Systems, ESP32-C6 Series Datasheet, Version 1.1, Oct. 2024.

[3] BlueIoT (Beijing) Technology Co., Ltd., "How Far Can BLE Really Transmit? Indoor vs Outdoor Range," 2025. [Online]. Available: <https://www.blueiot.com/blog/how-far-can-BLE-transmit.html>. [Accessed: Feb. 9, 2026].

[4] Micro Center, "Wi-Fi 5 vs Wi-Fi 6," 2025. [Online]. Available: <https://www.microcenter.com/site/mc-news/article/wifi-5-vs-wifi-6.aspx>. [Accessed: Feb. 9, 2026].

[5] K. Oliynyk, "Bluetooth vs WiFi for IoT Projects: Which is Better?," WebbyLab, Mar. 25, 2025. [Online]. Available: <https://webbylab.com/blog/bluetooth-vs-wifi-for-iot-project/>. [Accessed: Feb. 9, 2026].

[6] World Population Review, "Internet Users by Country 2026," 2026. [Online]. Available: <https://worldpopulationreview.com/country-rankings/internet-users-by-country>. [Accessed: Feb. 9, 2026].

[7] J. Howarth, "How Many People Own Smartphones? (2025–2029)," Exploding Topics, Jan. 12, 2026. [Online]. Available: (website URL). [Accessed: Feb. 9, 2026].

[8] M. Afaneh, "Bluetooth LE for Wi-Fi Onboarding and IoT Provisioning," Novel Bits, Feb. 11, 2026. [Online]. Available: <https://novelbits.io/ble-wifi-onboarding-provisioning/>. [Accessed: Feb. 9, 2026].

[9] B. Marnat, "BLE or Wi-Fi: What You Need to Know," ELA Innovation, Sep. 8, 2025. [Online]. Available: <https://elainnovation.com/en/ble-vs-wi-fi-what-you-need-to-know/>. [Accessed: Feb. 9, 2026].

#### **Conclusions/action items:**

Based on this design matrix, we are looking at moving forward with the BLE only design. While we recognize some limitations regarding distance of connection with this design, it still wins overall due to its simplicity and effectiveness. The biggest asset will be with how we conserve battery life when we don't have to support wi-fi.



## 2026/02/20 Preliminary Presentation

Claudia Beckwith - Feb 20, 2026, 11:41 AM CST

**Title:** Preliminary Presentation

**Date:** 2/20/26

**Content by:** claudia

**Present:** whole team

**Goals:** We want to create a presentation outlining all the work we have done so far. We will touch on our client requirements to give the audience a good idea of what our project is, and we will share our plan moving forward in the semester.

**Content:**

See attached pdf

**Conclusions/action items:**

We are going to present our prelim presentation to our advisor, clients, and 4 other teams. This will be a good opportunity to learn about other groups, gain inspiration, and share ideas. We are at a good place for setting up our timeline for the rest of the semester.

Claudia Beckwith - Feb 20, 2026, 11:42 AM CST



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wgas301PrelimPres\_2\_.pdf (705 kB)



# 2026/02/24 Preliminary Report

Claudia Beckwith - Feb 24, 2026, 9:45 PM CST

**Title:** Preliminary Report

**Date:** 2/24/2026

**Content by:** claudia

**Present:** whole team

**Goals:** We want to create a report reflective of all the work we have accomplished this semester along with last. This will be extremely helpful in drafting our final report, and outlines what we need to work on.

**Content:**

See attached pdf

**Conclusions/action items:**

We need to finish our prototyping and start testing.

Claudia Beckwith - Feb 24, 2026, 9:45 PM CST



## Preliminary Report

Wearable Glucose Alerting System

Team Members:

[Claudia Beckwith - BWIG & BPAU](#)

[Isabel Plonzi - Team Leader](#)

[Lucas Klein - BPAU & Co-creator](#)

Client: Olive Carraglin, Callie Berg, Dr. Beth Martin

Advisor: Dr. John Pucinski

TA: Isabelle Peters

February 25th, 2026

BME 301

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wgas301prelimreport.pdf (1.1 MB)

**Title:** Sugar Safe poster

**Date:** 4/28

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To finish out final poster

**Content:** Poster attached below

**Conclusions/action items:** Finish report !



**SugarSafe Band: A Diabetic Alerting Device**  
 Claudia Beckwith, Isabel Ploessl, Lauren Klein  
 Clients: Caille Berg, Olive Comiglia, Dr. Beth Martin  
 Advisor: Dr. John Puccinelli, PhD  
 TA: Isabelle Peters  
 IME Design 301, April 24, 2026

**Motivation & Problem Statement**  
 Motivation: Caring for a child with Type 1 Diabetes (T1D) demands constant vigilance, yet caregivers often lack a simple, immediate way to understand their child's sugar levels require action.  
 Problem Statement: Parents and caregivers of children with T1D often struggle to quickly use and interpret glucose readings, leading to stress and delayed decisions. The SugarSafe Band aims to solve this problem by providing a clear, visual representation of the child's current blood sugar.

**Background & Competing Designs**  
 Background: Type 1 Diabetes (T1D) is an autoimmune disease that prevents insulin production, causing elevated blood glucose and risk of long-term complications if unmanaged [1]. Unmanaged management may cause long-term glucose toxicity (LGT), ketoacidosis, hypoglycemia, and individualized results during [2]. There are 1.6M patients T1D patients in the U.S. [3].  
 Competing Designs:  
 • Apple Watch: Can receive glucose level directly with Dexcom Share-to-watch [4]. Parents find setup with Dexcom and difficult to read [4].  
 • GlucoSense: Uses a color scale for color temperature. Inexpensive, requires a constant Wi-Fi connection [5].

**Design Criteria**  
 • Display color-coded alerts for real-time glucose readings.  
 • Limit glucose reading delay to 7 seconds.  
 • Ensure compatibility with various OSes.  
 • Provide 18 hours of independent battery life.  
 • Include visible indicator for T1D or Bluetooth status.  
 • Target a visible and extended via Bluetooth at 70 m.  
 • Operate reliably in typical ambient-temperature conditions.  
 • Temperature: -20 °C to 43 °C [6].  
 • Water resistance: IP68 [7].  
 • Sleep resistance: Survive 2.5 m drops [8].  
 • Fit pediatric wrists (12.5-17.5 cm circumference) [9].

**Final Prototype**  
 Software:  
 • App connects to Dexcom's Share API using user credentials.  
 • Glucose data and trend information fetched every 30 seconds.  
 • App displays glucose values, trend, and color status.  
 • Adjustable brightness control.  
 • Bluetooth pair button.  
 • App sends lower values to microcontroller every 7 minutes.  
 • Microcontroller maps values to color and updates LEDs.  
 • Band automatically vibrates when after 12 minutes with no new data.  
 Hardware:  
 • Microcontroller with BLE capabilities.  
 • Resistor-integrated LEDs.  
 • Powered via USB-C, connected to a 300mAh, rechargeable Li-Ion battery.  
 • 12-hour battery life at maximum BLE and LED usage (10hrs & 6 hrs).  
 Band Design:  
 • 1.47 printed black resin case, measures 21 x 30 mm.  
 • Clear resin strap (1.64 and 1.93 C) clamping opening.  
 • Balanced band connection health reflect band, with double-loop locking mechanism.  
 • Adjustable band to fit child-size wrists.

**Testing & Results**  
 Band Security Testing: Average Percent Status of Band Around the Wrist. Shows a bar chart with values for Band Security, Band Accuracy, Band Reliability, and Band Usability.  
 Band Accuracy Testing: Average Percent Status of Band Around the Wrist. Shows a line graph comparing Band Accuracy to Band Reliability and Band Usability.  
 Band Reliability Testing: Average Percent Status of Band Around the Wrist. Shows a line graph comparing Band Reliability to Band Accuracy and Band Usability.  
 Band Usability Testing: Average Percent Status of Band Around the Wrist. Shows a line graph comparing Band Usability to Band Accuracy and Band Reliability.  
 Future Work:  
 • Enhance Dexcom calibration accuracy to enable direct retrieval of user data.  
 • Expand water resistance to additional platforms.  
 • Expand device compatibility to other popular OSes.  
 • Increase fit range with the goal of full compatibility (IP67).  
 • Focus on individualization for optimal fit and secure identification.  
 Acknowledgments:  
 • Thank you to our sponsor, IME Design, for providing us with the resources and support we needed to complete this project.  
 • Thank you to our advisor, Dr. John Puccinelli, for his guidance and support throughout the project.  
 • Thank you to our clients, Caille Berg, Olive Comiglia, and Dr. Beth Martin, for their trust and support.  
 • Thank you to our team members, Claudia Beckwith, Lauren Klein, and Isabel Ploessl, for their hard work and dedication.

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isabelploesslsugarsafe.jpg (3.14 MB)



## 2026/04/28 Final Report

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Claudia Beckwith - Apr 28, 2026, 9:36 PM CDT

**Title:** Final report

**Date:** 4/28/26

**Content by:** whole team

**Present:** whole team

**Goals:** we want to summarize all our background research, design ideas, prototype information, fabrication, testing, and discussion into one report. This will outline all the work we have done for SugarSafe over the past year.

**Content:**

See attached pdf

**Conclusions/action items:**

Submit report!

---

Claudia Beckwith - Apr 28, 2026, 9:37 PM CDT



### Final Report

Sugar Safe: A Diabetic Alerting Device

Team Members:

Claudia Beckwith - BWIG & EPAG

Isabel Plassel - Team Leader

Lauren Klein - BSNAC & Communication

Clients: Olive Comiglia, Calie Berg, Dr. Beth Martin

Advisor: Dr. John Pucinski

TA: Isabelle Peters

April 28th, 2026

BME 301

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sugarsafe301finalreport.pdf (2.1 MB)



## 2026/1/26 - Economic Impact of Diabetes

ISABEL PLOESSL - Jan 26, 2026, 6:18 PM CST

**Title:** The Economic Impact of Diabetes

**Date:** 1/26/26

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn more about how diabetes impacts the national and international economy, in hopes to fulfill more gaps in the 4b section of the design rubric.

**Content:**

- The article emphasizes that the economic impact of diabetes cannot be understood by prevalence alone, it must be interpreted through healthcare system development, population economics, and access to care
- “Two different approaches have been used to address the economic impact of an increasing incidence of diabetes.” These are DALYs and cost-of-illness models, each capturing different dimensions of burden
- DALYs: Disability-Adjusted Life Years combine premature mortality and years lived with disability, capturing costs that traditional dollar-based methods miss, especially quality of life losses
- Of 1,362 million DALYs lost worldwide in 1990, 7.97 million were due to diabetes, with ~80% occurring in developing countries
- The highest disease burden occurs where healthcare spending is lowest, making diabetes not just a medical problem but a development problem.
- Cost-of-illness breakdown:
  - Direct costs: hospitalizations, outpatient care, medications
  - Indirect costs: lost productivity, morbidity, premature death
  - Intangible costs: reduced quality of life and life expectancy
 These categories form the backbone of most national diabetes cost estimates
- The article shows how top-down vs bottom-up costing approaches can yield dramatically different results, with top-down favored for national estimates due to scalability and consistency
- “There is no clear relationship between the incidence and prevalence of a disease and its economic impact.”
- A person diagnosed with type 1 diabetes in childhood is expected to generate much higher lifetime costs than someone diagnosed with type 2 diabetes later in life, complicating incidence-based projections
- Roughly 50% of people with type 2 diabetes are undiagnosed, meaning many cost estimates likely understate the true economic burden

**Conclusions/action items:** Our project should prioritize early, clear, and actionable glucose communication to caregivers to support prevention of complications and reduce long-term economic and health costs and it should not add to the already extreme costs that diabetes control already consumes.

**Citation:** B. Jonsson, “The economic impact of diabetes,” *Diabetes Care*, vol. 21, suppl. 3, pp. C7–C10, Dec. 1998

ISABEL PLOESSL - Jan 26, 2026, 6:11 PM CST







## 2026/1/26 - Diabetes Global Impact

ISABEL PLOESSL - Jan 26, 2026, 6:30 PM CST

### Title: Diabetic Patients: Epidemiology and Global Impact

Date: 1/26/26

Content by: Isabel Ploessl

Present: N/A

**Goals:** To learn more about how diabetes impacts the globe, and which people in particular it affects, looking to fulfill more bullets in the 4b section of the rubric.

### Content:

- The article positions diabetes as a rapidly escalating global health problem driven by demographic change, urbanization, and lifestyle shifts, with disproportionate impact on developing regions.
- "Diabetes is a chronic disease defined by the level of hyperglycemia resulting from defects in insulin secretion, insulin action, or both."
- The worldwide diabetic population increased from ~135 million in 1995 and was projected to exceed 300 million by 2025, indicating a steep and sustained upward trajectory.
- The most dramatic increases in diabetes prevalence are expected in Asia, Africa, and Latin America, rather than in traditionally high-income countries.
  - This reframes diabetes as a global development and infrastructure challenge, not just a disease of affluent or aging populations
- Type 2 diabetes accounts for approximately 85–95% of all diabetes cases worldwide, making prevention and early management critical leverage points.
- Diabetes prevalence is highest among adults aged 45–64, but incidence is increasingly observed in younger populations due to obesity and sedentary lifestyles.
- "Diabetes is the leading cause of non-traumatic lower limb amputations worldwide."
- **Cardiovascular burden**
  - Diabetic patients face a 2–4× increased risk of cardiovascular disease, including myocardial infarction and stroke, which accounts for the majority of diabetes-related deaths.
  - Peripheral arterial disease (PAD) is significantly more common in patients with diabetes and is frequently asymptomatic, delaying diagnosis and intervention.
- **Neuropathy risk**
  - Loss of pain perception due to diabetic neuropathy allows foot ulcers and infections to progress unnoticed, increasing hospitalization and amputation risk.
- "Early detection and aggressive risk-factor management are essential to reduce morbidity and mortality associated with diabetes."
- Developing countries carry the greatest burden of diabetes-related complications while having the least access to preventive care, early diagnosis, and long-term disease monitoring.
- The mismatch between disease burden and monitoring capacity underscores the need for low-burden, continuous, and interpretable glucose feedback systems.

**Conclusions/action items:** The more accurate and helpful our device is for early hyper or hypo glycemia episodes in children, the less severe their risk is for these diseases and extra complications later on in life, that is why is it extremely important for our device to be easily readable and always accurate.

**Citation:** C. Setacci, G. de Donato, F. Setacci, and C. Chisci, "Diabetic patients: epidemiology and global impact," *J. Cardiovasc. Surg.*, vol. 50, no. 3, pp. 263–273, Jun. 2009

ISABEL PLOESSL - Jan 26, 2026, 6:24 PM CST

Diabetic patients: epidemiology and global impact

G. SETACCI, G. de DONATO, F. SETACCI, E. CHIESI

Department of Surgery  
Municipal University Hospital of Siena, Siena, Italy

Definition of the exact epidemiology and the global impact of diabetes is necessary, being strictly related to the availability of funds for diagnostic research and to the use of the existing population-based investigations of common chronic diseases and diabetes mellitus. According to the World Health Organization (WHO) the total number of people with diabetes was 171 million in 1985, which is projected to rise up to 300 million in 2030. The rate prevalence of type 2 diabetes mellitus (DM2) in people with diabetes has been different in America, in Asia and in Europe, and it may also vary in other countries, according to different socio-economic, cultural, genetic and ethnic factors. Population-based studies, using a validated and reproducible test, have revealed a prevalence of DM2 in people with diabetes to be up to 30%. Among people with diabetes, the overall incidence of developing a first chronic disease is 4.5% and the prevalence ranges from 27% to 35%, which suggest that the lifetime incidence may be as high as 25%. From data associated to DM2 in people with diabetes, although a higher number of studies on the occurrence of chronic diseases in relation to the non-availability of patients in treatment, the detection of metabolic disorders prevalence will probably result in increasing proportions of chronic diseases number and rate of occurrence. In fact, the prevalence of diabetes and associated complications will probably result in increasing proportions of chronic diseases number and rate of occurrence. In fact, the prevalence of diabetes and associated complications will probably result in increasing proportions of chronic diseases number and rate of occurrence. In fact, the prevalence of diabetes and associated complications will probably result in increasing proportions of chronic diseases number and rate of occurrence.

been related to macrovascular complications, increased risk of macrovascular complications (chronic heart disease, stroke and peripheral vascular disease), and decreased quality of life.

Definition of the exact epidemiology and the global impact of diabetes is not easy, being strictly related to the availability of funds for diagnostic research and to the use of the existing population-based investigations of common chronic diseases and diabetes mellitus.

The World Health Organization (WHO) has published guidelines for the diagnosis and classification of diabetes since 1985 and reviewed them in 1991. More information of relevance to the diagnosis of diabetes has become available since then, prompting the American Diabetes Association (ADA) to review the diagnostic criteria in 2007. According to the most recent WHO consensus criteria for the diagnosis of diabetes and to the metabolic hypoglycemia (Table 2, diabetes is defined by having plasma glucose  $\geq 126$  mmol/L (228 mg/dL) in 2 h postload glucose or 110 mmol/L (200 mg/dL).

Epidemiology

World Health Organization estimates the prevalence of diabetes.

WHO, 1993

In 1995, the World Health Organization Ad Hoc Diabetes Reporting Group published standardized

Diabetes is a complex syndrome, defined by the level of hyperglycemia arising due to a risk of microvascular damage (retinopathy, nephropathy and neuropathy). It is associated with increased life expectancy, significant morbidity due to specific chronic diseases.

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## 2026/1/26 - Why Are Diabetes Medications So Expensive?

ISABEL PLOESSL - Jan 26, 2026, 6:44 PM CST

**Title:** Why Are Diabetes Medications So Expensive?

**Date:** 1/26/26

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn more about how diabetic pricing of medications and treatments are affecting the nation, and what can be done to help curb them, looking to fulfill more bullets in the 2b section of the rubric.

**Content:**

- The article frames rising diabetes medication costs as a structural problem driven by pharmaceutical pricing practices, patent protections, and limited price negotiation, rather than by clinical necessity alone.
- “The costs of antihyperglycemic medications, especially insulin, have become a barrier to diabetes treatment.”
- Between 2002 and 2012, U.S. expenditures for antihyperglycemic medications increased from **\$10 billion to \$22 billion**, largely due to insulin costs.
- Expenditures for insulin increased sixfold during this period, while spending on non-insulin diabetes medications remained relatively stable.
  - This shows that insulin pricing, not overall diabetes drug use, is the dominant driver of rising treatment costs.
- In the U.S., pharmaceutical manufacturers are permitted to set their own prices for new drugs, with limited constraints from public payers.
- Biologic drugs such as insulin receive 12 years of market exclusivity, significantly limiting competition compared to small-molecule drugs.
- When multiple generic manufacturers enter the market, drug prices can drop to 13–33% of the original brand-name cost, a pattern not observed with insulin.
  - “There is little evidence to demonstrate an association between drug prices and the costs of research and development.”
  - The price of insulin glargine increased from **\$44 per vial in 2001 to \$298 per vial in 2016**, with repeated incremental price hikes. (THIS IS INSANE)
- Annual per-capita insulin costs increased nearly fourfold from 2002 to 2012, reaching over **\$2,300** per patient.
- Pharmacy benefit managers negotiate rebates and discounts, but their lack of transparency may incentivize higher list prices rather than lower net costs.
- Separation between prescribing decisions and medication payment often removes cost considerations from clinical decision-making.
- Suggested reforms include increased pricing transparency, greater price negotiation authority, stricter patent exclusivity requirements, and outcomes-based pricing models.

**Conclusions/action items:** Because high medication and insulin costs create barriers to consistent diabetes management, our project should prioritize clear, immediate, and low-effort glucose interpretation to help control this already extremely expensive market.

**Citation:** L. N. McEwen, S. S. Casagrande, S. Kuo, and W. H. Herman, “Why are diabetes medications so expensive and what can be done to control their cost?” *Curr. Diab. Rep.*, vol. 17, no. 9, p. 71, Jul. 2017

ISABEL PLOESSL - Jan 26, 2026, 6:39 PM CST

Curr Diab Rep (2017) 17:71  
DOI 10.1007/s12012-017-0493-0



ECONOMICS AND POLICY IN DIABETES (S. BUZINSKI AND A.J. BAILEY, SECTION EDITORS)

### Why Are Diabetes Medications So Expensive and What Can Be Done to Control Their Cost?

Lance N. McEwen<sup>1</sup>, Sarah Stack Casagrande<sup>2</sup>, Shihwan Kim<sup>3</sup>, William H. Herman<sup>4</sup>

Published online: 24 July 2017  
© Springer Science+Business Media, LLC 2017

**Abstract**  
Purpose of Review The purposes of this study were to describe how medication prices are established, to explain why antihyperglycemic medications have become so expensive, to show trends in expenditures for antihyperglycemic medications, and to highlight strategies to control expenditures in the U.S.  
Recent Findings In the U.S., pharmaceutical manufacturers

to meet a specific genetically engineered human insulin and insulin analogs, dramatic price increases for the available insulins, physician prescribing practices, policies that limit payers' abilities to negotiate prices, and reimbursement regulations of off-invoice discounts.  
Summary The costs of antihyperglycemic medications, especially insulin, have become a barrier to diabetes treatment. While a limited intervention to shift physician prescribing

not the price for new products. Between 2002 and 2012, expenditures for antihyperglycemic medications increased from \$10 billion to \$22 billion. This increase was primarily driven by expenditures for insulin, which increased 4x-fold. The increase in insulin expenditures may be attributed to several factors: the shift from insulin vials and pens to insulin

penicils towards insulin and dimer may provide some relief, as well as already used policy interventions such as more stringent requirements for patient education, greater transparency in medication pricing, greater opportunities for price negotiation, and consumer-based pricing models to control the costs of antihyperglycemic medications.

**Keywords:** Insulin • Cost antihyperglycemic medications • Cost • Medical Expenditure Panel Survey (MEPS)

This article is part of the Special Collection on *Economics and Policy in Diabetes*.

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## Introduction

In 1925, insulin became commercially available in the United States (U.S.) [1]. At first, there was no effective pharmacologic treatment for diabetes mellitus. It was not until 1956 that the first sulfonylurea, tolazamide, became available in the U.S. Although the biguanide, phenformin, was available in the U.S. in the 1960s and 1970s, it was withdrawn from the market in 1978 because of its association with lactic acidosis. It was not until 1985 that metformin became available in the U.S. Since then, the pace of introduction of new classes of antihyperglycemic medications has been rapid [1]. The first alpha-glucosidase inhibitor was marketed in 1995, the first incretin mimetic in 1996, and the firstagliptin in 1997. The first phoglitazone-like peroxisome proliferator-activated receptor-gamma (PPAR-γ) and the first arylsulfonamide were marketed in 2005, and the



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## 2026/1/26 - Availability and Affordability of Diabetes Treatment Across Economic Classes

ISABEL PLOESSL - Jan 26, 2026, 6:54 PM CST

**Title:** Availability and affordability of essential medicines for diabetes across high-income, middle-income, and low-income countries

**Date:** 1/26/26

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn more about how diabetic pricing of medications and treatments are affecting the different status economic countries across the globe, and what can be done to help fix the disparities, looking to fulfill more bullets in the 2b section of the rubric.

### Content:

- The study reveals major global inequities in the availability and affordability of essential diabetes medicines, with people in low-income countries facing the greatest barriers.
- Metformin was available in 100% of pharmacies in high-income countries, 88.2% in upper-middle-income countries, 86.1% in lower-middle-income countries, and 64.7% in low-income countries (excluding India).
- Insulin was available in 93.8% of pharmacies in high-income countries but only 40.2%, 29.3%, and 10.3% in upper-middle, lower-middle, and low-income countries, respectively.
- "Availability and affordability of essential diabetes medicines are poor in low-income and middle-income countries."
- Only 0.7% of households with diabetes in high-income countries could not afford metformin compared with 26.9% in low-income countries.
- In high-income countries 2.8% of households could not afford insulin versus 63.0% of households in low-income countries.
- Among people diagnosed with diabetes, 74.0% in high-income countries reported medicine use, whereas only 29.6% did in low-income countries.
- These disparities suggest that oxygen supply of medicines alone isn't enough, both availability and cost barriers directly shape whether individuals with diabetes can actually receive treatment.
- Availability and affordability were significantly associated with actual use of diabetes medicines across income groups.
- The study highlights an urgent need for monitoring, pricing policy reform, and systemic efforts to ensure essential medicines are both stocked and financially accessible worldwide.
- The poorest countries face a triple burden: lower availability, lower affordability, and lower use, compounding inequalities in diabetes outcomes.

**Conclusions/action items:** Because many people around the world struggle to access or afford diabetes medications, our device should focus on providing clear, easy-to-understand glucose alerts so caregivers can recognize problems early and take action even when treatment options are limited or delayed.

**Citation:** C. K. Chow, C. Ramasundarahettige, W. Hu, K. F. Alhabib, and A. Avezum, "Availability and affordability of essential medicines for diabetes across high-income, middle-income, and low-income countries: a prospective epidemiological study," *Lancet Diabetes Endocrinol.*, vol. 6, no. 10, pp. 798–808, Oct. 2018.

ISABEL PLOESSL - Jan 26, 2026, 6:52 PM CST



Availability and affordability of essential medicines for diabetes across high-income, middle-income, and low-income countries: a prospective epidemiological study

Prof Clara K. Chow, PhD <sup>1,2,3,4</sup> · Christine Ramasundaramoorthy, MSc <sup>5</sup> · Weiberg Hvi, MSc <sup>6</sup> · Khalid F. Al-Jabir, MBS <sup>7</sup> · Akoro Awolun, Jr, MD <sup>8</sup> · Xizou Cheng, MSc <sup>9</sup> · et al. Show more

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Summary

Background

Data are scarce on the availability and affordability of essential medicines for diabetes. Our aim was to examine the availability and affordability of metformin, sulfonylureas, and insulin across multiple regions



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**[Availability and affordability of essential medicines for diabetes across high-income middle-income and low-income countries\\_a prospective epidemiological study - The Lancet Diabetes Endocrinology.pdf \(711 kB\)](#)**



## 2026/2/4 - NeoPixel Jewel Datasheet

ISABEL PLOESSL - Feb 04, 2026, 4:32 PM CST

**Title:** Neo Pixel Jewel 7 ring LED

**Date:** 2/4/2026

**Content by:** Isabel Ploessl

**Present:** n/a

**Goals:** To store the information for the new LED we are trying for the product

**Content:** Data sheet attached as a PDF below

**Conclusions/action items:** Trying this new LED because it seems like it has larger holes to solder with and has a working Arduino folder which will hopefully make writing code to turn it on a lot easier.

ISABEL PLOESSL - Feb 04, 2026, 4:32 PM CST

东莞市歌思科光电科技有限公司  
DONGGUANG OPSCO OPTOELECTRONICS CO., LTD  
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Dongguan Tel: 07692302218 Dongguan Fax: 07692302219

**SK6812RGBW**  
SPECIFICATION  
INTEGRATED LIGHT SOURCE INTELLIGENT CONTROL  
CHIP-ON-TOPO SMD TYPE LED

Document No.: SPC/ SK6812RGBW-XX  
Model No.: SK6812RGBW-XX  
Description: 5.5x5.0x1.6mm Top SMD Type 0.25 Watt Power  
Integrated light source intelligent control LED  
Rev. No.: 01  
Date: 2015-07-31

正式规格书



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p2757\_SK6812RGBW\_REV01.pdf (1.07 MB)



## 2026/2/4 - XIAO Datasheet

ISABEL PLOESSL - Feb 04, 2026, 4:36 PM CST

**Title:** Seeed Studio XIAO ESP32-C6 Microcontroller data sheet

**Date:** 2/4/2026

**Content by:** Isabel Ploessl

**Present:** n/a

**Goals:** To store the information for the new XIAO microcontroller we ordered

**Content:** Data sheet attached as a PDF below

**Conclusions/action items:** Trying this new XIAO, one that has both BLE and the most updated WIFI system in hopes of making the coding connection easier and being able to recharge our LiPo battery via USB-C connection.

ISABEL PLOESSL - Feb 04, 2026, 4:34 PM CST

### ESP32-C6 Series Datasheet

Ultra-low-power SoC with RISC-V single-core microprocessor  
2.4 GHz Wi-Fi 6 (802.11ax), Bluetooth® 5 (BLE), Zigbee and Thread (802.15.4)  
Optional 4 MB flash in the chip's package  
30 or 22 GPIOs, rich set of peripherals  
QFN40 (5x5 mm) or QFN32 (5x5 mm) package

Including:  
ESP32-C6  
ESP32-06FH4



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**esp32-c6\_datasheet\_en.pdf (1.07 MB)**



## 2026/2/4 - XIAO example project using Iphone App

---

ISABEL PLOESSL - Feb 04, 2026, 5:10 PM CST

**Title:** Pet Activity Tracker using XIAO BLE Sense & Edge Impulse

**Date:** 2/4/2026

**Content by:** Isabel Ploessl

**Present:** n/a

**Goals:** To see how someone used the same brand of XIAO to successfully use the BLE connection and create an app on their phone

**Content:**

- Used a Seeed Studio XIAO BLE Sense (nRF52840) microcontroller with built-in 6-axis IMU.
- Added a 3.7V rechargeable Li-ion battery.
- Needed to collect IMU data while the dog was wearing the collar, so USB tethering wasn't possible.
- Built a custom Bluetooth data-collection mobile app called **EI Blue**.
- **EI Blue streams accelerometer data wirelessly to Edge Impulse Studio.**
- Collected 5-second samples, totaling about 6 minutes of data initially (rest, walk, run).
- **Used Edge Impulse Studio to:**
  - Receive IMU data from the EI Blue app.
  - Configure the Impulse (ML pipeline).
  - Set sampling frequency to 50 Hz.
  - Use Spectral Analysis as the DSP block.
  - Train a neural network classifier for activity recognition.
  - Achieved ~90% accuracy on test data.
- Exported the trained model as an Arduino library.
- Used Arduino IDE to:
  - Install XIAO BLE Sense board support.
  - Import the Edge Impulse-generated Arduino library.
  - Upload the firmware XIAO\_BLE\_Pet\_Activity.ino to the device.
- Firmware reads IMU data, runs the ML model, and sends predictions over Bluetooth every minute.
- **Built the EI Blue app using Google Flutter (Dart).**
- **Developed primarily for iOS, but code is cross-platform.**
- **Used Xcode to sign and deploy the iOS app.**
- App stores data locally and displays activity graphs.

**Conclusions/action items:** I think we should do more research on the apps listed here as they seem like they could be promising in our project as well.

ISABEL PLOESSL - Feb 04, 2026, 4:43 PM CST



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**Pet\_Activity\_Tracker\_using\_XIAO\_BLE\_Sense\_Edge\_Impulse\_-\_Hackster.io.pdf (4.49 MB)**



## 2026/03/17 - BLE Connections

---

ISABEL PLOESSL - Mar 17, 2026, 12:02 PM CDT

**Title:** Bluetooth Usage

**Date:** 3/17/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn loosely what steps we need to take to create a Bluetooth connection from iPhone to XIAO.

**Content:**

### 1. Environment Setup (Pre-work)

- Install **Arduino IDE**
- Add **ESP32 board package**
  - Board → XIAO\_ESP32C6
  - Correct COM port
- Verify board works (blink test)

### 2. Include BLE Libraries

- Import required BLE libraries in code:

```
#include <BLEDevice.h>
#include <BLEServer.h>
#include <BLEUtils.h>
```

- These provide:
  - Device control
  - Server/client functionality
  - UUID handling

### 3. Define BLE Identifiers (Critical Step)

- Create **UUIDs** for:
  - Service
  - Characteristic

Example:

```
#define SERVICE_UUID "..."  
#define CHARACTERISTIC_UUID "..."
```

- **Service = category (e.g., glucose data)**
- **Characteristic = actual data channel**

### 4. Initialize BLE Device

- Start BLE stack:

```
BLEDevice::init("Device_Name");
```

- Sets device name (what phone sees)
  - Initializes Bluetooth hardware

## 5. Create BLE Server

```
BLEServer *pServer = BLEDevice::createServer();
```

- ESP32 acts as a **server (peripheral)**
- Your phone = **client (central)**

## 6. Create Service

```
BLEService *pService = pServer->createService(SERVICE_UUID);
```

- Logical grouping of data
- Example (your project):
  - Service = “Glucose Alerts”

## 7. Create Characteristic

```
BLECharacteristic *pCharacteristic = pService->createCharacteristic(
  CHARACTERISTIC_UUID,
  BLECharacteristic::PROPERTY_READ |
  BLECharacteristic::PROPERTY_WRITE
);
```

- Defines:
  - Data type
  - Permissions (read/write/notify)

## 8. Start Service

```
pService->start();
```

- Makes service active and usable

## 9. Start Advertising (VERY IMPORTANT)

```
BLEAdvertising *pAdvertising = BLEDevice::getAdvertising();
pAdvertising->start();
```

- This is how your device becomes **discoverable**
- Without this → phone cannot find it

## 10. Connect from External Device (Phone/App)

- Use apps like:
  - nRF Connect
  - LightBlue

Steps:

- Scan for device name
- Connect
- Access service + characteristic

- Read/write data

## 11. Data Transmission

- Send data:

```
pCharacteristic->setValue("Hello");
```

```
pCharacteristic->notify();
```

- Receive data:
  - Use callbacks (advanced step)

Citation: Seeed Studio, "Bluetooth Usage with Seeed Studio XIAO ESP32C6," *Seeed Studio Wiki*, Apr. 11, 2024. [Online]. Available: [https://wiki.seeedstudio.com/xiao\\_esp32c6\\_bluetooth/](https://wiki.seeedstudio.com/xiao_esp32c6_bluetooth/)

**Conclusions/action items: Glean what apps we would need and send to Claudia to download.**

ISABEL PLOESSL - Mar 17, 2026, 11:58 AM CDT

» XIAO » XIAO ESP32C6 » Wireless Connectivity » **Bluetooth Usage**

## Bluetooth Usage with Seeed Studio XIAO ESP32C6



Get One Now 

The Seeed Studio XIAO ESP32C6 is a powerful development board that supports Bluetooth S, BLE, and Mesh networking, making it an ideal choice for a wide range of IoT applications that require wireless connectivity. With its outstanding RF performance, the XIAO ESP32C6 can provide reliable and high-speed wireless communication over a variety of distances, making it a versatile solution for both short-range and long-range wireless applications. In this tutorial, we will focus on the basic features of the XIAO ESP32C6's Bluetooth capabilities, such as how to scan for nearby Bluetooth devices, how to establish a Bluetooth connection, and how to transmit and receive data over a Bluetooth connection.

### Bluetooth Low Energy (BLE) Usage

Bluetooth Low Energy (BLE for short), is a power-consumption optimized protocol for applications that require short distance transmission of small amount of data.



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**Bluetooth\_Usage\_\_Seed\_Studio\_Wiki.pdf (11.3 MB)**



## 2026/02/08 - Smart phone owners percentage

ISABEL PLOESSL - Feb 08, 2026, 6:50 PM CST

**Title:** Smart phone owners percentage

**Date:** 2/8/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To develop the categories in our design matrix, and learn about the accessibility of Bluetooth devices in America and the world.

**Content:**

- Smartphones are nearly universal in developed countries — about **¾ of populations in the top developed nations own one**.
- There are **over 7–8+ billion smartphones worldwide** (more devices than users because many people own multiple phones).
- Around **90% of all cellular phones are smartphones** globally.
- Smartphone users grew **~96% from 2016 to 2025**.
- Growth is expected to continue, though **2026 projections slightly declined** due to supply issues and delayed product releases.
- Smartphones account for **~94% of devices used to access the internet**.
- Average mobile screen time **≈ 4 hours 37 minutes per day**.
- There are **~19.8 billion IoT connections worldwide**, showing ecosystem expansion around mobile devices.
- **China has the most users**, followed by India and the United States.
- The **U.S. has the highest penetration (~81.6% of population using smartphones)**.
- In the U.S. (late 2025):
  - ~97% penetration rate overall
  - Highest usage: ages 18–29
  - Slightly higher ownership among women
  - Higher income & college education → higher ownership
  - Suburban residents slightly higher than urban/rural
- Smartphone adoption still limited in some regions because **~8% of the world lacks electricity**.
- Leading brands (Q3 2025):
  - Samsung ~18.8%
  - Apple ~18.2%
  - Xiaomi ~13.3%
- OS market share globally:
  - Android ~79%
  - iOS ~17%
  - iOS has stronger presence in the U.S. market.

**Conclusions/action items:** Although cell phones are a very strong market in the US, it lacks presence in other countries, and WIFI access is still at a higher percentage in the US, so I think BLE connection will receive a 3/5 for this category.

**Citation:** J. Howarth, "How Many People Own Smartphones? (2025–2029)," *Exploding Topics*, Jan. 12, 2026. [Online]. Available: Exploding Topics website.

ISABEL PLOESSL - Feb 08, 2026, 6:40 PM CST

**EXPLODING TOPICS**  
How Many People Own Smartphones? (2025-2029)

**Trending** ▾  
**Platform** ▾  
**Tools** ▾  
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There are currently over **8 billion** smartphones worldwide – a number that's projected to increase overall in the coming years.

While the smartphone market grew in 2025, a combination of factors including a global memory shortage and Apple's decision to release its next base model in early 2027 has led experts to revise projections for 2026.

Original projections for 2026 showed a 12% increase. That number has been revised to predict a **0.9% decline in 2026**.

Table of contents ▾

Instantly Analyze  
Any Mar Weekly Reflection 3  
Assignment due in 5 hours

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**How\_Many\_People\_Own\_Smartphones\_2025-2029\_.pdf (1.98 MB)**



## 2026/02/08 - Internet users by country

ISABEL PLOESSL - Feb 08, 2026, 6:57 PM CST

**Title:** Internet user percentage by country and globally

**Date:** 2/8/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To develop the categories in our design matrix, and learn about the accessibility of WIFI and internet in America and the world.

**Content:**

- About **5.64 billion people (~68.7% of the world)** use the internet as of 2025.
- In 2000, only **361 million people (~6%)** were online → massive long-term growth.
- Around **144 million new users joined in the past year**, but growth is slowing (~2.6%).
- Roughly **2.6 billion people (31%) still have no internet access**, mostly in Africa.
- Highest penetration countries: Saudi Arabia, UAE, Bahrain (~100%).
- Western countries (U.S., U.K., Europe) generally **>90% usage**.
- Africa:
  - ~38% online overall
  - ~57% urban vs ~23% rural

### Internet Users by Country 2026

- China: ~1.1 billion users (~77% of population)
- India: ~806 million users (~66%)
- United States: ~322 million users (~93%)
- Average person spends **~6 hours 40 minutes online daily** (~47 hrs/week).
- Young adults nearly universal users; older adults rapidly catching up (~75% usage).
- Over **700 million new smartphone users (2021–2025)** helped expand access.
- Mobile share of internet use grew **from 52% → 63% in 5 years**.
- By 2030, ~73% of users may access the internet only through phones.
- Internet adoption expected to keep rising in India, China, and Africa.
- Biggest barrier remains infrastructure access rather than demand.

**Conclusions/action items:** Around the world, internet and WIFI access is generally more accessible and has a higher usage percentage, this would make it the best way to connect our device, but the ability to connect both WIFI and BLE is the best as it could hopefully reach a larger pool of people.

**Citation:** *Internet Users by Country 2026*, World Population Review, 2026. [Online]. Available: World Population Review website.

ISABEL PLOESSL - Feb 08, 2026, 6:42 PM CST



[Download](#)

**Internet\_Users\_by\_Country\_2026.pdf (2.38 MB)**



## 2026/02/08 - WIFI vs BLE power consumption

---

ISABEL PLOESSL - Feb 08, 2026, 7:03 PM CST

**Title: Understanding WIFI vs BLE: Power and Bandwidth**

**Date:** 2/8/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To develop the categories in our design matrix, and learn about the power consumption of both WIFI and BLE.

**Content:**

- WiFi typically uses **~0.5–2 W** depending on activity and signal strength.
- Bluetooth Low Energy (BLE) uses **<0.01 W**, making it ideal for wearables and IoT devices.
- WiFi consumes more energy because it maintains high data rates and longer-range connections.
- Bluetooth sends small packets intermittently → longer battery life.
- WiFi 6 speeds: up to **9.6 Gbps**.
- Bluetooth 5.3 speeds: up to **2 Mbps**.
- WiFi is best for:
  - video streaming
  - gaming
  - large file transfer
- Bluetooth is best for:
  - keyboards/mice
  - audio
  - sensors & synchronization
- Both operate in the **2.4 GHz band**, which can cause interference.
- Switching WiFi to **5 GHz/6 GHz** can improve performance.
- Firmware updates and configuration changes often fix connectivity issues.
- **WiFi = high speed + high power + long range**
- **Bluetooth = low speed + ultra-low power + short range**
- Many devices use both together but sometimes this harms optimal performance and battery life.

**Conclusions/action items:** WiFi uses a lot more power than BLE as BLE is specifically tailored to being low energy consumption, therefore it will get a 5/5 for this category while WIFI and both will lag with this.

**Citation:** Noman, "WiFi vs Bluetooth: Understanding Power and Bandwidth Use," *Archer IT Solutions*, Jan. 11, 2026. [Online]. Available: Archer IT Solutions website.

ISABEL PLOESSL - Feb 08, 2026, 6:43 PM CST



Medium · 17 articles · 10k views · 10k followers

## WiFi vs Bluetooth: Understanding Power and Bandwidth Use

WiFi vs Bluetooth Comparison

In a world filled with wireless technologies, WiFi and Bluetooth stand as the two dominant choices for connectivity. Both are used daily for communication between devices, but questions often arise—Which consumes more energy and bandwidth than Bluetooth? In this article, we explore power consumption, bandwidth differences, troubleshooting issues, and how to make the most of your connections in both home and business environments.

## Comparing WiFi and Bluetooth Power Usage Efficiently

WiFi is a power-hungry wireless communication technology capable of transmitting data over several hundred meters. This long-range capability comes with higher energy consumption as WiFi routers often draw between 5W to 20W of power depending on the router's activity and signal strength. In contrast, Bluetooth Low Energy (BLE) is designed for minimal energy use, often consuming less than 100mW, making it ideal for battery-powered IoT devices and wearables.

Use case examples to compare power consumption across a few devices and a few, and network to network.

References

WiFi

Bluetooth



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**WiFi\_vs\_Bluetooth\_Power\_Bandwidth.pdf (1.94 MB)**



## 2026/02/23 - 42 Factors that influence diabetes

---

ISABEL PLOESSL - Feb 23, 2026, 6:15 PM CST

**Title:** 42 Factors that Affect Blood Glucose

**Date:** 02/23/26

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn about the many factors that affect blood Glucose per individual, to help explain why it's so hard to have only one standardized treatment.

**Content:**

- Amount and type of carbohydrates both impact blood sugar differently
- Fat and protein content can change how quickly glucose rises
- Caffeine and alcohol can increase or decrease blood glucose
- Meal timing (especially late meals) affects glucose trends
- Hydration levels (dehydration can raise blood sugar)
- Insulin dose and timing directly influence glucose levels
- Medication interactions can alter blood sugar response
- Certain drugs like steroids or niacin can increase blood glucose
- Exercise type and intensity can raise or lower glucose
- Time of day and fitness level affect how the body responds
- Sleep quality and duration play a major role
- Stress and illness can increase blood sugar levels
- Hormonal changes (puberty, menstruation) impact glucose
- Dawn phenomenon (early morning rise in glucose)
- Recent hypoglycemia can affect later readings
- Underlying conditions (e.g., celiac disease) also play a role
- Temperature and weather can affect insulin absorption
- Altitude and sun exposure may impact glucose levels
- Device accuracy or expired insulin can alter readings

Citation:

Diabetes Research Connection, "42 Factors That Affect Blood Glucose," Dec. 19, 2023. [Online]. Available: <https://diabetesresearchconnection.org/42-factors-affect-blood-glucose/>. Accessed: Feb. 23, 2026.

**Conclusions/action items:** Diabetic treatment is highly specific to lifestyle and each individual. The smallest things you wouldn't think have any effect on it do. That's why is hard for there to be a required standardized training for caregivers to take.



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## 42 Factors That Affect Blood Glucose

DIABETES RESEARCH NEWS    DECEMBER 19, 2023

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**42\_Factors\_That\_Affect\_Blood\_Glucose.pdf (2.04 MB)**



## 2026/02/23 - The emerging burdens of diabetes

ISABEL PLOESSL - Feb 23, 2026, 6:15 PM CST

**Title:** The burden and risks of emerging complications of diabetes mellitus

**Date:** 02/23/26

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn more about the complicated side effects of high blood sugar and diabetes in general.

**Content:**

- Diabetes mellitus prevalence has increased significantly over recent decades, making it a major global health burden
- Traditional complications (cardiovascular disease, kidney disease, neuropathy, retinopathy) are still present but **declining due to improved management**
- As a result, **emerging complications are becoming more prominent**, especially as patients live longer
- Cancer has become a leading cause of death in diabetic populations in some regions, overtaking vascular disease
- Diabetes is associated with increased risk of multiple cancers, particularly:
  - Liver cancer ( $\approx 2x$  increased risk)
  - Pancreatic cancer ( $\approx 2x$  increased risk)
  - Colorectal cancer (20–30% increased risk)
- Biological mechanisms linking diabetes to cancer include:
  - Hyperinsulinemia promoting tumor growth
  - Hyperglycemia causing DNA damage and oxidative stress
  - Chronic inflammation contributing to carcinogenesis
- Diabetes significantly increases **risk of infection and hospitalization**, including:
  - Foot infections (highest risk increase)
  - Pneumonia (most common infection-related hospitalization)
  - Kidney infections, sepsis, and post-surgical infections
- Infection-related mortality is also higher, especially in individuals with T1D
- Diabetes is linked to worse outcomes in respiratory illnesses, including COVID-19, with higher rates of hospitalization and severe complications
- Liver disease, especially NAFLD, is highly prevalent:
  - $\sim 56\%$  of individuals with T2D have NAFLD
  - Diabetes increases risk of liver fibrosis and progression to NASH
- There is a **bidirectional relationship** between diabetes and liver disease
- Diabetes is associated with **mental health disorders**:
  - Depression prevalence  $\sim 28\%$  in T2D
  - Increased risk of anxiety and diabetes-related distress
- Diabetes is linked to **cognitive decline and dementia**:

- Increased risk of vascular dementia and Alzheimer’s disease
- Cognitive impairment can occur even in younger individuals
- Sleep disorders such as **obstructive sleep apnea (OSA)** are highly prevalent (~60%) in diabetic populations
- Diabetes contributes to **functional and physical disability**, including:
  - Reduced mobility
  - Increased fall risk
  - Decreased ability to perform daily activities
- Diabetes negatively impacts **work productivity and long-term independence**
- Many complications are driven by underlying mechanisms such as:
  - Chronic hyperglycemia
  - Inflammation
  - Insulin resistance
  - Impaired immune response

Citation: D. Tomic, J. E. Shaw, and D. J. Magliano, “The burden and risks of emerging complications of diabetes mellitus,” *Nature Reviews Endocrinology*, vol. 18, no. 9, pp. 525–539, Sep. 2022, doi: 10.1038/s41574-022-00690-7.

**Conclusions/action items:** Diabetes complications are shifting from traditional (cardiovascular) to **broader, multi-system impacts, it is a lot more than it seems and can affect so many other parts of the body. It is so important that our device accurately portrays blood sugar to help mediate these potential complications.**

ISABEL PLOESSL - Feb 23, 2026, 6:11 PM CST

## REVIEWS

### The burden and risks of emerging complications of diabetes mellitus

Danaja Kovacs<sup>1,2</sup>, Anuram E. Shetty<sup>1,2</sup> and Doreen J. Magliano<sup>1,2,3\*</sup>

**Abstract** The traditional complications of diabetes mellitus are well known and continue to pose a considerable burden on millions of people living with diabetes mellitus. However, advances in the management of diabetes mellitus and, consequently, longer life expectancies, have resulted in the emergence of evidence of the occurrence of a different set of lesser-acknowledged diabetes mellitus complications, with declining mortality from vascular disease, which once accounted for more than 90% of deaths among people with diabetes mellitus, cancer and dementia now comprise the leading causes of death in people with diabetes mellitus in some countries or regions. Additionally, it is now demonstrated possible links between diabetes mellitus and a broad range of comorbidities, including cognitive decline, functional disability, affective disorders, obstructive sleep apnoea and liver disease, and have not fostered a understanding of the association between diabetes mellitus and infection. However, research of this nature currently synthesizes this evidence to provide an in-depth discussion of the burden and risks of these emerging complications. This Review summarizes information from systematic reviews and major cohort studies regarding emerging complications of type 1 and type 2 diabetes mellitus by identifying and analyzing associations, highlighting and characterizing the evidence, and consider implications for the future management of diabetes mellitus.

Diabetes mellitus is a chronic, albeit generally detectable, medical condition that has increased in prevalence over the past few decades to constitute a major public health challenge of the twenty-first century. Complications that have traditionally been associated with diabetes mellitus include macrovascular conditions such as coronary heart disease, stroke and peripheral arterial disease, and microvascular conditions, including diabetic kidney disease, retinopathy and neuropathy (1). These findings have contributed to the identification of cardiovascular disease in patients with type 2 diabetes mellitus (T2DM) and cancer as major risk factors (2,3).

Diabetes mellitus is a chronic, albeit generally detectable, medical condition that has increased in prevalence over the past few decades to constitute a major public health challenge of the twenty-first century. Complications that have traditionally been associated with diabetes mellitus include macrovascular conditions such as coronary heart disease, stroke and peripheral arterial disease, and microvascular conditions, including diabetic kidney disease, retinopathy and neuropathy (1). These findings have contributed to the identification of cardiovascular disease in patients with type 2 diabetes mellitus (T2DM) and cancer as major risk factors (2,3). Although emerging complications have been briefly acknowledged in several diabetes mellitus monographs and reviews (4–6), no comprehensive review currently specifically provides an analysis of the evidence for the association of these complications with diabetes mellitus. In this Review, we synthesized all available published scientific evidence on the risks and burden of emerging complications associated with T1DM and T2DM.

**Diabetes mellitus and cancer** The burden of cancer mortality With the onset of cardiovascular mortality declining amongst people with diabetes mellitus, cancer deaths now constitute a larger proportion of deaths among this population in some countries (7,8). Although the proportion of deaths due to cancer appears to be

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s41574-022-00690-7.pdf (1.36 MB)



**Title:** Safe at School

**Date:** 02/23/26

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn about some of the requirements they have in place for schoolteachers/ available resources for learning about diabetic students.

**Content:**

- Diabetes care must be continuous and **integrated into all aspects of a child's day**, including school, extracurriculars, childcare, and camps
- The Safe at School® initiative is designed to ensure that children with diabetes can **participate fully and safely** in all school-related activities without discrimination
- Federal protections (Section 504, ADA) require schools to **accommodate medical needs and ensure equal access to education**
- Schools must ensure that **appropriately trained staff are available**, including:
  - Monitoring blood glucose levels
  - Administering insulin and emergency glucagon
  - Recognizing symptoms of hypo- and hyperglycemia
- Care must be provided not only in the classroom but also during:
  - Field trips
  - Extracurricular activities
  - Off-campus school-sponsored events
- Students who are capable should be **allowed and supported in self-management**, promoting independence and safety
- Schools are explicitly prohibited from practices that limit access, including:
  - Requiring parents/guardians to come administer care
  - Excluding students from activities
  - Forcing school transfers due to medical needs
- **Written care plans** are essential to standardize communication and care:
  - Diabetes Medical Management Plan (DMMP): outlines individualized medical needs
  - Section 504 Plan: ensures equal access and accommodations in school
- Care plans are necessary because **each child's diabetes management is unique**, requiring individualized instructions
- Schools are encouraged to use **ADA training resources** to educate staff and improve preparedness
- Legal advocacy and support systems exist to address **discrimination or inadequate care in schools**
- Diabetes care in schools requires coordination between:
  - Healthcare providers
  - Parents/guardians

- School nurses and staff
- The school environment presents unique risks because:
  - Staff may not have medical training
  - Emergencies (e.g., hypoglycemia) require rapid recognition and response
  - Children may not always communicate symptoms clearly

Citation: American Diabetes Association, "Safe at School State Laws," [Online]. Available: <https://diabetes.org/advocacy/safe-at-school-state-laws>. Accessed: Feb. 23, 2026.

**Conclusions/action items: School aren't required to have all their teachers be knowledgeable on diabetes, it is typically only the school nurse. This can lead to a lot of issues receiving timely care and children having to advocate for themselves which can be scary and confusing, especially for younger children.**

ISABEL PLOESSL - Feb 23, 2026, 6:17 PM CST

Home Advocacy Overview Safe at School®

ADVOCACY

## Safe at School®

### Overview

Diabetes must be managed 24/7, and for children with diabetes, that includes time spent at school or school-sponsored activities like field trips and extracurricular activities, in child care programs, and at summer camp or recreational programs. Our Safe at School campaign works to make sure the diabetes management needs of children are met so they are healthy and safe and able to enjoy the same opportunities as their peers.

Federal law gives students the right to receive the diabetes care they need to be safe and participate in school activities just like any other child. Schools should provide the following:

- Trained staff to monitor blood glucose (blood sugar) levels and administer insulin and glucagon
- Trained staff to provide diabetes care during field trips, extracurricular events, and all school-sponsored activities
- Capable students permitted to self-manage their diabetes anytime, anywhere

[Download](#)

**Safe\_at\_School\_\_ADA.pdf (5.37 MB)**



## 2026/02/24 - Age-related guidelines

ISABEL PLOESSL - Feb 24, 2026, 11:36 AM CST

**Title:** AGE-RELATED GUIDELINES FOR DIABETES RESPONSIBILITIES

**Date:** 02/24/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn about what the typical age for diabetic children to start managing their own care and treatment.

**Content:**

- Diabetes management responsibility develops **progressively over time** and should be tailored to each child's readiness rather than strictly their age
- Readiness for increased responsibility depends on multiple individualized factors, including:
  - Cognitive understanding of diabetes
  - Willingness to participate in care
  - Ability to correctly perform tasks
  - Emotional maturity and consistency
- Effective diabetes care requires a **balance between independence and supervision**, rather than full transfer of responsibility
- Caregiver involvement remains essential across all age groups, even as independence increases
- **Open, judgment-free communication** between caregiver and child is critical for:
  - Encouraging participation
  - Reducing conflict
  - Improving long-term outcomes
- Gradual assumption of responsibility provides developmental benefits, including:
  - Increased confidence in self-care
  - Awareness of personal health limitations
  - Preparation for independent disease management in adulthood
- **<5 years old:**
  - Child has **minimal responsibility** and primarily learns through observation
  - Caregiver performs all critical tasks (glucose monitoring, insulin administration)
  - Early education focuses on recognizing symptoms (especially hypoglycemia)
- **6–11 years old:**
  - Introduction to **basic self-management skills**, including:
    - Carb counting
    - Simple decision-making about food
  - Child may assist in insulin dosing but requires **full caregiver supervision**
  - Caregiver is always ready to intervene and correct errors

- Transition to **shared responsibility model**
- Child begins performing most diabetes-related tasks:
  - Blood glucose monitoring
  - Insulin administration
  - Food-related decisions
- Caregiver still monitors logs, provides feedback, and supports problem-solving
- Variability increases—some children are not ready for independence at this stage
- **15–18 years old:**
  - Shift toward **increased independence**, but not full autonomy
  - Child takes primary responsibility for:
    - Daily management tasks
    - Communication with healthcare providers
  - Caregiver involvement decreases gradually but remains necessary if management declines
  - Transition planning to adult healthcare systems begins

Citation: Children’s Minnesota, “Age-Related Guidelines for Diabetes Responsibilities,” 2023.

**Conclusions/action items: Even children up to 15 years, a shared model is recommended, meaning there is still supervision and help with care until high school, this helps show that our device would be helpful in the life of a diabetic child for many years.**

ISABEL PLOESSL - Feb 24, 2026, 11:33 AM CST

## AGE-RELATED GUIDELINES FOR DIABETES RESPONSIBILITIES

**Considerations**

Every child is different. Age by itself does not tell you when a child is ready for more diabetes responsibility. Most children will want to do tasks that they are ready to do. It is important for them to have a sense of accomplishment by participating in their diabetes care to the extent they are able and ready to.

The right amount of responsibility balanced with the right amount of supervision leads to the best results. Judgment-free, open communication is vital.

**When giving your child more responsibility, think about:**


- Your child’s **understanding** of diabetes
- Your child’s **interest** in having more responsibility
- Your child’s **actual performance** of diabetes tasks
- Your child’s overall **maturity**

**What benefits will my child receive by taking on age-appropriate diabetes responsibilities?**

- Develop self-confidence
- Learn his/her own limitations
- Be prepared for becoming an adult living on his/her own

**Teamwork & Shared Responsibility lead to better diabetes outcomes.**

---


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**age-related-guidelines-for-diabetes-responsibilities.pdf (321 kB)**



## 2026/03/11 - How to mirror

---

ISABEL PLOESSL - Mar 11, 2026, 3:37 PM CDT

**Title:** How to mirror entities in solid works

**Date:** 3/11/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** I forgot how to mirror things in solid works, so I needed a crash course, want to learn.

**Content: video link :** [How to Mirror Features | Solidworks Tutorial - YouTube](#)

To mirror:

Create a new plane by selected the sides you want to mirror onto

Click mirror

Go to drop down parts sections and select what you would like to mirror

Click okay

Citation: CAD CAM Tutorials, "How to Mirror Features | SolidWorks Tutorial," *YouTube*, Jul. 7, 2017. [Online]. Available: <https://www.youtube.com/watch?v=XB0PCtNaMkU>

**Conclusions/action items:** Using this technique to mirror each cut in the box to ensure perfect symmetry without having to recreate or measure again.



## 2026/03/11 - Apple watch design

---

ISABEL PLOESSL - Mar 11, 2026, 3:41 PM CDT

**Title:** How to create an apple watch in solidworks

**Date:** 3/11/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn the way most people, make the bad wholes in an apple watch and learn the measurements.

**Content: video link:** [Solidworks Design Tutorial | Design Apple Watch | Solidworks Watch Design - YouTube](#)

Gleaned how to create the side slots:

Two circles with two lines connecting them

You can ensure the circles are the same size by using the parallel lines tool

Use smart dimensions to make sure the distance between sides are the same

Citation: SP Design and Trade, "Solidworks Design Tutorial | Design Apple Watch | Solidworks Watch Design," *YouTube*, Jun. 30, 2022. [Online].

Available: <https://www.youtube.com/watch?v=XB0PCtNaMkU>

**Conclusions/action items:** Make the "Apple Watch" looking parts of the box, very helpful for measurements, still had to do quite a bit of bug fixing but good for dimensions.



## 2026/03/11 - Snap fit lid

---

ISABEL PLOESSL - Mar 11, 2026, 3:44 PM CDT

**Title:** Snap fit enclosure

**Date:** 3/11/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn how to create triangle bases, and to relearn how to make matching assemblies to ensure they will fit together.

**Content: video link:** [3D printable snap fit enclosure design using Solidworks // #2023 #solidworkstutorial - YouTube](#)

Learned many new tools, like molding, scaffolding, angle tools.

This part took me the longest by far- the process is very in depth and requires lots of precision

Citation: M. S. Abdullah, "3D printable snap fit enclosure design using SolidWorks," *YouTube*, Aug. 16, 2019. [Online]. Available: <https://www.youtube.com/watch?v=69njgBDgDiU>

**Conclusions/action items:** Creating the snap fit lid has proved quite difficult, I wanted this lid to be a bit more flush than last semester, and to do so is quite invasive. The video was very helpful though!



## 2026/04/15 - Dexcom Direct to Apple Watch

ISABEL PLOESSL - Apr 15, 2026, 4:18 PM CDT

**Title:** Dexcom direct to apple watch

**Date:** 04/15/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn about the Dexcom direct to watch system.

**Content:**

- Dexcom G7 now offers Direct to Apple Watch, allowing the sensor to connect straight to a compatible Apple Watch via Bluetooth.
  - This removes the prior requirement of keeping an iPhone nearby for smartwatch glucose readings.
- Users can leave their phone behind while still viewing glucose data in real time on their wrist.
- The feature improves convenience during activities such as running, workouts, errands, or when away from a phone.
- Glucose readings can be checked discreetly with a quick glance at the watch.
- Direct to Apple Watch provides an added backup if a user loses or misplaces their phone.
- Dexcom states the G7 is the first and only CGM capable of displaying glucose simultaneously on phone, watch, and receiver/AID device.
- Alerts for high and low glucose can appear directly on the watch.
- These alerts are acknowledgeable from the watch itself without needing the phone.
- The watch can display current glucose value, trend arrow, and trend graph history.
  - Trend graphs can be viewed over 1, 3, or 6 hour periods.
- Share/Follow functionality requires internet/Wi-Fi connectivity and has limitations when phone is absent.
- Third-party health app integrations may temporarily pause while phone is absent, then backfill later.
- Compatible hardware requires Apple Watch Series 6 or newer.
  - The watch must run watchOS 10 or later.
  - The paired iPhone must run iOS 17 or later for setup.
  - Setup is initiated through the Dexcom G7 app under Connections → Direct to Watch.
- Only one smartwatch can be paired to a Dexcom G7 sensor at a time.
- If an orange phone icon appears on the watch, the watch is temporarily receiving data relayed through the phone instead of directly from the sensor.
- Dexcom positions this feature as a major convenience improvement for mobile, active, or discreet diabetes management.

**Conclusions/action items:** Use this information and one of their images in our final poster. (Maybe figure out how to get mine to work too)

Citation:[1] Dexcom, "Dexcom G7 Direct to Apple Watch: Easy Glucose Monitoring," *Dexcom All Access*, Jun. 25, 2025. [Online]. Available:

<https://www.dexcom.com/all-access/dexcom-cgm-explained/direct-to-apple-watch>

ISABEL PLOESSL - Apr 20, 2026, 4:46 PM CDT

The screenshot shows a webpage from Dexcom. At the top left is the Dexcom logo. Below it, the article title is "Dexcom G7 Direct to Apple Watch: Manage Diabetes Hands-Free". The article is dated "Updated Jun 25, 2025" and "Written Apr 15, 2026". Below the title is a photograph of a woman with a Dexcom G7 sensor on her arm, looking at her Apple Watch. Below the photo is a disclaimer: "The content in this article should not be taken as medical advice. Please consult your healthcare provider regarding your individual health needs and Dexcom alert settings." The article text begins with "Over the last few to 10 years, as our lifestyles have become highly mobile, it's been clear that many people's lives. There are many ways to manage your diabetes, but one of the most convenient ways is to use a continuous glucose monitor (CGM). The only CGM that can be used for people living with diabetes to monitor glucose levels discreetly and reliably is the Dexcom G7. The Dexcom G7 is the only CGM that can be used on an Apple Watch. In fact, monitoring your glucose levels on an Apple Watch is now a Dexcom G7 feature. Dexcom is the leader in CGM technology. For your diabetes to be managed, it's essential to be with the best technology of

year's worth of data. That's fine for most diabetes, but what about those when it would be hard to log your glucose? What if your CGM sensor could connect directly to your Apple Watch?

Dexcom has been the leader in CGM innovation for the last 20 years with the singular goal of helping people manage their diabetes and take control of their health, and we couldn't be more excited to introduce the new Direct to Apple Watch feature!



[Download](#)

**Dexcom\_G7\_Direct\_to\_Apple\_Watch\_Easy\_Glucose\_Monitoring\_\_Dexcom.pdf (14.4 MB)**



## 2026/04/20 - Apple Watch and Diabetes

ISABEL PLOESSL - Apr 20, 2026, 4:50 PM CDT

**Title:** The Role of Smartwatch Technology in the Provision of Care for Type 1 or 2 Diabetes

**Date:** 04/20/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To learn more about what it looks like to monitor your diabetes via an apple watch.

**Content:**

- Smartwatch technology has grown rapidly as a diabetes management tool over the past decade, offering new ways to monitor glucose, activity, and medication adherence.
- Smartwatches can provide real-time alerts, reminders, and visual cues that may improve daily diabetes self-management.
- Devices can wirelessly sync with smartphones and cloud systems, allowing patients, caregivers, and clinicians to view glucose data remotely.
- This remote access may help caregivers monitor children with Type 1 Diabetes more safely and efficiently.
- Four of the five studies focused mainly on feasibility, usability, or user acceptance rather than long-term health outcomes.
  - One pilot study found a 0.6% reduction in HbA1c after 12 weeks using a smartphone-centered diabetes care system with wearable integration.
- Higher user engagement and more frequent glucose logging were linked with better glucose control outcomes.
- A Fitbit-based study showed physical activity tracking had the highest completion rates compared with medication, weight, or glucose logging.
- Some participants needed technical support due to syncing or login issues, highlighting usability barriers.
- Another study found users with poor glucose time-in-range improved by an average of 22.7% when combining CGM with wearable tracking and an AI app.
- A proof-of-concept exercise timing study increased daily physical activity by about 10 minutes per day.
- However, adherence to prescribed exercise times was low, showing behavior change remains challenging.
- Smartwatches may be especially useful for younger Type 1 Diabetes users who are comfortable with technology and need hypoglycemia alerts.
  - Future smartwatch systems may integrate directly with CGMs for discreet wrist-based glucose viewing and alerts (already happening)
- Researchers noted that noninvasive glucose sensing through smartwatches is still in early development.
- Overall, current evidence is promising but limited, and stronger long-term randomized clinical trials are still needed.

**Conclusions/action items:** This review allowed me to see the scale at which smart watches are being used as a primary monitor for diabetes, which is very little, especially for young kids they aren't being used. This gives our device the ability to capture more market in diabetes monitoring than apple and other smart watches.

**Citation:** S. Diez Alvarez, A. Fellas, K. Wynne, D. Santos, D. Sculley, S. Acharya, P. Navathe, X. Gironès, and A. Coda, "The role of smartwatch technology in the provision of care for type 1 or 2 diabetes mellitus or gestational diabetes: Systematic review," *JMIR Mhealth Uhealth*, vol. 12, p. e54826, Dec. 2024, doi: 10.2196/54826.

ISABEL PLOESSL - Apr 20, 2026, 4:44 PM CDT

JMIR PUBLISHED AND PEER REVIEWED

Diez Alvarez et al.

### Index

### The Role of Smartwatch Technology in the Provision of Care for Type 1 or 2 Diabetes Mellitus or Gestational Diabetes: Systematic Review

Sergio Diez Alvarez<sup>1</sup>, MMHBC, RHIA; Antoni Felas<sup>2</sup>, BHE (Hons), BPSol, PhD; Katie Wynne<sup>3,4</sup>, MBBS, PhD; Derek Santos<sup>5</sup>, PhD; Dana Sculley<sup>6</sup>, PhD; Shanmugan Acharya<sup>7</sup>, MBBS; Poornima Navathe<sup>8</sup>, MBBS; Xavier Gironès<sup>9</sup>, PhD; Andrea Coda<sup>10</sup>, BSc (Hons), BPSol, PhD

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#### Abstract

**Background:** The use of smart technology in the management of all forms of diabetes mellitus has grown significantly in the past 10 years. Technologies such as the smartwatch have been proposed as a method of assisting in the monitoring of blood glucose levels as well as other alert prompts such as medication adherence and daily physical activity logs. These important concerns track across all forms of diabetes and have the potential to increase compliance of self-monitoring with the aim of improving long-term outcomes such as hemoglobin A<sub>1c</sub> (HbA<sub>1c</sub>).

**Objective:** This systematic review aims to explore the literature for evidence of smartwatch technology in type 1, 2, and gestational diabetes.

**Methods:** A systematic review was undertaken by searching Cochrane MEDLINE and Cochrane CRD44 databases. A second search using all identified keywords and index terms was performed on Cochrane MEDLINE (January 1966 to August 2025), Embase Classic (January 1967 to August 2025), Cochrane Central Register of Controlled Trials (CENTRAL), the Cochrane Library, JAMA (January 1966 to August 2025), EMBASE, IEEE Xplore, ACM Digital Libraries, and Medline. Studies involving type 1, type 2, and gestational diabetes were eligible for inclusion. Quantitative studies such as prospective cohort or randomized clinical trials that explored the feasibility, usability, or effect of smartwatch technology in people with diabetes were eligible. Outcomes of interest were changes in blood glucose or HbA<sub>1c</sub>, physical activity levels, medication adherence, and feasibility or usability scores.

**Results:** Of the 3258 titles and abstracts screened, 2 studies were included for qualitative synthesis in this review. A total of 352 participants with either type 1 or type 2 diabetes mellitus were included in the review. A total of 4 studies focused on the feasibility and usability of smartwatch technology in diabetes management. One study described a piece of concept and/or clinical trial including smartwatch technology for exercise time prescription for participants with type 2 diabetes mellitus. Absence of participants to smartwatch technology varied between included studies, with one reporting significant

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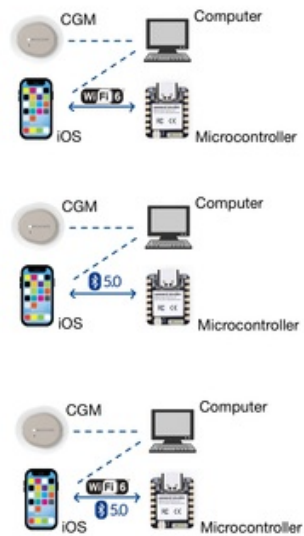
**mhealth-2024-1-e54826.pdf (282 kB)**

 **2026/02/11 - Design Matrix Designs**

ISABEL PLOESSL - Feb 11, 2026, 1:37 PM CST

**Title:** Designs I Made for Desing Matrix**Date:** 02/11/2026**Content by:** Isabel Ploessl**Present:** N/A**Goals:** To create functional images for the design matrix this semester**Content:** Attached in PDF below**Conclusions/action items:** Use these images in design matrix, and presentations going forward

ISABEL PLOESSL - Feb 11, 2026, 1:37 PM CST

[Download](#)

s26matrix.jpg (234 kB)



## 2026/02/19 - Design Matrix Design part 2

ISABEL PLOESSL - Feb 19, 2026, 11:09 AM CST

**Title:** Designs I Made for Desing Matrix

**Date:** 02/19/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To alter the images used in the design matrix

**Content:** Attached in PDF below

**Conclusions/action items:** Use these images in design matrix, and presentations going forward

ISABEL PLOESSL - Feb 19, 2026, 11:09 AM CST



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a5bf14e7-00c0-4ccb-bfaf-15d8b3a32a4b.jpg (9.51 kB)



## 2026/03/11 - New Box 1

---

ISABEL PLOESSL - Mar 11, 2026, 3:52 PM CDT

**Title:** Box 1

**Date:** 3/11/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To rebuild the box into solid works for more simple editing and printing

**Content:** Attached below

**Conclusions/action items:** See if this larger and shorter box fits our new battery, and the new lid. Make changes if not.

---

ISABEL PLOESSL - Mar 17, 2026, 11:35 AM CDT



[Download](#)

**Box1.STL (126 kB)**



## 2026/03/11 - New Lid 1

---

ISABEL PLOESSL - Mar 11, 2026, 3:52 PM CDT

**Title:** Lid 1

**Date:** 3/11/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To rebuild the lid into solid works for more simple editing and printing

**Content:** Attached below

**Conclusions/action items:** See if this new lid fits the new box and is secure in its placement. Make changes if not.

---

ISABEL PLOESSL - Mar 17, 2026, 11:35 AM CDT



[Download](#)

Lid1.STL (8.68 kB)



## 2026/03/17 - New Box 2

---

ISABEL PLOESSL - Mar 17, 2026, 11:36 AM CDT

**Title:** Box 1

**Date:** 3/17/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To rebuild the box with some tweaks to structure and size

**Content:** Attached below

**Conclusions/action items:** Print this in resin and see if any changes need to be made

---

ISABEL PLOESSL - Mar 17, 2026, 11:35 AM CDT



[Download](#)

**Box2.STL (127 kB)**



## 2026/03/17 - New Lid 2

---

ISABEL PLOESSL - Mar 17, 2026, 11:36 AM CDT

**Title:** Box 1

**Date:** 3/17/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To rebuild the Lid to be a bit smaller on the width size

**Content:** Attached below

**Conclusions/action items:** See if this makes the lid better fit into the box. Make changes if not.

---

ISABEL PLOESSL - Mar 17, 2026, 11:35 AM CDT



[Download](#)

Lid2.STL (10.3 kB)

 **2026/03/17 - Mock User Interface for App**

ISABEL PLOESSL - Mar 17, 2026, 11:38 AM CDT

**Title:** Mock App Interface**Date:** 3/17/2026**Content by:** Isabel Ploessl**Present:** N/A**Goals:** To create an outline for what we hope the app begins to look at.**Content:** Attached as pdf below**Conclusions/action items:** Help Claudia create this app interface, maybe make fake buttons for now when moving into Show and Tell.

ISABEL PLOESSL - Mar 17, 2026, 11:38 AM CDT

[Download](#)**Fake\_App\_Interface\_.pdf (762 kB)**



## 2026/04/19 - New everything but smaller

---

ISABEL PLOESSL - Apr 20, 2026, 4:55 PM CDT

**Title:** New dimensions of box and lid

**Date:** 4/19/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To rebuild box and lid to be a better size

**Content:** Attached below

**Conclusions/action items:** See if this makes the lid better fit into the box. Make changes if not.

---

ISABEL PLOESSL - Apr 20, 2026, 4:55 PM CDT



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wgasboxnew.STL (129 kB)

---

ISABEL PLOESSL - Apr 20, 2026, 4:55 PM CDT



[Download](#)

wgaslidnew.STL (7.68 kB)



## 2026/04/20 - New everything

---

ISABEL PLOESSL - Apr 20, 2026, 4:52 PM CDT

**Title:** New dimensions of box and lid

**Date:** 3/17/2026

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To rebuild box and lid to be a better size

**Content:** Attached below

**Conclusions/action items:** See if this makes the lid better fit into the box. Make changes if not.

---

ISABEL PLOESSL - Apr 20, 2026, 4:54 PM CDT



[Download](#)

ISABELnewbox.STL (127 kB)

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ISABEL PLOESSL - Apr 20, 2026, 4:54 PM CDT



[Download](#)

ISABELnewlid.STL (4.28 kB)



## 2026/03/11 - Blood Born Pathogens Training

ISABEL PLOESSL - Mar 11, 2026, 1:37 PM CDT

**Title:** Required Training

**Date:** 03/11/2025

**Content by:** Isabel Ploessl

**Present:** N/A

**Goals:** To complete a training of my selection for continuing education

**Content:**

This certifies that Isabel Ploessl has completed training for the following course(s):

Course	Assignment	Completion	Expiration
2023-24 HIPAA Privacy & Security Training	HIPAA Attestation	9/9/2024	
2024-2025 HIPAA Privacy & Security Training	2024-2025 HIPAA Privacy & Security Training	12/10/2024	
2025-2026 HIPAA Privacy & Security Training	2025-2026 HIPAA Privacy & Security Training	11/19/2025	
Biosafety 102: Bloodborne Pathogens for Laboratory and Research	Biosafety 102: Bloodborne Pathogens Safety in Research Quiz 2026	3/10/2026	3/10/2027
Biosafety 106: Autoclave Use	Biosafety 106: Autoclave Use: Safety and Efficacy - Verification Quiz	1/8/2026	No Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	3/3/2025	3/3/2030
Chemical Safety: Cryogen Safety Training	Part 1 Final Quiz	1/8/2026	1/8/2031
Chemical Safety: Cryogen Safety Training	Part 2 Final Quiz	1/8/2026	1/8/2031
Chemical Safety: The OSHA Lab Standard	Final Quiz	3/3/2025	
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	10/23/2025	10/23/2028

Data Last Imported: 03/10/2026 01:55 PM

**Conclusions/action items:** Use this interesting information for my own sharps container use and what should go in a sharp's container for use in the labs as well.



## 2026/01/28 - Literature searches

---

ISABEL PLOESSL - Jan 28, 2026, 1:53 PM CST

**Title:** Library Session 1

**Date:** 1/28/2026

**Content by:** Isabel Ploessl

**Present:** 301's

**Goals:** To learn about literature searches and citation managers

**Content:**

- AI (chat gpt) is a predictive text generator, not a search engine
  - They can make up sources
  - Trained on undisclosed data
  - Can give information that is completely inaccurate
- Should be searching under more than just the engineering data base
  - Scopus
    - Use more refined search to get very narrow topics
- Citation Manager
  - Zotero is most popular
  - can import things directly from files
  - can start a group library
    - can merge duplicate sources
  - will format bibliography for you
- Evaluating sources
  - relevance: what is the source about
  - authority: who created this
  - quality: why was this written and how does that affect the information
  - currency: when was this source created
- Technical report
  - publish the results of scientific or technical research, often use federal funds. the research is performed and reports are produced by companies, universities, and government laboratories
  - DTIC, NTRL, OSTI
- Refining search
  - quotation marks for specific phrases

**Conclusions/action items:** The library is great resource to find databases, I think I should look on their more rather than what I typically do to which is look on google scholar.



## 2026/02/11 - Presentation Lecture

---

ISABEL PLOESSL - Feb 11, 2026, 1:35 PM CST

**Title: Presentation tips****Date:** 2/11/2026**Content by:** Isabel Ploessl**Present:** 301's**Goals:** To learn how to more effectively present**Content:**

- No single hanging bullet
- Consistent font
- align bullets
- use a logical information flow
  - not always chronological
  - design ideas should be presented in the same order in all places - initial designs and then within the design matrix
- use your content - don't use pictures you won't discuss
- 6x6; 6 words, 6 lines
- keep your audience interested
  - So what?
  - Attitude: don't talk down
  - Presence: be excited!
  - Mannerisms: talk to audience not screen
- highlights vs depth
  - cannot possibly cover everything
    - hit highlights
- catch attention and understand what's on the slide
- Figure captions
  - for images: figure X . [what is measured]
- Graphics
  - no CAD drawings
  - labels and scales required
  - detailed sketch is fine
  - no background
- Graph it, never use raw data
- appropriate font sizes
- comparable axis values
- statistics
  - appropriate sample size
  - bin trails
- Storyteller with figures
  - exploded view
  - can also use block diagrams

**Conclusions/action items: Use these tips to create both design matrix and Prelim Presentation**



## 2026/02/25 - Diversity and Inclusion

---

ISABEL PLOESSL - Feb 25, 2026, 1:48 PM CST

**Title:** Diversity and Inclusion in design lecture

**Date:** 2/25/26

**Content by:** Isabel Ploessl

**Present:** 301's

**Goals:** To learn about how to be inclusive in our project

**Content:**

- What does diversity mean in engineering
  - make sure device is available to everyone
  - size adjustments
  - inviting all ideas
  - limiting price barriers
  - quality is consistent for all
  - using inclusive language
- What does universal design mean
  - unbiased device
  - targeting many different aspects of personality
    - gender
    - race
    - economic status
    - ability
    - ethnicity
  - using intuitive design
  - test with broad demographic
  - design simplicity
- Universal Design: design that's usable by all people to the greatest extent possible, without the need for adaptation or specialized design
- 7 principles of universal design
  - 1. equitable use
  - 2. flexibility of use
  - 3. simple and intuitive use
  - 4. perceptible information
  - 5. tolerance for error
  - 6. low physical effort
  - 7. size and space for approach and use
- How does this relate to ethics?
  - it is good ethics and morals to design a device that is accessible to everyone
    - not intentionally leaving anyone out
  - the more people your design works for the more people it can help

**Conclusions/action items:** It is important to think of all of these 7 principles when creating your design, you have to think about a myriad of factors, but it is extremely worth it ethically.



## 2026/03/04 - Patents, and Standards

ISABEL PLOESSL - Mar 04, 2026, 1:57 PM CST

**Title:** Patents, Standards and other resources for design

**Date:** 03/04/26

**Content by:** Isabel

**Present:** 301's

**Goals:** Learn about patents and design resources from the library

**Content:**

- What libraries have:
  - ASTM
  - ASABE
  - IEEE
  - Lots free online
  - Can also request a standard
    - Different resources for business specific sources
      - Data Axle Reference Solutions
      - IBIS World Industry Reports
      - ProQuest One Business
        - Tong Focus
- Patents and Prior Art
  - Prior Art: Inventions disclosed in US and foreign patents and patent applications, inventions disclosed in publications, inventions currently for sale or in public use
  - Use lens.org to find patents and other patents that are related
    - Ways to expand search:
      - Patent citations
      - Keywords
      - CPC Classifications: invention categories
      - Filter bar
- Patent Examiners evaluate for:
  - Usefulness
  - Novelty (searched against prior art)
  - Non-obviousness
- Claims:
  - Define legally enforceable aspects of patent
  - Every utility patent has at least one claim
  - Each claim is a single sentence
    - Preamble
    - Transition
    - Antecedent
      - Independent: standalone, contains all limitations necessary to define an invention
      - Dependent: must refer to a previous claim, must further limit the claim
  - Claims of one patent try to work around claims of another
    - Example: one patent more specifically mentions squirrels and the other keeps the animal it feeds pretty general
      - Patents expired, so you can market

**Conclusions/action items:** Lens.org is a good website to use to find patents to compare to our product. Should look into this when we submit for the tong award. Should be mindful of other patents when creating devices.





## 2026/03/06 - Tong Lecture

ISABEL PLOESSL - Mar 11, 2026, 3:23 PM CDT

**Title:** Tong Lecture - Justin Williams

**Date:** 03/06/2025

**Content by:** Isabel

**Present:** BME's

**Goals:** To learn about Justin Williams and what he has accomplished in his career!

**Content:**

- Justin grew up in a very small town in South Dakota; his parents were farmers and there were really no resources for him to excel in academics
- He started running in college which got him through
- Undergrad in ME
  - went to work for Daktronics making score boards, realized he wanted to create new things
  - started a background in BME
  - worked for both Michigan and UW
  - started many things that failed/got shelved
- NeuroOne
  - Sometimes less is more
  - Sat in on my surgery's for epilepsy that were incredibly invasive
    - co founded a new way to place thinner and more flexible electrodes in the brain
    - opening bell for the Nasdaq
- Brainsync
  - Market and timing is everything
  - electrode cap used for tying with the brain
  - 50 best inventions of 2009
  - elon musk tried to take credit
  - wanted to bridge into more patients as their scope was small
  - branched into stroke rehabilitation with a automated glove
    - helps patients re-create the brain to limb process
- NeuraWorx
  - Sometimes its personal
    - Father suffered from a rare progressive nueral disease, PSP
    - caused by a bulidup of tau protein
    - attempted to active the cleaning pathway via other methods
  - Still in clinial testing
    - current headband, mouthguard and eventually mico-implant
- Main Lessons:
  - know your market and find the right market
  - start with the end in mind
  - timing is crucial
  - keep it simple
  - work with good people
  - find your motivation
  - show up!

**Conclusions/action items:** I thought Justin's talk was incredibly interesting, I hope to take the lessons to heart and remember them going forward. (I also really want to take his class in the fall)



## 2026/03/11 - Testing Protocol

---

ISABEL PLOESSL - Mar 11, 2026, 1:46 PM CDT

**Title: Fabrication Protocol****Date:** 3/11/2026**Content by:** Isabel Ploessl**Present:** 301's**Goals:** To learn about how to better our protocol**Content:**

- fail fast and fail often
  - low fidelity prototyping
  - circuit diagrams
  - circuit testing
  - fittings (connection points)
  - simple calculations
- documentation
  - materials
    - name of the material
    - concentration, amount
    - manufacturer and part number
    - purpose of material
    - list of equipment needed
    - include reference to paper or research in other parts of the notebook
  - methods
    - mix - for how long and with what vigor
    - cut - with what tool and what size
  - rule #1 - repeatable by unfamiliar reader
  - examples:
    - not listing where they are getting materials from
      - okay for first iteration
    - lacking explanation of mixing steps
- 3d printing
  - include all settings used
  - what thickness
  - what material
- Manufacturing
  - consider throughout the process
  - cannot manufacture everything you can 3d print
  - common methods
    - molding
    - machining
    - joining
- Be very deliberate on fabrication details
- Statistics (n=30)
- Controls
- Reference and discuss the PDS criterion being tested

**Conclusions/action items:** We will use this information to develop our own testing protocol and use this going forward when we begin testing.





## 2026/03/18 - Brevity and Communication

ISABEL PLOESSL - Mar 18, 2026, 1:44 PM CDT

**Title:** Lecture 9

**Date:** 3/18/2026

**Content by:** Isabel Ploessl

**Present:** 301s

**Goals:** To learn how to make and give a successful elevator pitch

**Content:**

- Elevator Pitches
  - succinctly and effectively communicate your ideas
  - seize opportunities
  - goal
    - capture attention
    - generate interest
- Creating pitch
  - know your audience
  - practice, practice, practice
  - be authentic
  - keep it simple
  - adapt iterate
- general structure
  - attention grabber
  - introduction
  - value proposition
  - benefits
  - call to action
- Tong award
  - introduction: hi, I'm ... and our project is the ...
  - attention grabber: we have developed a device to do X
  - value proposition: currently there is not a device to do X as existing technologies and patents fail because of Y
  - benefits: it is estimated that Z people would benefit from this device which has a potential market of \$, we have filed for a patent with WARF. demonstrate the prototype fully
  - call to action: do you have any questions
    - approx. 5 minutes
- Dos
  - maintain eye contact and exude confidence
  - keep it concise and focused
  - tailor your pitch to different audiences
- Don'ts
  - don't overwhelm with unnecessary details
  - don't forget to listen and engage with your audience
  - don't sound rehearsed or robotic
- Executive Summary
  - elevator pitch but make it one page
  - say more with less words
  - know your audience
  - focus on the essentials
  - use clear and concise language
  - highlight key points
- Purpose of an Abstract

- provides a clear, concise, and specific summary of your work
- help readers decide if they want to read the full paper
- journals may require a longer executive summary style abstract
- typically, 250 words, 1 paragraph
- Structure of abstract
  - background/context
  - objective
  - methods
  - results and analysis
  - discussion and conclusion
- Reports - writing concisely
  - eliminate extraneous text
  - avoid conversational text
  - spell out acronyms once when first introduced
  - remove redundancies
  - do not include raw data
  - proofread thoroughly (entire document)

**Conclusions/action items: Claudia will update the website with what we will compete for (Tong). We will write our executive summary which is due after spring break and submit it on our website once we receive feedback.**



## 2026/03/25 - Ethics in Engineering

ISABEL PLOESSL - Apr 06, 2026, 7:38 AM CDT

**Title:** Ethics in Engineering

**Date:** 3/25/2026

**Content by:** Isabel Ploessl

**Present:** 301's

**Goals:** To learn more about ethics and how to apply them in our current project and also in later careers.

**Content:**

- What ethics are and where they come from is subjective
- Ethics can differ between:
  - Personal ethics (individual beliefs/values)
  - Professional ethics (standards in a field)
- Encourages reflection and peer discussion
- Instructors generally value ethics more highly than students
- Differences seen across:
  - Communication
  - Teamwork
  - Ethics
  - Leadership
- Highlights a gap in perceived importance of ethical considerations
- Biomedical engineers follow a formal code of conduct
- Provides guidance for:
  - Professional behavior
  - Responsibility to patients and society
- Used as a framework for ethical decision-making
- Ethical problem-solving mirrors engineering design (page 5 diagram):
  - Identify need / ethical dilemma
  - Understand the problem
  - Generate solutions
  - Evaluate solutions
  - Develop and test
- Process is iterative and revisited as needed
- Key steps:
  - Awareness: recognize ethical issue
  - Stakeholders: consider all affected parties
  - Options: generate possible actions
  - Analysis: evaluate using ethical frameworks
- Core Tests
  - Harm test: minimize negative consequences
  - Publicity test: would you be okay with it being public?
  - Reversibility test: would you accept this outcome yourself?
  - Universality test: what if everyone acted this way?
  - Respect for persons: protects dignity and rights
  - Utilitarian test: greatest good for most people
  - Social justice test: avoids harm to vulnerable groups

**Conclusions/action items:** Use what we have learned in the slides to use in our design and use to complete the ethics assignment.



## 2026/04/08 - Engineering Judgment

---

ISABEL PLOESSL - Apr 08, 2026, 1:37 PM CDT

**Title:** Engineering Judgement

**Date:** 04/08/2026

**Content by:** Isabel Ploessl

**Present:** 301's

**Goals:** To learn what engineering judgment is

**Content:**

- The process of making informed decisions, often in situations where there isn't a clear-cut answer or a specific code or standard to follow, by weighting available information, experience to arrive at a reasonable solution.
- ABET outcome 6:
  - an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions
- How to lean engineering judgement
  - Real world engineering problems
  - open ended problems
  - teamwork collaboration with others
  - communication
  - critical thinking evaluates solutions testing/analysis
  - handling uncertainty, including complete information
  - ask questions
  - embrace lifelong learning
- Three domains model
  - Attitudes: what you feel and believe
  - Behaviors: how you act upon your knowledge
  - Cognitive: what you know about things

**Conclusions/action items:** Use these modes to complete the in class activity about the model.



## 2026/04/15 - Poster Presentation

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ISABEL PLOESSL - Apr 15, 2026, 1:46 PM CDT

**Title:** Poster Presentation

**Date:** 4/15/26

**Content by:** Isabel Ploessl

**Present:** 301s

**Goals:** To learn how to make a better poster

**Content:**

Good posters

- clear figures
- large font
- concise
- color and limited blank space
- figure labels and legends
- same scales on graphs
- no single hanging bullets

Bad posters

- blurry figures
- no figures
- text too small
- too much text
- too advanced wording
- no raw data
- too much going on

Getting started

- read requirements
- include relevant and correct information
- descriptive but succinct
- have a storyline
- show your best results
- minimize text
- lots of colorful high-resolution pictures
- captions on figure: number, title, description, citation if necessary
- read from 3 ft (excludes acknowledgments, and references)

Final Details

- Handouts
  - business cards
  - copies of poster
  - surveys
- have several other people proofread
  - general feedback on appearance and layout

**Conclusions/action items:** Use these tips to create a good poster for next Friday, have it printed out and ready for next class.



## 2026/01/28 Difficulties in using Technology to Manage Diabetes in children

Claudia Beckwith - Jan 28, 2026, 3:24 PM CST

**Title:** FEATURES OF PARENTS' DIFFICULTIES IN USING TECHNOLOGIES TO MANAGE DIABETES IN CHILDREN AND ADOLESCENTS.

**Date:** 1/28/26

**Content by:** claudia

**Present:** claudia

**Source:** [1] W. Barifah, B. Davey, and V. Bruno, "Features of parents' difficulties in using technologies to manage diabetes in children and adolescents," *Proc. IADIS Int. Conf. Web Based Communities*, pp. 77–84, 2018.

**Search:** type 1 diabetes AND (children or adolescents or youth or child or teenager) AND (school)

EBSCOhost database, searching Applied Science and Technology Full Text (H.W. Wilson)

**Goals:** I want to get a better understanding of the current limitations surrounding technology for the management of T1D in kids. This article stood out to me particularly because it contains testimonies from parents and health professionals alike, which will help me get a nuanced understanding. This will also help me narrow down our requirements for the PDS.

### Content:

Study conducted:

- interviewing 37 parents of T1D children and 20 allied health professionals
- asked about challenges that result from technology or challenges that could be alleviated from the use of tech
- parents often the primary managers of diabetes in children

Trends observed:

- challenging for patients and parents to search for self-care info online
  - no streamlined navigation
  - slow
- websites/tech not user friendly
- many people still rely on the internet for a lot of info regarding treatment and management vs other sources
- tools on how to use technology resources are not available/nonexistent
  - several testimonies from parents
    - too many types, easy to miss
    - may be some info available in english, not really other languages
    - lack of partnership between fields (medicine, medication, technicians, etc)
  - endocrinologist testimonies had aligning perspectives
- expected to rely on physical books/manuals, not very likely
- affordability is a common concern, T1D already expensive to manage
  - tech companies are focused on profit
- lack of technology aligning with preferences of parents and their children
  - too much documentation, not user friendly or realistic
  - information overloading the user
    - unable to make a decision because too much info is provided
    - info from trusted sources (more related to insulin metrics)

### Conclusions/action items:

It is clear from the testimonies that caregivers, mainly parents, are lacking a straightforward way to understand, manage, and monitor their child's blood glucose. Tech is often either unavailable, or too complex, leading to a market need for simple, intuitive solutions. I do think some of the points brought up in the interviews would be solved with our device, namely the one about language being a barrier.

Claudia Beckwith - Jan 28, 2026, 3:25 PM CST

## FEATURES OF PARENTS' DIFFICULTIES IN USING TECHNOLOGIES TO MANAGE DIABETES IN CHILDREN AND ADOLESCENTS

Wale's Baribelli<sup>1,2</sup>, Bill Davey<sup>1</sup> and Vince Bruno<sup>1</sup>

<sup>1</sup>School of Business, IT & Logistics, RMIT University, Melbourne, Australia  
<sup>2</sup>Management Information Systems, RMIT University, Parkville, Australia

### ABSTRACT

Type 1 diabetes (T1D) is a chronic disease (CD) affecting people of all ages, including children. The growing number of diabetes has placed a burden not only on healthcare providers, but also on caregivers at home, including parents, grandparents and family. Information and communication technologies (ICT) have been suggested to support the self-management of CD. However, little is known about how these ICTs help parents' parents to manage their children's disease. This study aimed to identify the challenges experienced by parents, which may hinder the use and effectiveness of ICT. Employing a qualitative approach, 50 semi-structured in-depth interviews were conducted with 71 parents of T1D children and 20 adult health professionals. Data was analysed using the software 'bracket coding' identified two major themes namely that ICTs are ineffective in facilitating the acquisition of T1D information and are unable to provide personal and culture benefits from this study can help various organisations such as educators, and ICT companies, and schools and parents, including parents, doctors and web designers to provide recommendations for the diverse ICT tools that could empower parents' use of ICT and facilitate the adoption of ICT tools for other sub-conditions.

### KEYWORDS

ICT; T1D; Difficulty; Parents; Management; Health Information

### 1. INTRODUCTION

Enhancing parents' understanding of their children's T1D is one of the ways to ensure that T1D patients receive quality home care and management of the condition. T1D is more prevalent among children and adolescents (IARC, International Agency for Cancer Research) affecting children globally (Nouri et al., Hatcher, 2011; Stewart et al., Mangham, 2014). As Moore Davis et al. (2017) state, diagnosis of T1D in G&A presents a considerable medical and public health issue, mainly because of the challenges related to the condition's management, coupled with the threat of severe and chronic complications. Parents of the children with T1D are responsible for the daily management of the disease (Carer, 2017; Xiong, 2018), including frequent glucose monitoring, diet regulation, insulin administration, and physical activity regulation (American Diabetes Association, 2013). Therefore, T1D management can be a challenging task for parents for various reasons. Not only the associated physiological factors and heightened sensitivity to insulin, but also the children's behavioural, cognitive and socio-emotional development.

To effectively provide support to children and ensure effective T1D management, parents must apply novel strategies, such as education and support concerning their coping skills. These strategies should be embedded in the healthcare services to empower parents and reduce their stress in providing care to their children (Grey et al., 2011). To cope with the difficulty of helping their children to conform to the rigorous and frequent monitoring of blood glucose, parents of children with T1D need access to information that can help them effectively manage their children's disease. In a meta-analysis conducted by Popovic (2007), it was revealed that having access to multiple sources of information was linked to better outcomes for parents of children with T1D. A common approach through which parents can gain access to valuable information is using information and communication technology (ICT).

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## 2026/01/29 Relationship between overparenting and autonomy in families with T1D

Claudia Beckwith - Jan 29, 2026, 1:49 PM CST

**Title:** Developmental Differences in Reported Overparenting, Autonomy, and Glucose Monitoring within a Medical Specialty Camp Context

**Date:** 01/29/2026

**Content by:** Claudia

**Present:** Claudia

**Goals:** I want to research the relationships stemming within families with children that have t1d. I think autonomy is a common area of conflict with children managing their own blood sugar and I'm interested to see what the literature says on that. I will use this research in the background/motivation for our project.

**Cite:** [1]

"Developmental Differences in Reported Overparenting, Autonomy, and Glucose Monitoring within a Medical Specialty Camp Context-Web of Science Core Collection." <https://www-webofscience-com.ezproxy.library.wisc.edu/wos/woscc/full-record/WOS:000982586000001>

**Search:** T1D and Children and Parents in Web of Science

**Content:**

Parenting trends:

- excessive parenting observed more in parents with children with t1d
- lower autonomy
- lower use of CGM
- data collected from a camp serving 262 youth with t1d
- average checking 12.75 times a day by child
- average checking 12.02 times a day by parent
- overparenting decreased as age increased
- adherence to diabetes management tends to decline in parallel with youth experience level
  - more experience = less checks
- CGM's associated with improved health outcomes and less parental stress
- remote monitoring very popular
- more "followers" or shared data leads to better management
- parents check CGM data ranging from 0-51 times a day
- overparenting leads to inability to problem solve in the future
- parent involvement shown to decrease with age and years of management
- other studies show that overparenting leads to better understanding of the management practices by the child and can lead to better long term outcomes
- as children get older, they often feel more controlled whereas parents feel their level of involvement decreases
  - differing perspectives, point of conflict
- overall no consistent trends observed between parental involvement and the amount of self CGM checks administered or the amount of checks by the parent
- study recognized limitations with diverse range of backgrounds, mentions factors such as income or insurance covering can drastically change opinions on management

**Conclusions/action items:**

Overall I was interested that a lot of the self reported data is conflicting based on perspective. Parents will think they're less involved and the children feel like they're being overstepped. One piece of data I think would be helpful to highlight in the future is that the more followers or involved people a child with T1D has, the better the outcome is of their management. I think that's super applicable to our project and a possible advantage.

Claudia Beckwith - Jan 29, 2026, 1:56 PM CST

## Developmental differences in reported overparenting, autonomy, and glucose monitoring within a medical specialty camp context

Journal of Social and  
Personal Relationships  
2024, Vol. 41(1) 45–67  
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Ryan J. Gagnon   
Barry A. Garst   
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 Clemson University, Clemson, SC, USA

### Abstract

Developmentally inappropriate and excessive parenting can manifest in higher levels in children with Type 1 diabetes (T1D). A child's age, level of T1D training, and time since T1D diagnosis have been associated with higher levels of developmentally excessive parenting (i.e., overparenting), lower rates of autonomy granting, and lower rates of continuous glucose monitoring (CGM). Utilizing a structural equation model, the present study examined these associations with data collected from a medical specialty camp (MSC) serving 262 youth with T1D. Respondents primarily identified as female (59.5%), were an average 13.83 years old, and had attended the MSC for an average of 3.72 years. Respondents had an average of 5.95 years since T1D diagnosis, an average of 3.62 years utilizing a CGM, reported checking their CGM data an average of 12.75 times per day, and an average of 12.01 parent CGM checks per day. As youth age increased, rates of overparenting decreased. Similarly, youth with more MSC experience reported lower rates of overparenting. Contrary to the study hypotheses, overparenting had a positive effect on autonomy granting. Finally, a negative relation was found between years with T1D and average CGM checks, consistent with the broader T1D literature where adherence to diabetes management tends to decline in parallel with youth experience level managing T1D.

### Keywords

overparenting, helicopter parenting, parenting, diabetes, glucose monitoring, chronic disease, youth

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[gagnon-et-al-2023-developmental-differences-in-reported-overparenting-autonomy-and-glucose-monitoring-within-a-medical.pdf \(675 kB\)](#)



## 2026/01/29 Stress and Burden of Parents of Children with T1D

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Claudia Beckwith - Jan 29, 2026, 3:39 PM CST

**Title:** Stress and Burden Experienced by Parents of Children with Type 1 Diabetes-A Qualitative Content Analysis Interview Study

**Date:** 1/29/2026

**Content by:** claudia

**Present:** claudia

**Goals:** I want to get a better idea of what parents of children with t1d experience. I think having a better understanding of the burndens of parents can help inform some of our descisions on our design. I am especially curious to see if there's research about stress with other caregivers.

**Cite:** parenting and "type 1 diabetes" and school on Web of Science

"Stress and Burden Experienced by Parents of Children with Type 1 Diabetes-A Qualitative Content Analysis Interview Study-Web of Science Core Collection." <https://www-webofscience-com.ezproxy.library.wisc.edu/wos/woscc/full-record/WOS:001557287300001>

**Search:**

**Content:**

Parents reported

- exhaustion
- sleeplessness
- cognitive issues
- difficult between fostering independence and diabetes management
- increased need for external support, such as psychosocial support

Study analysis:

- interviewed 16 parents from sweden
  - 14 mothers
  - 2 fathers
- children 10-17 with t1d
  - mean age 13.5
- parents ranged 40-62 years of age

Results:

- being a parent to a child with t1d related to stress and burden, parents described it as being "tied in knots"
- increased relationship challenges in family dynamics
- struggles with partner interactions and intimacy
- sadness about overlooked sibilings
- independence and control confusions
- greif of "loss over a normal life"
- struggle to find reliable support channels
  - emphasis on the importance of dependable school environments
  - need for trustworthy devices
  - reliable back ups
  - accessable healthcare guidance
  - worries about the committment and level of education of school staff
  - lack of open and clear communication systems
  - worries about group activities
- main takeaway was theme of "tying oneself in knots"
  - difficulties in managing
  - feelings of being intertwined between family members

Importance of a dependable school environment:

- frustrated by school's lack of support
- many didnt get necessary professional resources for the their children
- no clear person to turn to
- one parent noted the principal missed a crucial meeting, leaving parents feeling anxious
- instances reported where no one intervned in a period of high or low blood glucose, creating dancier

Conclusions/action items:

I was interested of the stress related to parents sending their children to school. It seems like a common theme is that parents worry about the level of dedication other have into learning and understanding their child. I think our device could be really helpful in this context because it will help streamline the process of understanding the glucose levels with intuitive signals.

Claudia Beckwith - Jan 29, 2026, 3:37 PM CST

**children** **MDPI**

Article  
**Stress and Burden Experienced by Parents of Children with Type 1 Diabetes—A Qualitative Content Analysis Interview Study**  
 Ana Carlsson <sup>1</sup>, Sara Olsson <sup>2</sup> and Ana Håsten <sup>1</sup>

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**Highlights**  
 What are the main findings?  
 • The complex factors of stress and burden in parenting a child with T1D can be like trying to walk on ice.  
 • Constant stress and worry lead to parental exhaustion, sleeplessness, and cognitive issues, but balance between fostering independence and diabetes management adds to these challenges.  
 What is the implication of the main finding?  
 • Fund and incorporate social workers and psychologists with expertise in T1D into standard diabetes care teams.  
 • Include psychosocial support as a standard part of care, with scheduled visits for parents.

**Abstract**  
**Background:** Parents of children with type 1 diabetes play a key role in managing their child's self-management, which can be stressful and burdensome. High involvement can lead to reactions such as emotional, cognitive, and physical exhaustion in parents. Understanding parents' psychosocial impact due to their child's disease is crucial for the family's overall well-being. The purpose of this study was to describe stress and burden experienced by parents in families with children living with type 1 diabetes. **Methods:** This study utilized a qualitative approach, analyzing interviews with 16 parents of children aged 10 to 17 years living with T1D through qualitative content analysis. The data collection occurred between January and February 2023. **Results:** Managing a child's type 1 diabetes can be tough on family relationships, affecting how partners interact, intimacy, and sibling relationships. The constant stress and worry might leave parents feeling exhausted, unable to sleep, and struggling to think clearly, on top of the pain of losing a normal everyday life. The delicate balance between allowing a child with type 1 diabetes to be independent and maintaining control over their self-management makes these challenges even more demanding for the parents. **Conclusions:** Parents' experiences highlight the need for robust support systems, including dependable school environments, trustworthy technical devices, reliable family and friends, and accessible healthcare guidance. These elements are essential for the child's health and well-being but also for alleviating the emotional and practical burdens parents face.

**Keywords:** children; parents; qualitative content analysis; type 1 diabetes

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## 2026/01/29 Cognitive and Psychological effects of t1d

Claudia Beckwith - Jan 29, 2026, 10:58 PM CST

**Title:** The cognitive and psychological effects of living with type 1 diabetes: a narrative review

**Date:** 1/29/2025

**Content by:** Claudia

**Present:** claudia

**Goals:** I want to get a deeper understanding of what it is like for the patients who have t1d. I've done a lot of research about the perspective of the parents/caregivers but in terms of the child, I think it would be helpful to understand their needs better. This can help us target things in our design to best tailor the the bracelet wearer.

**Cite:**

"The cognitive and psychological effects of living with type 1 diabetes: a narrative review-Web of Science Core Collection." <https://www-webofscience-com.ezproxy.library.wisc.edu/wos/woscc/full-record/WOS:000504576000001>

**Search:** parenting and "type 1 diabetes" and school in web of science database

**Content:**

Effects in young people:

- t1d can interfere with psychosocial development and hinder school performance
- affects relationships with friends and family
- related to mild cognitive decrements
- related to affective disorders (depression, anxiety)
- related to slightly lower overall cognitive performance
  - moderately lower memory
  - lower attention
  - effects often lasting into adulthood
  - hinder executive functioning
  - slow info processing speed
- deficits in visuospatial abilities
- deficits in reading and writing

Emotional effects:

- self-esteem is often an issue in children with t1d
- may experience peer difficulties
- increased burden from daily diabetes management
- increased risk for eating problems
  - often due to the constant energy of thinking of food
  - disordered eating prevalent in young adults with t1d
  - less likely to have a diagnosed eating disorder, though
- particularly vulnerable to social pressure, stigma, and discrimination
- may be link to biochemical disturbances
- documented very heightened risk for depression and/or anxiety

**Conclusions/action items:**

I learned that having t1d is linked with several different cognitive and mental challenges. I didn't know that biochemical disturbances could have such a profound effect on factors like memorization and cognitive function. The social implications make more sense, saying that being different can be a cause for stress and isolation in kids/adolecents with t1d. It would be helpful to keep this in mind during our prototype as to make it alerting for caregivers but not isolating for the wearer.

Claudia Beckwith - Jan 29, 2026, 10:58 PM CST

ENABLING RESEARCH  
DOI 10.1111/1469-7610

## James Lind Alliance Research Priorities

### The cognitive and psychological effects of living with type 1 diabetes: a narrative review

E. van Duinkerken<sup>1,2,3</sup>, F. J. Snoek<sup>1,2</sup> and M. de Wit<sup>1,2</sup>

Typhlog Centre, Pictetlaan 6, 6100 CA Wageningen, The Netherlands; <sup>1</sup>Department of Medical Psychology and <sup>2</sup>Department of Diabetes Center, Department of Internal Medicine, Groningen University Medical Center, 3000 Groningen, Netherlands; <sup>3</sup>The Netherlands

Accepted 12 December 2020

**Abstract**

Across the lifespan, type 1 diabetes mellitus has a profound (neuro)psychological impact. In young people, type 1 diabetes can interfere with psychosocial development and longer school performance. In adulthood, it can interfere with work life, relationships and parenting. A substantial minority of adults with type 1 diabetes experience coping difficulties and high diabetes-related distress. In youth and adulthood, type 1 diabetes is related to mild cognitive decrements as well as affective disorders, such as depression and anxiety. There is limited literature available that explores the interaction between cognitive and psychological comorbidity and underlying mechanisms. The aims of the present narrative review were to summarize the current state of the literature regarding both cognitive and psychological comorbidity in type 1 diabetes across the lifespan, and to explore potential links between the two domains of interest to make suggestions for future research and clinical practice.

*Diabet. Med.* 37, 555–563 (2020)

**Introduction**

This review is part of a series on the James Lind Alliance Research Priorities in Diabetes. Type 1 diabetes mellitus is primarily diagnosed during childhood and adolescence [1], although many cases are diagnosed during adulthood [2]. Despite significant improvements in its medical treatment, type 1 diabetes carries an increased risk of developing micro- and macrovascular complications [3]. It is well recognized that living with and self-managing type 1 diabetes, with and without complications, is psychologically challenging, impacting on emotional health and social functioning [4]. There is also evidence that type 1 diabetes is associated with mild to moderate cognitive deficits, also called 'diabetes-related cognitive [1] and adulthood [5]. It is known about the impact of type 1 diabetes on cognition in the elderly age will never be clear their role of diabetes.

Type 1 diabetes and related acute and long-term complications can have a profound effect on cognitive, emotional and social functioning of the person living with diabetes. In the narrative review, we present relevant review and narrative papers, where possible combined with original research studies, to highlight the most recent advances in research on cognitive and psychological, i.e. emotional and behavioural, problems across the lifespan of type 1 diabetes. A systematic search of the literature was not performed. The main objective of this review was to explore the current state of the art on these issues, wherever possible rather than to summarize. We explore the limited research to date on the complex relationship between psychological and cognitive functions in the aging population of people with type 1 diabetes and discuss potential implications for future research.

**Type 1 diabetes-related cognitive sequelae**

In this section we discuss the current state of cognitive findings in type 1 diabetes across the lifespan. Most research to date has used neuropsychological tests to measure domains such as memory, attention and executive functions (see similar throughout adolescence to older age. For younger children, adapted versions of the tests are sometimes used.

**Disability/dependence**

The measurement of TD status in young people has shown that type 1 diabetes-related cognitive decrements are characterized by higher levels of neurocognitive performance and moderately lower memory skills, attention and executive

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## 2025/01/28 Computer App to iPhone App Process Flow

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Claudia Beckwith - Jan 28, 2026, 2:59 PM CST

### Title: Computer App to iPhone App Process Flow

Date: 1/28/26

Content by: claudia

Present: claudia

**Goals:** At this point, we have a working connection from the backend API to the flutter app (running on my laptop, locally) to the microcontroller. Our team wants to produce a device that is fully remote/wireless, which includes the option to control via smartphone. I want to research the big steps of converting our Flutter application to a mobile one, and then I can break it down from there.

### Content:

overall steps:

1. productize the app
2. solidify the auth/data flow
3. establish in Apple via their pipeline

The first step right now would be to decide the path, either choosing to go through the official Dexcom Developer API (delay time but better for production) or the Dexcom Share approach (better for delay, less official, not good for App Store)

- might be able to experiment with official API but a strong UX around delay

To get Flutter into iOS app build, we need to do the following:

- work in Xcode
  - set up iOS build
- configure iOS permissions (we will for sure need bluetooth)
- secure the storage of data

We need to ensure ample authentication and encryption

- keep Dexcom tokens saved in iOS secure storage (keychain, can implement via Flutter)

BLE connection from microcontroller must be phone-grade

- handle errors for lost app connection, app killed, etc
- implement some sort of device identity for pairing purposes
- design BLE communication protocol
  - messages, retry options
  - handle errors, such as missing or delayed data

Background behavior and reliability

- more into what still runs when the app isn't open
  - alerts/notifs

Other considerations

- iOS is strict, especially surrounding BLE
  - usually not "always-on" setting
  - can work to have periodic refreshes instead of constant streaming, our time is ~5 minutes so this could work
- notif types
  - high/low data, maybe something for trend changes?

- make timestamp clear (data aging)
- error handling
- privacy
  - data handling (how long, where is it being stored, etc)
  - HTTPS encryption
  - keychain storage
- Testing
  - distribution to iPhones
  - test on poor networks, locked apps, low power mode, etc
- app store prep
  - if we need the app on the official app store
    - need developer acct
    - app review considerations (disclaimers, health data claims, reliability)
  - also need to make sure we're not overstepping on Dexcom

**Conclusions/action items:**

Overall I have a general plan of what needs to get done, but I am concerned about the possibility of shifting over the Dexcom Developer API, as our entire project is routed in the Dexcom Share program. Our clients are helping us get in contact with the CS department to see if I can get some help on this, which will be very appreciated on my end. I think Dexcom Developer still will give us some lag, so I'm not sure its entirely a feasible route at this time.



## 2026/0205 XIOA BLE Sense in Practical Use

Claudia Beckwith - Feb 05, 2026, 1:26 PM CST

**Title:** Pet Activity Tracker using XIAO BLE Sense & Edge Impulse

**Date:** 2/5/2026

**Content by:** claudia

**Present:** claudia

**Goals:** One of the biggest hurdles our team is trying to overcome is how to understand the BLE connection between our microcontroller and app. This article was written by a person that was able to use our same microcontroller with a mobile app, and I think I could draw inspiration from his project. He provided a lot of the steps also, which is incredibly helpful for our purposes.

**Cite:** [1] Hackster.io, "Pet Activity Tracker using XIAO BLE Sense & Edge Impulse," *Hackster.io*, Mar. 27, 2022. <https://www.hackster.io/mithundas/pet-activity-tracker-using-xiao-ble-sense-edge-impulse-858d73>

**Content:**

*Items used in project:*

physical:

- Seeed studio xiao BLE sense (microcontroller used last semester)
- rechargeable 3.7 V battery

software:

- arduino IDE
- edge impuse studio
- google flutter

fab tools:

- 3d printer
- soldering iron

\* right off the bat, these are all things we have access to/and or currently are using

\* really exited to see they used Flutter for this project!

Steps:

- 3d design for the pet mount - looks like a cube enclosure
- not focusing too closely on this part, no applicable for our process

ARDUINO

- read IMU accell > run Edge Impulse model > smooth out prediction > send to phone over BLE > store history in QPSI flahs > occasionally read/send battery
- lot of libraries used
  - ArduinoBLE
  - LSM6D3 + wire (this only used for accelerometer, we don't need)
- BLE service and configuration
  - custom ble service
  - two TX characteristics to help send from device to phone
  - RX characteristic (phone to device)
  - all are BLEStringCharacteristic (1024 bytes)
- Data writing/saving/overwriting

- allocating one erase-sector worth of RAM and use it to read flash content at startup and write buffer
- flash auto erases data saved and overwrites each time
- Battery
  - HackAnalogIn battery reading
    - creates subclass to get control of the battery info
    - creates ADC object for the VBAT pin
    - triggers sampling
    - readBattery() function to convert ADC into volts
- smoothing predictions
  - not applicable at this point in our project
- BLE event handlers
  - on connect: different colors for different statuses
  - String value = rxCharacteristic.value();
 

```
if(value == "r"){
  receiving = true;
  global_data = "";
}
```
- Battery Read (ADC > voltage > BLE notify)
  - startReadingBatteryLevel(&BatteryLevel);
 

```
if (nrf_saadc_event_check(NRF_SAADC_EVENT_DONE)) {
  nrf_saadc_event_clear(...);
  float vBat = (float)BatteryLevel / 4096 * 3.3 / 510 * (1000 + 510);
  txBatCharacteristic.writeValue(String(vBat));
}
```
  - gives battery level and converts

ARDUINO OVERALL: Every loop, the board samples accelerometer data to fill an Edge Impulse input window, runs the model, saves the predicted class; every 20 predictions it computes a smoothed label, appends it to a CSV-like history string, sends it over BLE to the phone, and writes that history to QSPI flash; battery voltage is sampled via SAADC and sent over BLE too.

#### FLUTTER:

the accompanying flutter app talks to the microcontroller and does the phone app stuff

- builds mobile app UI and logic in flutter/dart
- flutter app connects via BLE
- collects IMU data wirelessly and uploads to Edge Impulse (EI blue app)
  - accelerometer data
- targets iOS from one codebase

#### Conclusions/action items:

The biggest constraint we are facing with the development of an iOS app is that I don't have a mac computer. It is almost impossible to replicate the mac os on a VM in the capacity I need, especially if this needs to scale. Our best bet is getting someone else on the team with a Mac. I think the Arduino packages are very interesting as well, especially the battery monitor system hack. I think we will definitely need to incorporate something similar in our app.

2:06, 12:58 PM Pet Activity Tracker using XIAO BLE Sense & Edge Impulse - Hackster.io

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**Mihailo (mihailo-dag)**  
Published March 21, 2022 © GPL 3.0 (<https://en.wikipedia.org/wiki/GPL-3.0>)

## Pet Activity Tracker using XIAO BLE Sense & Edge Impulse

Our pets deserve more to stay active. A tinyML model predicts activities based on the data coming from 3 Axis IMU.

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## 2026/02/06 Flutter onto iOS development

---

Claudia Beckwith - Feb 06, 2026, 10:02 AM CST

### Title: Set up iOS development

Date: 2/6/2026

Content by: claudia

Present: claudia

**Goals:** Now that I have access to a mac computer, I want to convert my Flutter app to an iOS app. I know I need to install Xcode on the Mac and transfer my code over, which will likely involve some sort of git repo. Once that is established, I don't believe the process to get a mobile interface running will be too complex.

Cite: [1]

"Set up iOS development." <https://docs.flutter.dev/platform-integration/ios/setup>

### Content:

Steps:

1. Install Xcode
  1. latest version
2. Set up Xcode command-line tools
  1. run the following in terminal
    1. `sudo sh -c 'xcode-select -s /Applications/Xcode.app/Contents/Developer && xcodebuild -runFirstLaunch'`
3. Agree to Xcode licenses
  1. open terminal
  2. run
    1. `sudo xcodebuild -license`
  3. read and agree to licenses
4. download prerequisite tooling
  1. iOS platform support
    1. `xcodebuild -downloadPlatform iOS`
5. Install Rosetta
  1. Rosetta 2 for apple silicon Mac, I am unsure which mine is but assuming the original
  2. `xcodebuild -downloadPlatform iOS`
6. Install Cocoa Pods
  1. support flutter plugings that use native iOS or macOS code
7. Set up an iOS device
  1. better to start on a simulator
    1. open -a Simulator
    2. then you can start developing for iOS
  2. On physical device
    1. \*recent update caused a temporary break in flutters debug mode
    2. attach iOS device to USB port on mac
      1. I dont think I have these permissions with a rented mac
    3. trust device
    4. enable developer mode
    5. reset device
    6. required deeloper code signing cert
  3. Access VPN and device management
    1. enable and trust
    2. then you can develop with external device

Conclusions/action items:

I now know all the necessary packages and steps to get my code into an iOS app format. My next step will be to upload all my current code to a git repo and then download it onto my rented mac. Then I need to follow the steps above to make it compatible.

Claudia Beckwith - Feb 06, 2026, 10:04 AM CST

The screenshot shows the Flutter documentation page for setting up iOS development. At the top, it says '2026, 10:11 AM' and 'Set up iOS development'. Below that, there's a navigation bar with 'On this page > Start developing for iOS'. A link points to 'Check out our newly published best practices for building AI-powered apps with Flutter!'. The main heading is 'Set up iOS development' with a sub-heading 'Configure your development environment to run, build, and deploy Flutter apps for iOS devices.' A note box contains the text: 'Note: If you haven't set up Flutter already, visit and follow the Get started with Flutter guide first. If you've already installed Flutter, ensure that it's up to date.' The section 'Set up iOS tooling' explains that Xcode is used to run Flutter apps on an iOS physical device or simulator. It lists two steps: 1. Install Xcode, with instructions to install the latest version or update it. 2. Set up Xcode command-line tools, with instructions to run a terminal command: `sudo sh -c 'xcode-select -s /Applications/Xcode.app/Contents/Develop`. The page number '1/6' is visible at the bottom right.

[Download](#)

**Set\_up\_iOS\_development.pdf (959 kB)**



# 2026/02/12 Bluetooth vs Wi-Fi for IoT Projects

Claudia Beckwith - Feb 12, 2026, 9:15 AM CST

**Title:** Bluetooth vs Wi-Fi for IoT projects

**Date:** 2/12/2026

**Content by:** Claudia

**Present:** claudia

**Goals:** I want to understand an overview of using Bluetooth vs Wi-Fi for an IoT project as our bracelet. This guide will help decide which route is best. It explains the differences and best route for project goals.

Cite:

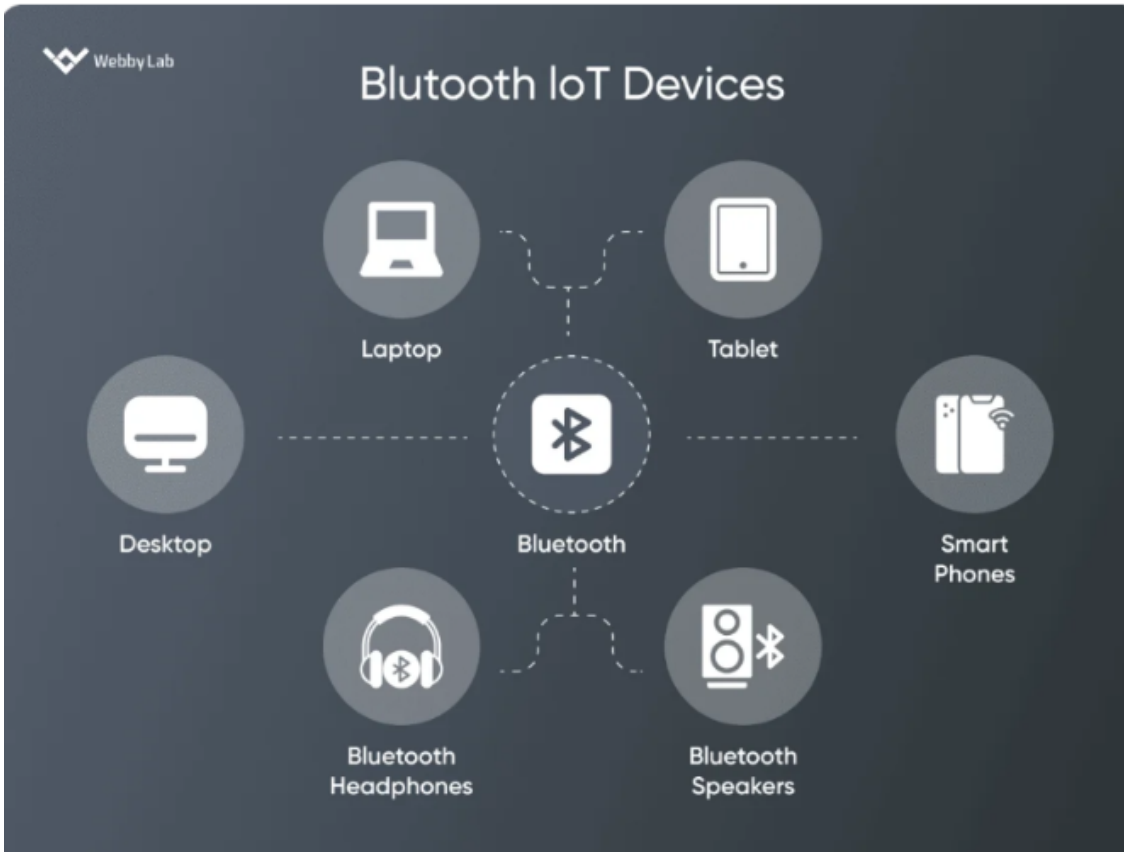
K. Oliynyk, "Bluetooth vs WiFi for IoT Projects: Which is Better?," *webbylab*, Mar. 25, 2025. [https://webbylab.com/blog/bluetooth-vs-wifi-for-iot-project/?utm\\_source=chatgpt.com](https://webbylab.com/blog/bluetooth-vs-wifi-for-iot-project/?utm_source=chatgpt.com)

Search: BLE vs Wifi for IoT projects (internet of things) on google

**Content:**

- wi-fi powers 31% of IOT
- bluetooth is 25%
- bluetooth alone isn't part of iot, so it cant connect to the internet
- bluetooth is better in low power in short range environments
- bluetooth needs a gateway, a device with a microprocessor that supports bluetooth IoT
- bluetooth more common for
  - wearable gadgets
  - fitness trackers
  - smartwatches
  - moving systems
  - battery powered devices
  - **medical equipment and remote patient monitoring**
  - range 10-20 meters indoors
- speed transfer
  - 2 Mbps for BLE
  - good for small data transfers
  - Wifi better for videos, streaming, large data files
- cost and complexity
- 

Feature	Bluetooth	WiFi
Power Consumption	Low (especially BLE)	Higher compared to Bluetooth
Range	Short (up to 100 meters)	Longer (up to several hundred meters)
Data Transfer Speed	Moderate (up to 2 Mbps for BLE)	High (up to several Gbps)
Internet Integration	Requires a gateway	Direct Internet connection
Cost and Complexity	Low-cost, simple setup	More complex and costly setup



- wifi better for
  - high data transfer
  - constant power supply
  - surveillance cameras
  - home thermostat

Use Case	Technology	Pros	Cons
----------	------------	------	------

Wearables	Bluetooth	Low energy consumption, ease of pairing	Limited range, lower data transfer rates
Asset Tracking	Bluetooth	Cost-effective, energy-efficient	Limited range
Smart Home Systems	WiFi	High-speed data transfer, remote access	Requires constant power supply
Industrial Automation	WiFi	Fast and stable connections for critical data	Higher implementation costs

- connection to multiple devices
  - wifi allows many connections at once, better for large scale deployment
  - BLE better for one on one or small group connections

Pros	Cons	
<b>Bluetooth</b>	Low energy consumption, ideal for battery-powered devices  Generally lower implementation cost  Easy integration with modern mobile devices  Simple pairing and connection process  Low latency for short-distance data transfers	Limited range of 10-100 meters  Low data transfer rate (up to 2 Mbps for BLE)  Dependence on gateways  Supports fewer simultaneous connections  Vulnerable to interference issues
<b>WiFi</b>	High data transfer rate, perfect for large data volumes  Long-range, suitable for home and office networks  Direct internet connection without intermediate gateways  Stable connection for mission-critical applications  Can handle multiple simultaneous connections	Higher power consumption compared to Bluetooth  Higher costs for modules and integration  More complex setup and maintenance  Susceptible to network congestion in crowded environments  Limited security on open networks

Conclusions/action items:

Overall, BLE is simpler, cheaper, and better suited for our project. We dont need the wifi infrastructure to transmit large amounts of data, just one number every 5 minutes. It doesn't make sense to build such a complex system for this simple of a data push.

Claudia Beckwith - Feb 12, 2026, 9:13 AM CST



[Download](#)

**Bluetooth\_vs\_WiFi\_for\_IoT\_Projects\_Which\_is\_Better\_.pdf (3.79 MB)**



## 2026/02/13 challenges of wifi provisioning

---

Claudia Beckwith - Feb 13, 2026, 10:01 AM CST

**Title:** challenges of wifi provisioning

**Date:** 2/13/2026

**Content by:** claudia

**Present:** claudia

**Goals:** I want to understand what some of the limitations may be when we look into using wifi. We are still deciding if BLE, wifi, or a hybrid design is best suited for our project. This info will help inform my design matrix.

**Cite:**

“Challenges with Wi-Fi Provisioning for Embedded Systems - Argenox,” *Argenox*. [https://argenox.com/library/wifi/challenges-with-wi-fi-provisioning-for-embedded-systems?utm\\_source=chatgpt.com](https://argenox.com/library/wifi/challenges-with-wi-fi-provisioning-for-embedded-systems?utm_source=chatgpt.com)

**Search:** wifi pros and cons with IoT devices on google

**Content:**

The article explains why connecting Wi-Fi-enabled embedded devices to a network (Wi-Fi provisioning) is often complex, especially for devices without a display or user interface.

Main Challenges Identified

1. Headless Device Limitations

- Embedded devices typically lack screens and keyboards
- Users cannot simply select a network and type a password like on a phone or laptop
- Developers must design a method to securely transfer SSID and password credentials to the device

2. User Experience Expectations

- Consumers expect fast and seamless Wi-Fi setup
- Poor provisioning experiences increase support calls and product returns (for our project doesn't exist)
- Setup friction directly impacts product success, client anger and dissatisfaction

3. Multiple Provisioning Methods (Each with Trade-offs)

- WPS (Wi-Fi Protected Setup)
  - Simple but often disabled due to security vulnerabilities
- Soft Access Point (Soft AP) Mode
  - Device becomes a temporary Wi-Fi network
  - User connects to it and enters credentials
  - Can be confusing for users and disrupts internet connectivity during setup
- Ad-hoc Methods
  - Less common and limited in support.
- Vendor-Specific SmartConfig Solutions
  - Can simplify setup but reduce portability and interoperability.
- BLE (Bluetooth Low Energy) Provisioning

- User stays connected to their normal Wi-Fi during setup.
- Increasingly common in IoT products.

#### Why BLE Provisioning often better

- widely supported on smartphones
- simpler user experience
- Does not require the phone to disconnect from its Wi-Fi network
- Allows encrypted credential transfer
- Commonly used in modern consumer devices

#### Security Considerations

- Credentials must be securely transmitted and stored
- Some provisioning methods introduce security risks
- Developers must balance ease of use with strong authentication and encryption

#### overall

- Wi-Fi provisioning is one of the most challenging parts of embedded IoT development
- There is no universal best method; trade-offs depend on product requirements
- BLE is often used specifically to simplify Wi-Fi onboarding
- More provisioning complexity increases development time, testing, and potential support issues

#### Conclusions/action items:

it seems overall like BLE will be much easier to use for this project. Lots of limitations with wifi are directly related to a more negative user experience, which is important if many different people will be interacting with the device per child wearing it. Based on this and my other source, I think we'll definitely try to use BLE.

Claudia Beckwith - Feb 13, 2026, 10:01 AM CST

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Challenges with Wi-Fi Provisioning for Embedded Systems - Argenox



**ARGENOX**

Challenges with Wi-Fi Provisioning for Embedded Systems

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Challenges with Wi-Fi Provisioning for Embedded Systems



Apr 11, 2025 · Argenox · 13 min read

### Getting Wi-Fi Products Connected

Imagine yourself for a second as a customer that just bought a laptop. They arrive home and want to connect to the internet. The customer wants to do so wirelessly so what do they do? Windows, Linux and Mac OS X each provide a list of Wireless Networks available. Once selected the customer can provide a password and login. This process is used for hundreds of millions of devices and despite some issues with interoperability, signal strength, and other factors, usually works well.

Consider the same scenario for a customer who just bought a new Wi-Fi enabled Garage Door opener. This device has no native need for an LCD.

File: C:\Users\cbeckwith\Documents\challenges-with-wifi-provisioning-for-embedded-systems\2026-02-13-challenges-with-wifi-provisioning-for-embedded-systems.md

1/11

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**Challenges\_with\_Wi-Fi\_Provisioning\_for\_Embedded\_Systems\_-\_Argenox.pdf (3.73 MB)**



## 2026/02/14 GitHub Deployment

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Claudia Beckwith - Feb 17, 2026, 4:09 PM CST

**Title:** GitHub Deployment

**Date:** 2/14/2026

**Content by:** claudia

**Present:** claudia

**Goals:** I want to upload my code to git hub so I can pull it onto the other computer. It also makes sense for the long term retrieval of the data storage and will be easier to pull onto any computer in the future.

**Content:**

STEPS TO UPLOAD TO GITHUB:

on old computer (windows, within powershell):

1. cd to flutter project
2. git init
3. configure git identity
  1. git config --global user.name "Your Name"
  - git config --global user.email "you@example.com"
4. git add .
5. git commit -m "initial commit"
6. git branch -M main (renames branch)
7. git remote add origin [https://github.com/cjbeckwith2-cyber/dexcom\\_project.git](https://github.com/cjbeckwith2-cyber/dexcom_project.git)
  1. connect local repo to github
8. git push -u origin main

PART 2 (new computer, mac, on terminal)

1. git clone [https://github.com/cjbeckwith2-cyber/dexcom\\_project.git](https://github.com/cjbeckwith2-cyber/dexcom_project.git)
  1. user and pw input
  2. PW is github personal access token
2. cd to proj dir
3. at this point, project is setup!

MY GIT REPO:

[https://github.com/cjbeckwith2-cyber/dexcom\\_project](https://github.com/cjbeckwith2-cyber/dexcom_project)

**Conclusions/action items:**

I have now uploaded and stored my code from where it was stored on my windows computer to where I am using it on the Mac. Next steps include updating the code to run on an iOS app instead of a windows app. I will use the phone simulator to help with visualization.



## 2026/03/10 Api Servicer

Claudia Beckwith - Mar 11, 2026, 2:36 PM CDT

**Title:** API servicer preliminary (api\_servivce.dart)

**Date:** 3/10/2026

**Content by:** claudia

**Present:** Claudia

**Goals:** I want to explain the steps and flow of api\_service.dart in our backend API. This helps us draw numbers from Dexcom into the app.

**Content:**

The UI in main.dart knows that it wants to get glucose data but not how to get it. dexcom\_session.dart can retrieve but can't connect to the UI. api\_service.dart is the in between that allows for session caching to be separate from error codes, http errors, and other info. this service smooths things out

variable called \_session:

the thing that knows the username, pw, and cached login tokens

private file, only handling here

upon opening, session is null bc no login yet

once login button pressed, session gets a value that is held as long as the app is running

configure() stores the session, no network calls

holds region call (US vs everywhere else)

throws away any old cached tokens

getLatestReading() - main event

runs every 30s

checks for not null session

gets latest reading

checks for return from dexcom

handles errors

converts to a clean GlucoseReading object to be sent to UI

logout() for cleaning up

- wipes cache session

- sets session to null

```
// lib/api_service.dart  
  
//  
  
// Thin service layer used by the UI. Owns a single DexcomSession so the
```

```
// session is reused across every poll rather than re-created each time.
```

```
import 'dexcom_session.dart';
```

```
import 'glucose_reading.dart';
```

```
class ApiService {
```

```
DexcomSession? _session;
```

```
/// Call once after login to store credentials.
```

```
void configure({
```

```
  required String username,
```

```
  required String password,
```

```
  String region = 'share2', // 'share2' US | 'shareous1' OUS
```

```
}) {
```

```
  _session = DexcomSession(
```

```
    username: username,
```

```
    password: password,
```

```
    region: region,
```

```
  );
```

```
}
```

```
/// Fetch the single latest reading.
```

```
/// Throws [DexcomAuthException] on bad credentials.
```

```
/// Throws [DexcomException] on network / data errors.
```

```
Future<GlucoseReading> getLatestReading() async {

  if (_session == null) {

    throw const DexcomAuthException(

      'Not configured - call configure() first.');
```

```
}  
  
/// Wipe session on logout so the next login starts fresh.  
  
void logout() => _session?.invalidate();  
  
}
```

**Conclusions/action items:**

All in all, this file works as follows: This is the bridge between the session engine and the UI — a thin wrapper that owns a single `DexcomSession` instance and exposes simple clean methods the UI can call without knowing anything about authentication. It has a `configure()` method called once at login to store your credentials into the session, a `getLatestReading()` method that returns a single `GlucoseReading`, a `getReadings()` method that can return a list of recent readings if you ever want to show a history or sparkline, and a `logout()` method that wipes the cached session. The key architectural decision here is that `ApiService` is instantiated once at the app level in `main.dart` as a global `_api` object — this is what ensures the session is truly reused across every poll. If it were recreated on each screen or each fetch, you'd lose the cache and be back to re-authenticating every time. No new packages are introduced here — it just coordinates between `dexcom_session.dart` and the UI.

---

Claudia Beckwith - Mar 11, 2026, 2:36 PM CDT



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**api\_service.dart (1.74 kB)**



## 2026/03/10 dexcom session

Claudia Beckwith - Mar 11, 2026, 3:20 PM CDT

**Title:** Dexcom Session Code (dexcom\_session.dart)

**Date:** 3/10/26

**Content by:** claudia

**Present:** Claudia

**Goals: Goals:** I want to explain the steps and flow of dexcom\_session.dart in our backend API. This helps us draw numbers from Dexcom into the app.

**Content:**

dexcom\_session.dart functionality

- the big picture: acts like "the kitchen"
- handles every network call to dexcom serves
- handles and caches auth flow
- fetches actual glucose readings
- does NOT interact with the UI directly, gets called by ApiService
- equivalent of what pydexcom does internally
  - PHP example from dr p needed to be reauthenticated every request
- dexcom session tokens last for hours, cache and reuse

Steps:

1. authenticate publisher account: send username pw and application ID (hardcoded)
  1. dexcom response with an accountID tied permenately to your account
2. login publisher account by ID: send dexcom your acctID, pw, and app ID
  1. dexcom dives sessionID (temporary token)
  2. like a door key
  3. expires every 6 hours
3. read publisher latest glucose values
  1. send sessionID as url parameter
  2. Dexcom sends readings

**Step 1 done once ever**

**Step 2 done every 6 hours**

**step 3 done on every pull**

last code did 1-3 every time! bad and slow

\_applicatonID: hardcoded string d89443d2-327c-4a6f-89e5-496bbb0317db which is dexcom's share API (legit source verification)

\_sessionTtl: set to 5.5 hours (safety margin vs 6 hour dexcom token)

recomenededPollInterval: every 30s

also storing acct, session details, private and local to the cache

checks to make sure the variables are updated at each of the 3 steps

**public method for fetching data:**

- very simple
- checks for an active session
- supports retry logic

```
// lib/dexcom_session.dart

//

// Mirrors what pydexcom does internally:

// 1. AuthenticatePublisherAccount → accountId (stable, cache it)

// 2. LoginPublisherAccountById → sessionId (expires ~6 hrs, cache it)

// 3. ReadPublisherLatestGlucoseValues → readings

//

// Sessions are cached in memory so we never re-authenticate unless the

// session has actually expired (HTTP 500 / sessionId error). This is the

// key difference from the original code that did a full login on every poll.

import 'dart:convert';

import 'package:http/http.dart' as http;

class DexcomSession {

// — configuration —————

static const String _applicationId =

'd89443d2-327c-4a6f-89e5-496bbb0317db';

static const Duration _sessionTtl = Duration(hours: 5, minutes: 30);

// Dexcom CGM posts a new reading every 5 minutes; polling faster than

// ~30 s gives you no extra data but does risk rate-limiting.

static const Duration recommendedPollInterval = Duration(seconds: 30);
```

```
final String region; // 'share2' (US) or 'shareous1' (OUS)

final String username;

final String password;

DexcomSession({

  required this.username,

  required this.password,

  this.region = 'share2',

});

// — cached state —————

String? _accountId;

String? _sessionId;

DateTime? _sessionCreatedAt;

bool get _sessionValid =>

  _sessionId != null &&

  _sessionCreatedAt != null &&

  DateTime.now().difference(_sessionCreatedAt!) < _sessionTtl;

// — base URL —————

String get _base =>

  'https://$region.dexcom.com/ShareWebServices/Services';

// — internal helpers —————
```

```
static const Map<String, String> _jsonHeaders = {

  'Content-Type': 'application/json',

  'Accept': 'application/json',

};

Future<String> _post(String url, Map<String, dynamic> body) async {

  final response = await http

    .post(Uri.parse(url), headers: _jsonHeaders, body: jsonEncode(body))

    .timeout(const Duration(seconds: 15));

  if (response.statusCode != 200 || response.body.isEmpty) {

    throw DexcomAuthException(

      'HTTP ${response.statusCode} from $url\n${response.body}');

  }

  // Dexcom returns plain quoted strings for auth endpoints, e.g. "\"abc123\""

  return response.body.replaceAll('"', '').trim();

}

// — auth steps —————

/// Step 1 – username – accountId (a GUID that never changes)

Future<void> _ensureAccountId() async {

  if (_accountId != null) return;

  _accountId = await _post(
```

```
'$_base/General/AuthenticatePublisherAccount',  
  
{  
  
  'accountName': username,  
  
  'password': password,  
  
  'applicationId': _applicationId,  
  
},  
  
);  
  
if (_accountId == null || _accountId!.length < 10) {  
  
  _accountId = null;  
  
  throw DexcomAuthException(  
  
    'Authentication failed - check username and password.');  
}  
  
}  
  
/// Step 2 - accountId → sessionId (valid ~6 hours)  
  
Future<void> _ensureSession() async {  
  
  if (_sessionValid) return;  
  
  await _ensureAccountId();  
  
  _sessionId = await _post(  
  
    '$_base/General/LoginPublisherAccountById',  
  
    {  
  
      'accountId': _accountId,
```

```
'password': password,

'applicationId': _applicationId,

},

);

if (_sessionId == null || _sessionId!.length < 10) {

  _sessionId = null;

  throw DexcomAuthException('Login failed - could not obtain session.');
```

---

```
}

_sessionCreatedAt = DateTime.now();

}

// — public API —————

/// Returns the latest [maxCount] readings from the last [minutes] minutes.

/// Automatically refreshes the session if it has expired.

Future<List<Map<String, dynamic>>> getLatestReadings({

  int minutes = 1440,

  int maxCount = 1,

}) async {

  await _ensureSession();

  return _fetchReadings(minutes: minutes, maxCount: maxCount);

}
```

```
Future<List<Map<String, dynamic>>> _fetchReadings({
  required int minutes,
  required int maxCount,
  bool retried = false,
}) async {
  final url =
    '$_base/Publisher/ReadPublisherLatestGlucoseValues'
    '?sessionId=$_sessionId&minutes=$minutes&maxCount=$maxCount';

  final response = await http
    .post(Uri.parse(url), headers: _jsonHeaders)
    .timeout(const Duration(seconds: 15));

  // Session expired → force re-auth once

  if ((response.statusCode == 500 || response.statusCode == 401) &&
    !retried) {
    _sessionId = null;
    _sessionCreatedAt = null;
    await _ensureSession();
  }
  return _fetchReadings(
    minutes: minutes, maxCount: maxCount, retried: true);
}
```

```
if (response.statusCode != 200 || response.body.isEmpty) {

throw DexcomException(

'Failed to fetch glucose data (HTTP ${response.statusCode}).');

}

final List<dynamic> raw = jsonDecode(response.body);

return raw.cast<Map<String, dynamic>>();

}

/// Clears the cached session (e.g. on logout)

void invalidate() {

  _accountId = null;

  _sessionId = null;

  _sessionCreatedAt = null;

}

}

// — exceptions —————

class DexcomException implements Exception {

final String message;

const DexcomException(this.message);

@override

String toString() => message;
```

```
}  
  
class DexcomAuthException extends DexcomException {  
  
  const DexcomAuthException(super.message);  
  
}
```

**Conclusions/action items:**

the function of `dexcom_session` can be summed as follows: This is the engine of the app and the most important file — it's the direct equivalent of what `pydexcom` does internally. It handles the three-step Dexcom authentication flow: first converting your username into a stable `accountId` (a GUID that never changes), then converting that into a `sessionId` (which is valid for ~6 hours), and finally using that `sessionId` to fetch glucose readings. The critical improvement over your original code is session caching — the `accountId` is stored forever in memory, and the `sessionId` is stored for 5.5 hours and only refreshed when it expires or Dexcom returns an auth error. This means instead of doing 2 auth network calls before every single glucose fetch, it does them once and reuses the result hundreds of times. It also has automatic retry logic — if a fetch fails because the session silently expired, it transparently re-authenticates and retries once without the UI ever knowing. The only package used is `package:http` for making HTTP POST requests to the Dexcom Share API endpoints. This file also defines two exception classes, `DexcomException` and `DexcomAuthException`, so the UI can tell the difference between a credentials problem and a network problem.

---

Claudia Beckwith - Mar 11, 2026, 2:49 PM CDT



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**dexcom\_session.dart (6.51 kB)**



## 2026/03/10 main UI code

Claudia Beckwith - Mar 11, 2026, 3:20 PM CDT

**Title:** main UI code (main.dart)

**Date:** 3/10/26

**Content by:** claudia

**Present:** claudia

**Goals:** I want to explain the steps and flow of main.dart in our backend API. This helps us draw numbers from Dexcom into the app.

**Content:**

big picture: visible face of the app

- takes data from other files and presents it
- 4 pieces
  - entry point
    - runs app with a widget
    - stateless widget (doesn't change)
    - defines color theme and rounds buttons
    - sets Home Screen to be login screen
  - shared ApiService instance
    - shares api across a single shared instance
    - writes to configure()
  - login screen
    - stateful widget - can change
    - disposes login text once screen changes
    - eye icon to show password
    - runs async call for network calls
    - stores login in session object
  - glucose screen
    - poll timer calls fetch every 30s
    - tick timer calls set state every 30 seconds
      - ui rebuild for the min ago label
    - both timers canceled with dispose
    - sets color coding
    - displays widget
    - logout button

```
// lib/main.dart

import 'dart:async';

import 'package:flutter/material.dart';

import 'api_service.dart';

import 'dexcom_session.dart';

import 'glucose_reading.dart';
```

```
void main() => runApp(const MyApp());

// — single shared ApiService instance —————

final _api = ApiService();

// —————

class MyApp extends StatelessWidget {

  const MyApp({super.key});

  @override

  Widget build(BuildContext context) {

    return MaterialApp(

      title: 'Dexcom',

      theme: ThemeData(

        colorScheme: ColorScheme.fromSeed(seedColor: Colors.blue),

        useMaterial3: true,

      ),

      home: const LoginScreen(),

    );

  }

}

// =====
```

```
// LOGIN

// =====

class LoginScreen extends StatefulWidget {

  const LoginScreen({super.key});

  @override

  State<LoginScreen> createState() => _LoginScreenState();

}

class _LoginScreenState extends State<LoginScreen> {

  final _userCtrl = TextEditingController();

  final _passCtrl = TextEditingController();

  bool _busy = false;

  bool _obscure = true;

  String? _error;

  @override

  void dispose() {

    _userCtrl.dispose();

    _passCtrl.dispose();

    super.dispose();

  }

}
```

```
Future<void> _login() async {

  final username = _userCtrl.text.trim();

  final password = _passCtrl.text;

  if (username.isEmpty || password.isEmpty) {

    setState(() => _error = 'Enter both username and password.');
```

```
    return;

  }

  setState(() {

    _busy = true;

    _error = null;

  });

  // Configure the shared session then do a single test fetch

  _api.configure(username: username, password: password);

  try {

    await _api.getLatestReading(); // validates credentials

    if (!mounted) return;

    Navigator.pushReplacement(

      context,

      MaterialPageRoute(builder: (_) => const GlucoseScreen()),

    );

  } on DexcomAuthException catch (e) {
```

```
setState(() {  
  
  _busy = false;  
  
  _error = e.message;  
  
});  
  
} catch (e) {  
  
  setState(() {  
  
    _busy = false;  
  
    _error = e.toString();  
  
  });  
  
}  
  
}  
  
@override  
  
Widget build(BuildContext context) {  
  
  return Scaffold(  
  
    appBar: AppBar(title: const Text('Dexcom Login')),  
  
    body: Center(  
  
      child: ConstrainedBox(  
  
        constraints: const BoxConstraints(maxWidth: 400),  
  
        child: Padding(  
  
          padding: const EdgeInsets.all(24),  
  
          child: Column(  

```

```
mainAxisSize: MainAxisSize.min,

children: [

  TextField(

    controller: _userCtrl,

    decoration: const InputDecoration(

      labelText: 'Dexcom Username',

      border: OutlineInputBorder(),

      prefixIcon: Icon(Icons.person),

    ),

  ),

  const SizedBox(height: 12),

  TextField(

    controller: _passCtrl,

    obscureText: _obscure,

    decoration: InputDecoration(

      labelText: 'Dexcom Password',

      border: const OutlineInputBorder(),

      prefixIcon: const Icon(Icons.lock),

      suffixIcon: IconButton(

        icon: Icon(

          _obscure ? Icons.visibility_off : Icons.visibility),
```

```
onPressed: () => setState(() => _obscure = !_obscure),
),
),
),
const SizedBox(height: 16),
if (_error != null)
  Padding(
    padding: const EdgeInsets.only(bottom: 8),
    child: Text(_error!,
      style: const TextStyle(color: Colors.red)),
  ),
  SizedBox(
    width: double.infinity,
    child: ElevatedButton(
      onPressed: _busy ? null : _login,
      child: _busy
        ? const SizedBox(
            height: 18,
            width: 18,
            child: CircularProgressIndicator(strokeWidth: 2))
        : const Text('Login'),
```

```
),  
),  
],  
),  
),  
),  
),  
),  
),  
);  
}  
}  
  
// =====  
  
// GLUCOSE SCREEN  
  
// =====  
  
class GlucoseScreen extends StatefulWidget {  
  
  const GlucoseScreen({super.key});  
  
  @override  
  State<GlucoseScreen> createState() => _GlucoseScreenState();  
}  
  
class _GlucoseScreenState extends State<GlucoseScreen> {  
  
  GlucoseReading? _reading;
```

```
Timer? _pollTimer;

Timer? _tickTimer; // refreshes "X min ago" label every 30 s

bool _loading = true;

String? _error;

@override

void initState() {

super.initState();

_fetch();

// Poll Dexcom every 30 seconds - session is reused, no re-login overhead.

// A new reading only arrives every 5 minutes but polling fast means we

// display it the moment it lands rather than waiting a full minute.

_pollTimer = Timer.periodic(

DexcomSession.recommendedPollInterval, (_) => _fetch());

// Refresh the "X min ago" counter in the UI every 30 s

_tickTimer =

Timer.periodic(const Duration(seconds: 30), (_) => setState(() {}));

}

@override

void dispose() {

_pollTimer?.cancel();
```

```
_tickTimer?.cancel();

super.dispose();

}

Future<void> _fetch() async {

if (!mounted) return;

setState(() {

_loading = _reading == null; // only show spinner on first load

_error = null;

});

try {

final r = await _api.getLatestReading();

if (!mounted) return;

setState(() {

_reading = r;

_loading = false;

});

} on DexcomAuthException catch (e) {

if (!mounted) return;

setState(() {

_error = e.message;

_loading = false;
```

```
});

} catch (e) {

if (!mounted) return;

setState(() {

_error = e.toString();

_loading = false;

});

}

}

void _logout() {

_api.logout();

Navigator.pushAndRemoveUntil(

context,

MaterialPageRoute(builder: (_) => const LoginScreen()),

(_) => false,

);

}

Color _colorFor(int mg) {

if (mg < 55) return Colors.red;

if (mg <= 65) return Colors.orange;

if (mg <= 80) return Colors.yellow.shade700;
```

```
if (mg <= 139) return Colors.green;

if (mg <= 200) return Colors.blue;

return Colors.purple;

}

@override

Widget build(BuildContext context) {

return Scaffold(

  appBar: AppBar(

    title: const Text('Glucose'),

    actions: [

      IconButton(

        tooltip: 'Logout',

        icon: const Icon(Icons.logout),

        onPressed: _logout),

    ],

  ),

  body: _loading

  ? const Center(child: CircularProgressIndicator())

  : _error != null && _reading == null

  ? Center(

    child: Padding(
```

```
padding: const EdgeInsets.all(24),

child: Column(

mainAxisSize: MainAxisSize.min,

children: [

Text('Error: $_error',

style: const TextStyle(color: Colors.red),

textAlign: TextAlign.center),

const SizedBox(height: 16),

ElevatedButton(

onPressed: _fetch,

child: const Text('Retry')),

],

),

),

),

): _GlucoseBody(

reading: _reading!,

color: _colorFor(_reading!.value),

error: _error,

onRefresh: _fetch,

),
```

```
);  
  
}  
  
}  
  
class _GlucoseBody extends StatelessWidget {  
  
  final GlucoseReading reading;  
  
  final Color color;  
  
  final String? error;  
  
  final VoidCallback onRefresh;  
  
  const _GlucoseBody({  
  
    required this.reading,  
  
    required this.color,  
  
    required this.onRefresh,  
  
    this.error,  
  
  });  
  
  @override  
  
  Widget build(BuildContext context) {  
  
    return Column(  
  
      mainAxisAlignment: MainAxisAlignment.center,  
  
      children: [  
  
        Card(  

```

```
color: color.withOpacity(0.15),

margin: const EdgeInsets.symmetric(horizontal: 24),

shape:

RoundedRectangularBorder(borderRadius: BorderRadius.circular(16)),

child: Padding(

padding: const EdgeInsets.all(32),

child: Column(

children: [

// Big value + arrow

Text(

'${reading.value} ${reading.trendArrow}',

style: TextStyle(

fontSize: 56,

fontWeight: FontWeight.bold,

color: color),

),

const SizedBox(height: 8),

Text('mg/dL',

style: TextStyle(fontSize: 18, color: color)),

const SizedBox(height: 12),

Text(
```

```
'${reading.timeText} · ${reading.agoText}',

style: const TextStyle(fontSize: 15, color: Colors.grey),

),

],

),

),

),

),

),

if (error != null)

Padding(

padding: const EdgeInsets.all(12),

child: Text(

'Last refresh failed: $error',

style: const TextStyle(color: Colors.orange, fontSize: 12),

textAlign: TextAlign.center,

),

),

const SizedBox(height: 20),

ElevatedButton.icon(

onPressed: onRefresh,

icon: const Icon(Icons.refresh),

label: const Text('Refresh Now'),
```

```
),  
],  
);  
}  
}
```

**Conclusions/action items:**

main.dart works by the following: This is the UI layer — it contains all the screens and visual logic. It has three main pieces. The LoginScreen collects username and password, calls `_api.configure()` to set up the session, does a single test fetch to validate the credentials, and if successful navigates to the GlucoseScreen. The GlucoseScreen is where the app lives during normal use — it runs two timers simultaneously: a poll timer that calls `_api.getLatestReading()` every 30 seconds (matching `DexcomSession.recommendedPollInterval`), and a tick timer that refreshes the "X min ago" label in the UI every 30 seconds so it stays accurate even between readings. Importantly, the spinner only shows on the very first load — subsequent background polls update the display silently so the UI never goes blank while you're using it. If a background poll fails it shows a small orange warning at the bottom rather than replacing the last good reading with an error. The `_GlucoseBody` widget handles the color coding (red for dangerous lows, green for in-range, purple for highs) and displays the value, arrow, time, and age of the reading. The only package used is Flutter's own `material.dart` for the UI components, plus `dart:async` for the timers.

---

Claudia Beckwith - Mar 11, 2026, 3:13 PM CDT



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main.dart (11 kB)



## 2026/03/10 glucose reading process code

Claudia Beckwith - Mar 11, 2026, 3:20 PM CDT

**Title:** glucose reading process (glucose\_reading.dart)

**Date:** 3/10/26

**Content by:** claudia

**Present:** claudia

**Goals:** I want to explain the steps and flow of glucose\_reading.dart in our backend API. This helps us draw numbers from Dexcom into the app.

**Content:**

big picture - define what a glucose reading is for the app, package data neatly

transforms big jumble of data into understandable variables (timestamp=number)

like a language translator

only file to handle raw dexcom JSON

4 core properties

1. value (int): holds glucose measurement in mg/dL
2. trend (string): trend direction
3. trend arrow (string): visual arrow character
4. timestamp (datetime): paired with a value, makes it immutable (not able to change)

also tracks minutes ago

formats minutes ago into human readable

fromDexcomJSON()

restrives a Map string (JSON to Dart) and is a factory constructor that can do work before creating the object

stores it like a dictionary

```
// lib/glucose_reading.dart
```

```
class GlucoseReading {
```

```
  final int value;
```

```
  final String trend;
```

```
  final String trendArrow;
```

```
  final DateTime timestamp;
```

```
  GlucoseReading({
```

```
required this.value,  
  
required this.trend,  
  
required this.trendArrow,  
  
required this.timestamp,  
  
});  
  
/// How many minutes ago this reading was taken  
  
int get minutesAgo =>  
  
DateTime.now().difference(timestamp).inMinutes;  
  
/// Display string e.g. "just now" or "3 min ago"  
  
String get agoText =>  
  
minutesAgo == 0 ? 'just now' : '$minutesAgo min ago';  
  
/// Formatted time string e.g. "3:04 PM"  
  
String get timeText {  
  
final h = timestamp.hour % 12 == 0 ? 12 : timestamp.hour % 12;  
  
final m = timestamp.minute.toString().padLeft(2, '0');  
  
final period = timestamp.hour >= 12 ? 'PM' : 'AM';  
  
return '$h:$m $period';  
  
}  
  
static const Map<String, String> _trendArrows = {  
  
'DoubleUp': '↑↑',
```

```
'SingleUp': '↑',

'FortyFiveUp': '↗',

'Flat': '→',

'FortyFiveDown': '↘',

'SingleDown': '↓',

'DoubleDown': '↓↓',

'None': '→',

'NotComputable': '?',

'RateOutOfRange': '△',

};

static String arrowForTrend(String trend) =>

_trendArrows[trend] ?? '→';

factory GlucoseReading.fromDexcomJson(Map<String, dynamic> json) {

final trend = json['Trend'] as String? ?? 'None';

final wt = json['WT'] as String? ?? '';

final ms = int.tryParse(RegExp(r'\d+').firstMatch(wt)?[0] ?? '0') ?? 0;

return GlucoseReading(

value: json['Value'] as int,

trend: trend,

trendArrow: arrowForTrend(trend),
```

```
timestamp: DateTime.fromMillisecondsSinceEpoch(ms),  
  
);  
  
}  
  
}
```

### Conclusions/action items:

This is the data model — it's the simplest file and the foundation everything else builds on. It defines what a single glucose reading *is*: a value in mg/dL, a trend direction, a trend arrow, and a timestamp. It has a `fromDexcomJson` factory constructor that takes the raw JSON blob Dexcom sends back and converts it into a clean Dart object. It also has helper getters like `agoText` ("3 min ago"), `timeText` ("3:04 PM"), and `trendArrow` ("↗") so the UI never has to do any data formatting itself. The trend arrow lookup table lives here too, mapping Dexcom's string names like "FortyFiveUp" to the actual arrow characters. No packages are needed here — it's pure Dart. Every other file either produces or consumes a `GLucoseReading` object, making this the common language the whole app speaks.

---

Claudia Beckwith - Mar 11, 2026, 3:20 PM CDT



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**glucose\_reading.dart (1.66 kB)**



## 2026/03/11 App Deployment (iOS standalone)

Claudia Beckwith - Mar 11, 2026, 3:51 PM CDT

**Title:** iOS standalone app deployment

**Date:** 3/11/2026

**Content by:** claudia

**Present:** Claudia

**Goals:** I want to outline the steps of getting the code stored on my Mac onto the actual iOS app. This will be important for replication, especially considering that without paying for apple developer, I will have to redo this every single week .

**Content:**

1. install Xcode
2. in terminal: `xcode-select --install`
3. open Xcode and accept license agreement
4. download Flutter SDK from flutter.dev
5. download and install VS code from code.visualstudio.com
6. install flutter extension in VS code
  1. ext pannel
  2. search flutter
  3. install one published by dart
7. run flutter doctor in terminal and install anything else needed (android and chrome fine to ignore)
8. in terminal: cd to project and make flutter create flutter\_app
9. open code flutter\_app (or manually in VS code)
10. open pub spec.yaml and add the following
  1. dependencies:

```
flutter:  
  sdk: flutter  
  http: ^1.2.0  
  cupertino_icons: ^1.0.8
```
11. open terminal and type flutter pub get (reads file above)
12. navigate to lib/ folder, delta existing main.dart
13. add the 4 new files (main.dart, api\_service.dart, dexcom\_session.dart, glucose\_reading.dart)
14. confirm only these 4 files are present
15. run "open iOS/Runner.xcworkspace"
16. click on runner (within Xcode)
17. click signing and capabilities tab at top
18. check automatically manage signing box
19. under team dropdown: select Claudia (my Apple ID)
20. change bundle identifier from default to something new and unique (ex. com.claudia.dexcomapp)
21. confirm green check mark, fix errors if ID not showing
22. plug in phone with USB-C cable
23. trust computer on iphone
24. flutter devices in terminal - confirm phone is seen
25. build in release mode: flutter run --release -d YOUR\_DEVICE\_ID
  1. can also run flutter run --release and select the device, usually 1
26. building, takes a few minutes
27. trust computer in settings (first build)
  1. settings > general > vpn and device management > your Apple ID email > trust
28. back to Home Screen and look for app icon
29. rebuild release with each change of VS code
30. note that signing cert expires every 7 days

1. plug phone back in and run `flutter run --release` command again

**Conclusions/action items:**

These are the steps to deploy the app onto a phone. I will try to get the app running on everyone in my group's phone, so this will be handy to have. It also makes sure you don't skip any steps because there's a lot to troubleshoot.



## 2026/03/18 Upgrading iOS App with Additional Pages

Claudia Beckwith - Mar 18, 2026, 3:47 PM CDT

### Title: Upgrading App to add additional pages (settings and education)

Date: 3/18/2026

Content by: claudia

Present: Claudia

**Goals:** I want to make some changes the the UI of the app (just updating main.dart) to match the app interface designed by Isabel. This will add a settings page with some location, brightness, and package options. Ill add a warning about treatment decisions on the main page, and an education page where the videos will be.

### Content:

The main.dart updated as of 3/18/2026 is attached below, changes are as outlined:

- green rectangle with big number in the center of the screen
- in the same box on the right side is the arrow
- top left is a settings gear icon that the user can click on that will take them to a page
  - on the settings page now is a "LED brightness" that slides from 0 to 100%
  - dropdown with 3 country options (USA, Canada, Mexico)
  - a section called "Plan" the currently has Entry Level (\$0.00) selected but option for Beginner Package (\$5.00)
- the settings page will have a home button on bottom right and sign out button bottom left
- home page has sign out button bottom left \* on top of the colored box is a smaller text that has a caution emoji followed by "Consult Dexcom App before treatment decision"
- Refresh button below the colored box (smaller button)
- below refresh button is a (Last reading \*time\* \*timezone\*) ex ( Last reading: 5:43 PM CT)
- Top right of home page is a button that takes you to an education page. button is grey and just says Education
- Education tab has
  - the education tab has a spot that mimics a video player and the video title being "App Setup & Use", another video called "Diabetes: A Comprehensive Guide", and 2 locked videos called "Guide to Hyperglycemia" and "Guide to Hypoglycemia"
- education tab has button to home in bottom right and button to sign out in bottom left
- both education and settings tab have a title at the top
- white mode
- login has title "wearable glucose alerting system monitor"

```
// lib/main.dart

import 'dart:async';

import 'package:flutter/material.dart';

import 'package:flutter/cupertino.dart';

import 'package:flutter_secure_storage/flutter_secure_storage.dart';
```

```
import 'api_service.dart';

import 'dexcom_session.dart';

import 'glucose_reading.dart';

void main() => runApp(const MyApp());

final _api = ApiService();

const _storage = FlutterSecureStorage();

const _kUsername = 'dexcom_username';

const _kPassword = 'dexcom_password';

const _kCountry = 'dexcom_country';

const _kPlan = 'dexcom_plan';

// -----

// APP ROOT

// -----

class MyApp extends StatelessWidget {

  const MyApp({super.key});

  @override

  Widget build(BuildContext context) {

    return MaterialApp(

      title: 'WGASM',

      debugShowCheckedModeBanner: false,
```

```
theme: ThemeData(  
  
  colorScheme: ColorScheme.fromSeed(  
  
    seedColor: const Color(0xFF1A73E8),  
  
    brightness: Brightness.light,  
  
  ),  
  
  useMaterial3: true,  
  
  scaffoldBackgroundColor: const Color(0xFFF5F7FA),  
  
  appBarTheme: const AppBarTheme(  
  
    backgroundColor: Color(0xFFF5F7FA),  
  
    elevation: 0,  
  
    foregroundColor: Color(0xFF1A1A2E),  
  
  ),  
  
  ),  
  
  home: const SplashScreen(),  
  
);  
  
}  
  
}  
  
// _____  
  
// SPLASH – checks Keychain for saved credentials  
  
// _____
```

```
class SplashScreen extends StatefulWidget {

  const SplashScreen({super.key});

  @override

  State<SplashScreen> createState() => _SplashScreenState();

}

class _SplashScreenState extends State<SplashScreen> {

  @override

  void initState() {

    super.initState();

    _check();

  }

  Future<void> _check() async {

    final username = await _storage.read(key: _kUsername);

    final password = await _storage.read(key: _kPassword);

    if (!mounted) return;

    if (username != null && password != null) {

      _api.configure(username: username, password: password);

      try {

        await _api.getLatestReading();

        if (!mounted) return;

        Navigator.pushReplacement(context,
```

```
MaterialPageRoute(builder: (_) => const GlucoseScreen()));

} catch (_) {

await _storage.delete(key: _kUsername);

await _storage.delete(key: _kPassword);

if (!mounted) return;

Navigator.pushReplacement(context,

MaterialPageRoute(builder: (_) => const LoginScreen()));

}

} else {

Navigator.pushReplacement(context,

MaterialPageRoute(builder: (_) => const LoginScreen()));

}

}

@override

Widget build(BuildContext context) {

return const Scaffold(

backgroundColor: Color(0xFFF5F7FA),

body: Center(child: CircularProgressIndicator()),

);

}

}
```

```
// -----  
  
// LOGIN SCREEN  
  
// -----  
  
class LoginScreen extends StatefulWidget {  
  
  const LoginScreen({super.key});  
  
  @override  
  
  State<LoginScreen> createState() => _LoginScreenState();  
  
}  
  
class _LoginScreenState extends State<LoginScreen> {  
  
  final _userCtrl = TextEditingController();  
  
  final _passCtrl = TextEditingController();  
  
  bool _busy = false;  
  
  bool _obscure = true;  
  
  String? _error;  
  
  @override  
  
  void dispose() {  
  
    _userCtrl.dispose();  
  
    _passCtrl.dispose();  
  
    super.dispose();  
  
  }  
  
}
```

```
Future<void> _login() async {  
  
  final username = _userCtrl.text.trim();  
  
  final password = _passCtrl.text;  
  
  if (username.isEmpty || password.isEmpty) {  
  
    setState(() => _error = 'Please enter both username and password.');  
    return;  
  
  }  
  
  setState(() { _busy = true; _error = null; });  
  
  _api.configure(username: username, password: password);  
  
  try {  
  
    await _api.getLatestReading();  
  
    await _storage.write(key: _kUsername, value: username);  
  
    await _storage.write(key: _kPassword, value: password);  
  
    if (!mounted) return;  
  
    Navigator.pushReplacement(context,  
  
    MaterialPageRoute(builder: (_) => const GlucoseScreen()));  
  
  } on DexcomAuthException catch (e) {  
  
    setState(() { _busy = false; _error = e.message; });  
  
  } catch (e) {  
  
    setState(() { _busy = false; _error = e.toString(); });  
  
  }  
}
```

```
}  
  
@override  
  
Widget build(BuildContext context) {  
  
  return Scaffold(  
  
    backgroundColor: const Color(0xFFF5F7FA),  
  
    body: SafeArea(  
  
      child: Center(  
  
        child: SingleChildScrollView(  
  
          padding: const EdgeInsets.all(32),  
  
          child: ConstrainedBox(  
  
            constraints: const BoxConstraints(maxWidth: 400),  
  
            child: Column(  
  
              mainAxisAlignment: MainAxisAlignment.min,  
  
              crossAxisAlignment: CrossAxisAlignment.start,  
  
              children: [  
  
                // Logo / title block  
  
                Container(  
  
                  padding: const EdgeInsets.all(14),  
  
                  decoration: BoxDecoration(  
  
                    color: const Color(0xFF1A73E8),  
  
                    borderRadius: BorderRadius.circular(16),
```

```
),  
  
child: const Icon(CupertinoIcons.waveform_path_ecg,
```

```
color: Colors.white, size: 32),
```

```
),
```

```
const SizedBox(height: 20),
```

```
const Text(  
  

```

```
'Wearable Glucose\nAlerting System\nMonitor',
```

```
style: TextStyle(  
  

```

```
fontSize: 30,
```

```
fontWeight: FontWeight.w800,
```

```
color: Color(0xFF1A1A2E),
```

```
height: 1.15,
```

```
),
```

```
),
```

```
const SizedBox(height: 8),
```

```
Text(  
  

```

```
'Sign in with your Dexcom credentials',
```

```
style: TextStyle(  
  

```

```
fontSize: 14, color: Colors.grey.shade500),
```

```
),
```

```
const SizedBox(height: 36),
```

```
// Username

_buildField(

controller: _userCtrl,

label: 'Username',

icon: CupertinoIcons.person),

const SizedBox(height: 12),

// Password

_buildField(

controller: _passCtrl,

label: 'Password',

icon: CupertinoIcons.lock,

obscure: _obscure,

suffix: IconButton(

icon: Icon(

_obscure

? CupertinoIcons.eye_slash

: CupertinoIcons.eye,

color: Colors.grey.shade400,

size: 20,

),
```

```
onPressed: () =>

setState(() => _obscure = !_obscure),

),

),

if (_error != null) ...[

const SizedBox(height: 12),

Container(

padding: const EdgeInsets.all(12),

decoration: BoxDecoration(

color: Colors.red.shade50,

borderRadius: BorderRadius.circular(10),

border: Border.all(color: Colors.red.shade200),

),

child: Row(children: [

Icon(CupertinoIcons.exclamationmark_circle,

color: Colors.red.shade600, size: 16),

const SizedBox(width: 8),

Expanded(

child: Text(_error!,

style: TextStyle(

color: Colors.red.shade700,
```

```
fontSize: 13))),  
  
]),  
  
),  
  
],  
  
const SizedBox(height: 24),  
  
SizedBox(  
  
width: double.infinity,  
  
height: 52,  
  
child: ElevatedButton(  
  
onPressed: _busy ? null : _login,  
  
style: ElevatedButton.styleFrom(  
  
backgroundColor: const Color(0xFF1A73E8),  
  
foregroundColor: Colors.white,  
  
shape: RoundedRectangleBorder(  
  
borderRadius: BorderRadius.circular(14)),  
  
elevation: 0,  
  
),  
  
child: _busy  
  
? const SizedBox(  
  
height: 20, width: 20,  
  
child: CircularProgressIndicator(  

```

```
strokeWidth: 2, color: Colors.white))
```

```
: const Text('Sign In',
```

```
style: TextStyle(
```

```
fontSize: 16,
```

```
fontWeight: FontWeight.w600)),
```

```
),
```

```
),
```

```
],
```

```
),
```

```
),
```

```
),
```

```
),
```

```
),
```

```
);
```

```
}
```

```
Widget _buildField({
```

```
required TextEditingController controller,
```

```
required String label,
```

```
required IconData icon,
```

```
bool obscure = false,
```

```
Widget? suffix,
```

```
}) {  
  
return TextField(  
  
controller: controller,  
  
obscureText: obscure,  
  
style: const TextStyle(color: Color(0xFF1A1A2E)),  
  
decoration: InputDecoration(  
  
labelText: label,  
  
labelStyle: TextStyle(color: Colors.grey.shade500),  
  
prefixIcon:  
  
Icon(icon, color: Colors.grey.shade400, size: 20),  
  
suffixIcon: suffix,  
  
filled: true,  
  
fillColor: Colors.white,  
  
border: OutlineInputBorder(  
  
borderRadius: BorderRadius.circular(12),  
  
borderSide: BorderSide(color: Colors.grey.shade200),  
  
),  
  
enabledBorder: OutlineInputBorder(  
  
borderRadius: BorderRadius.circular(12),  
  
borderSide: BorderSide(color: Colors.grey.shade200),  
  
),
```

```
focusedBorder: OutlineInputBorder(

borderRadius: BorderRadius.circular(12),

borderSide: const BorderSide(

color: Color(0xFF1A73E8), width: 1.5),

),

),

);

}

}

// -----

// GLUCOSE SCREEN

// -----

class GlucoseScreen extends StatefulWidget {

const GlucoseScreen({super.key});

@override

State<GlucoseScreen> createState() => _GlucoseScreenState();

}

class _GlucoseScreenState extends State<GlucoseScreen> {

GlucoseReading? _reading;

Timer? _pollTimer;
```

```
Timer? _tickTimer;

bool _loading = true;

String? _error;

double _ledBrightness = 50;

@override

void initState() {

super.initState();

_fetch();

_pollTimer = Timer.periodic(

DexcomSession.recommendedPollInterval, (_) => _fetch());

_tickTimer = Timer.periodic(

const Duration(seconds: 30), (_) => setState(() {}));

}

@override

void dispose() {

_pollTimer?.cancel();

_tickTimer?.cancel();

super.dispose();

}

Future<void> _fetch() async {
```

```
if (!mounted) return;

setState(() { _loading = _reading == null; _error = null; });

try {

final r = await _api.getLatestReading();

if (!mounted) return;

setState(() { _reading = r; _loading = false; });

} on DexcomAuthException catch (e) {

if (!mounted) return;

setState(() { _error = e.message; _loading = false; });

} catch (e) {

if (!mounted) return;

setState(() { _error = e.toString(); _loading = false; });

}

}

Future<void> _logout() async {

await _storage.delete(key: _kUsername);

await _storage.delete(key: _kPassword);

_api.logout();

if (!mounted) return;

Navigator.pushAndRemoveUntil(context,

MaterialPageRoute(builder: (_) => const LoginScreen()),
```

```
(_) => false);  
  
}  
  
Future<void> _goToSettings() async {  
  
final result = await Navigator.push<double>(  
  
context,  
  
MaterialPageRoute(  
  
builder: (_) => SettingsScreen(  
  
ledBrightness: _ledBrightness, onLogout: _logout),  
  
),  
  
);  
  
if (result != null && mounted) {  
  
setState(() => _ledBrightness = result);  
  
}  
  
}  
  
void _goToEducation() {  
  
Navigator.push(context,  
  
MaterialPageRoute(  
  
builder: (_) => EducationScreen(onLogout: _logout)));  
  
}  
  
Color _colorFor(int mg) {
```

```
if (mg < 55) return const Color(0xFFD32F2F);

if (mg <= 65) return const Color(0xFFE64A19);

if (mg <= 80) return const Color(0xFFFF57C0);

if (mg <= 139) return const Color(0xFF2E7D32);

if (mg <= 200) return const Color(0xFF1565C0);

return const Color(0xFF6A1B9A);

}

String get _tzAbbr {

final offset = DateTime.now().timeZoneOffset.inHours;

const map = {-5: 'ET', -6: 'CT', -7: 'MT', -8: 'PT'};

return map[offset] ?? DateTime.now().timeZoneName;

}

@override

Widget build(BuildContext context) {

return Scaffold(

backgroundColor: const Color(0xFFFF5F7FA),

body: SafeArea(

child: _loading

? const Center(child: CircularProgressIndicator())

: (_error != null && _reading == null)
```

```
? _buildError()  
  
: _buildBody(),  
  
) ,  
  
);  
  
}  
  
Widget _buildError() {  
  
  return Center(  
  
    child: Padding(  
  
      padding: const EdgeInsets.all(32),  
  
      child: Column(mainAxisSize: MainAxisSize.min, children: [  
  
        Icon(CupertinoIcons.exclamationmark_circle,  
  
          color: Colors.red.shade400, size: 48),  
  
        const SizedBox(height: 16),  
  
        Text(_error!,  
  
          style: TextStyle(  
  
            color: Colors.grey.shade700, fontSize: 15),  
  
            textAlign: TextAlign.center),  
  
        const SizedBox(height: 24),  
  
        ElevatedButton(  
  
          onPressed: _fetch,  
  
          style: ElevatedButton.styleFrom(  

```

```

backgroundColor: const Color(0xFF1A73E8),

foregroundColor: Colors.white,

shape: RoundedRectangleBorder(

borderRadius: BorderRadius.circular(12)),

),

child: const Text('Retry'),

),

]),

),

);

}

Widget _buildBody() {

final reading = _reading!;

final glColor = _colorFor(reading.value);

return Padding(

padding: const EdgeInsets.symmetric(horizontal: 24, vertical: 8),

child: Column(children: [

// — Top bar —————

Row(

mainAxisAlignment: MainAxisAlignment.spaceBetween,

children: [

```

```
IconButton(  
  
  onPressed: _goToSettings,  
  
  icon: Icon(CupertinoIcons.settings,  
  
  color: Colors.grey.shade500, size: 26),  
  
  tooltip: 'Settings',  
  
),  
  
GestureDetector(  
  
  onTap: _goToEducation,  
  
  child: Container(  
  
    padding: const EdgeInsets.symmetric(  
  
      horizontal: 16, vertical: 8),  
  
    decoration: BoxDecoration(  
  
      color: Colors.grey.shade200,  
  
      borderRadius: BorderRadius.circular(20),  
  
    ),  
  
    child: Text('Education',  
  
      style: TextStyle(  
  
        color: Colors.grey.shade600,  
  
        fontSize: 14,  
  
        fontWeight: FontWeight.w500)),  
  
  ),
```

```
),  
],  
),  
  
const Spacer(),  
  
// — Caution banner —————  
  
Container(  
  
margin: const EdgeInsets.only(bottom: 14),  
  
padding:  
  
const EdgeInsets.symmetric(horizontal: 14, vertical: 8),  
  
decoration: BoxDecoration(  
  
color: Colors.amber.shade50,  
  
borderRadius: BorderRadius.circular(10),  
  
border: Border.all(color: Colors.amber.shade200),  
  
),  
  
child: Row(  
  
mainAxisSize: MainAxisSize.min,  
  
children: [  
  
const Text('△', style: TextStyle(fontSize: 13)),  
  
const SizedBox(width: 6),  
  
Flexible(  

```

```
child: Text(

  'Consult Dexcom App before treatment decision',

  style: TextStyle(

    fontSize: 12,

    color: Colors.amber.shade900,

    fontWeight: FontWeight.w500),

  ),

),

],

),

),

// — Glucose card —————

Container(

  width: double.infinity,

  padding: const EdgeInsets.symmetric(

    horizontal: 32, vertical: 44),

  decoration: BoxDecoration(

    color: glColor.withOpacity(0.08),

    borderRadius: BorderRadius.circular(28),

    border:

      Border.all(color: glColor.withOpacity(0.35), width: 2),
```

```
boxShadow: [

  BoxShadow(

    color: glColor.withOpacity(0.15),

    blurRadius: 30,

    spreadRadius: 2,

    offset: const Offset(0, 6),

  ),

],

),

child: Row(

  mainAxisAlignment: MainAxisAlignment.center,

  crossAxisAlignment: CrossAxisAlignment.center,

  children: [

    Expanded(

      child: Center(

        child: Text(

          '${reading.value}',

          style: TextStyle(

            fontSize: 100,

            fontWeight: FontWeight.w800,

            color: glColor,

            height: 1.0,
```

```
),  
  
),  
  
),  
  
),  
  
Text(  
  
  reading.trendArrow,  
  
  style: TextStyle(  
  
    fontSize: 52,  
  
    color: glColor.withOpacity(0.8),  
  
    height: 1.0),  
  
  ),  
  
],  
  
),  
  
),  
  
const SizedBox(height: 28),  
  
// — Refresh button —————  
  
SizedBox(  
  
  height: 40,  
  
  child: OutlinedButton.icon(  
  
    onPressed: _fetch,
```

```
icon: Icon(CupertinoIcons.refresh,

size: 15, color: Colors.grey.shade500),

label: Text('Refresh',

style: TextStyle(

fontSize: 14, color: Colors.grey.shade600)),

style: OutlinedButton.styleFrom(

side: BorderSide(color: Colors.grey.shade300),

shape: RoundedRectangleBorder(

borderRadius: BorderRadius.circular(20)),

padding: const EdgeInsets.symmetric(

horizontal: 20, vertical: 0),

),

),

),

),

const SizedBox(height: 14),

// — Last reading timestamp —————

Text(

'Last reading: ${reading.timeText} $_tzAbbr',

style: TextStyle(

fontSize: 13, color: Colors.grey.shade500),

),
```

```
if (_error != null)

Padding(

padding: const EdgeInsets.only(top: 8),

child: Text('Last refresh failed – retrying',

style: TextStyle(

color: Colors.orange.shade600, fontSize: 12)),

),

const Spacer(),

// — Sign out —————

Align(

alignment: Alignment.bottomLeft,

child: TextButton.icon(

onPressed: _logout,

icon: Icon(CupertinoIcons.square_arrow_left,

size: 16, color: Colors.grey.shade400),

label: Text('Sign Out',

style: TextStyle(

color: Colors.grey.shade400, fontSize: 13)),

),

),
```

```
]),  
  
);  
  
}  
  
}  
  
// -----  
  
// SETTINGS SCREEN  
  
// -----  
  
class SettingsScreen extends StatefulWidget {  
  
  final double ledBrightness;  
  
  final Future<void> Function() onLogout;  
  
  const SettingsScreen({  
  
    super.key,  
  
    required this.ledBrightness,  
  
    required this.onLogout,  
  
  });  
  
  @override  
  
  State<SettingsScreen> createState() => _SettingsScreenState();  
  
}  
  
class _SettingsScreenState extends State<SettingsScreen> {
```

```
late double _brightness;

String _country = 'USA';

String _plan = 'Entry Level';

static const _countries = ['USA', 'Canada', 'Mexico'];

static const _plans = ['Entry Level', 'Beginner Package'];

static const _planPrices = {

  'Entry Level': '\$0.00',

  'Beginner Package': '\$5.00',

};

@override

void initState() {

  super.initState();

  _brightness = widget.ledBrightness;

  _loadSaved();

}

Future<void> _loadSaved() async {

  final country = await _storage.read(key: _kCountry);

  final plan = await _storage.read(key: _kPlan);

  if (!mounted) return;

  setState(() {

    if (country != null) _country = country;
```

```
if (plan != null) _plan = plan;

});

}

Future<void> _saveCountry(String v) async {

setState(() => _country = v);

await _storage.write(key: _kCountry, value: v);

}

Future<void> _savePlan(String v) async {

setState(() => _plan = v);

await _storage.write(key: _kPlan, value: v);

}

void _goHome() => Navigator.pop(context, _brightness);

@override

Widget build(BuildContext context) {

return Scaffold(

backgroundColor: const Color(0xFF5F7FA),

body: SafeArea(

child: Padding(

padding:

const EdgeInsets.symmetric(horizontal: 24, vertical: 12),
```

```
child: Column(  
  
  crossAxisAlignment: CrossAxisAlignment.start,  
  
  children: [  
  
    // Title  
  
    const Padding(  
  
      padding: EdgeInsets.only(top: 12, bottom: 28),  
  
      child: Text('Settings',  
  
        style: TextStyle(  
  
          fontSize: 32,  
  
          fontWeight: FontWeight.w800,  
  
          color: Color(0xFF1A1A2E)),  
  
      ),  
  
    Expanded(  
  
      child: ListView(  
  
        children: [  
  
          // — LED Brightness —————  
  
          _sectionCard(children: [  
  
            _sectionHeader(  
  
              CupertinoIcons.lightbulb, 'LED Brightness'),  
  
            const SizedBox(height: 12),
```

```
Row(

  mainAxisAlignment:

  MainAxisAlignment.spaceBetween,

  children: [

    Text('Brightness',

      style: TextStyle(

        color: Colors.grey.shade700,

        fontSize: 15)),

    Container(

      padding: const EdgeInsets.symmetric(

        horizontal: 10, vertical: 4),

      decoration: BoxDecoration(

        color: const Color(0xFF1A73E8)

          .withOpacity(0.1),

        borderRadius: BorderRadius.circular(8),

      ),

      child: Text('${_brightness.round()}%',

        style: const TextStyle(

          color: Color(0xFF1A73E8),

          fontSize: 14,

          fontWeight: FontWeight.w600)),

    ),
```

```
],  
)  
  
SliderTheme(  
  
  data: SliderTheme.of(context).copyWith(  
  
    activeTrackColor: const Color(0xFF1A73E8),  
  
    inactiveTrackColor:  
  
    Colors.grey.shade200,  
  
    thumbColor: const Color(0xFF1A73E8),  
  
    overlayColor: const Color(0xFF1A73E8)  
  
    .withOpacity(0.1),  
  
    thumbShape: const RoundSliderThumbShape(  
  
      enabledThumbRadius: 10),  
  
    trackHeight: 4,  
  
  ),  
  
  child: Slider(  
  
    value: _brightness,  
  
    min: 0,  
  
    max: 100,  
  
    onChanged: (v) =>  
  
    setState(() => _brightness = v),  
  
  ),  
)
```

```
),  
  
Padding(  
  
padding:  
  
const EdgeInsets.symmetric(horizontal: 4),  
  
child: Row(  
  
mainAxisAlignment:  
  
MainAxisAlignment.spaceBetween,  
  
children: [  
  
Text('0%',  
  
style: TextStyle(  
  
color: Colors.grey.shade400,  
  
fontSize: 11)),  
  
Text('100%',  
  
style: TextStyle(  
  
color: Colors.grey.shade400,  
  
fontSize: 11)),  
  
],  
  
),  
  
),  
  
]),  
  
const SizedBox(height: 16),
```

```
// — Country —————

_sectionCard(children: [

_sectionHeader(

CupertinoIcons.globe, 'Country'),

const SizedBox(height: 12),

Container(

padding: const EdgeInsets.symmetric(

horizontal: 14, vertical: 4),

decoration: BoxDecoration(

color: Colors.white,

borderRadius: BorderRadius.circular(12),

border: Border.all(

color: Colors.grey.shade200),

),

child: DropdownButtonHideUnderline(

child: DropdownButton<String>(

value: _country,

isExpanded: true,

icon: Icon(

CupertinoIcons.chevron_down,

color: Colors.grey.shade400,
```

```
size: 16),

style: const TextStyle(

color: Color(0xFF1A1A2E),

fontSize: 15),

items: _countries

.map((c) => DropdownMenuItem(

value: c,

child: Text(c)))

.toList(),

onChanged: (v) {

if (v != null) _saveCountry(v);

},

),

),

),

),

]),

const SizedBox(height: 16),

// — Plan —————

_sectionCard(children: [

_sectionHeader(
```

```
CupertinoIcons.star, 'Plan'),

const SizedBox(height: 12),

..._plans.map((p) {

final selected = _plan == p;

return GestureDetector(

onTap: () => _savePlan(p),

child: Container(

margin: const EdgeInsets.only(bottom: 8),

padding: const EdgeInsets.symmetric(

horizontal: 16, vertical: 14),

decoration: BoxDecoration(

color: selected

? const Color(0xFF1A73E8)

.withOpacity(0.08)

: Colors.white,

borderRadius:

BorderRadius.circular(12),

border: Border.all(

color: selected

? const Color(0xFF1A73E8)

: Colors.grey.shade200,

width: selected ? 1.5 : 1,
```

```
),  
  
),  
  
child: Row(  
  
  mainAxisAlignment:  
  
    MainAxisAlignment.spaceBetween,  
  
  children: [  
  
    Row(children: [  
  
      Icon(  
  
        selected  
  
        ? CupertinoIcons  
  
          .checkmark_circle_fill  
  
        : CupertinoIcons.circle,  
  
        color: selected  
  
        ? const Color(0xFF1A73E8)  
  
        : Colors.grey.shade300,  
  
        size: 20,  
  
      ),  
  
      const SizedBox(width: 12),  
  
      Text(p,  
  
        style: TextStyle(  
  
          fontSize: 15,
```

```
fontWeight: selected
```

```
? FontWeight.w600
```

```
: FontWeight.w400,
```

```
color: selected
```

```
? const Color(0xFF1A73E8)
```

```
: const Color(0xFF1A1A2E),
```

```
)),
```

```
]),
```

```
Text(
```

```
_planPrices[p] ?? '',
```

```
style: TextStyle(
```

```
fontSize: 14,
```

```
fontWeight: FontWeight.w600,
```

```
color: selected
```

```
? const Color(0xFF1A73E8)
```

```
: Colors.grey.shade500,
```

```
),
```

```
),
```

```
],
```

```
),
```

```
),
```

```
);  
  
}),  
  
]),  
  
const SizedBox(height: 24),  
  
],  
  
),  
  
),  
  
// — Bottom bar —————  
  
Row(  
  
  mainAxisAlignment: MainAxisAlignment.spaceBetween,  
  
  children: [  
  
    TextButton.icon(  
  
      onPressed: widget.onLogout,  
  
      icon: Icon(CupertinoIcons.square_arrow_left,  
  
        size: 16, color: Colors.grey.shade400),  
  
      label: Text('Sign Out',  
  
        style: TextStyle(  
  
          color: Colors.grey.shade400,  
  
          fontSize: 13)),  
  
    ),
```

```
    IconButton.icon(

      onPressed: _goHome,

      icon: Icon(CupertinoIcons.house,

        size: 16, color: Colors.grey.shade600),

      label: Text('Home',

        style: TextStyle(

          color: Colors.grey.shade600,

          fontSize: 13)),

    ),

  ],

),

],

),

),

),

),

);

}

Widget _sectionCard({required List<Widget> children}) {

  return Container(

    padding: const EdgeInsets.all(18),

    decoration: BoxDecoration(
```

```
color: Colors.white,  
  
borderRadius: BorderRadius.circular(18),  
  
boxShadow: [  
  
  BoxShadow(  
  
    color: Colors.black.withOpacity(0.04),  
  
    blurRadius: 12,  
  
    offset: const Offset(0, 2),  
  
  ),  
  
],  
  
),  
  
child: Column(  
  
  crossAxisAlignment: CrossAxisAlignment.start,  
  
  children: children),  
  
);  
  
}  
  
Widget _sectionHeader(IconData icon, String title) {  
  
  return Row(children: [  
  
    Icon(icon, color: const Color(0xFF1A73E8), size: 18),  
  
    const SizedBox(width: 8),  
  
    Text(title,  
  
    style: const TextStyle(  

```

```
fontSize: 16,  
  
fontWeight: FontWeight.w700,  
  
color: Color(0xFF1A1A2E)),  
  
]);  
  
}  
  
}  
  
// -----  
  
// EDUCATION SCREEN  
  
// -----  
  
class EducationScreen extends StatelessWidget {  
  
  final Future<void> Function() onLogout;  
  
  const EducationScreen({super.key, required this.onLogout});  
  
  // Video data: title, subtitle, locked, duration  
  
  static const _videos = [  
  
    {  
  
      'title': 'App Setup & Use',  
  
      'duration': '6:42',  
  
      'locked': false,  
  
    },  
  
    {  
  
      'title': 'Diabetes: A Comprehensive Guide',
```

```
'duration': '18:15',

'locked': false,

},

{

'title': 'Guide to Hyperglycemia',

'duration': '11:30',

'locked': true,

},

{

'title': 'Guide to Hypoglycemia',

'duration': '9:55',

'locked': true,

},

];

@override

Widget build(BuildContext context) {

return Scaffold(

backgroundColor: const Color(0xFFFF5F7FA),

body: SafeArea(

child: Padding(

padding:
```

```
const EdgeInsets.symmetric(horizontal: 24, vertical: 12),

child: Column(

crossAxisAlignment: CrossAxisAlignment.start,

children: [

// Title

const Padding(

padding: EdgeInsets.only(top: 12, bottom: 24),

child: Text('Education',

style: TextStyle(

fontSize: 32,

fontWeight: FontWeight.w800,

color: Color(0xFF1A1A2E))),

),

Expanded(

child: ListView.separated(

itemCount: _videos.length,

separatorBuilder: (_, __) =>

const SizedBox(height: 14),

itemBuilder: (context, i) {

final v = _videos[i];

final locked = v['locked'] as bool;
```

```
return _VideoCard(  
  
  title: v['title'] as String,  
  
  duration: v['duration'] as String,  
  
  locked: locked,  
  
);  
  
},  
  
),  
  
),  
  
// Bottom bar  
  
Padding(  
  
  padding: const EdgeInsets.only(top: 8),  
  
  child: Row(  
  
    mainAxisAlignment: MainAxisAlignment.spaceBetween,  
  
    children: [  
  
      TextButton.icon(  
  
        onPressed: onLogout,  
  
        icon: Icon(CupertinoIcons.square_arrow_left,  
  
          size: 16, color: Colors.grey.shade400),  
  
        label: Text('Sign Out',  
  
          style: TextStyle(  
  
            color: Colors.grey.shade400,
```

```
fontSize: 13)),  
  
),  
  
TextButton.icon(  
  
  onPressed: () => Navigator.pop(context),  
  
  icon: Icon(CupertinoIcons.house,  
  
    size: 16, color: Colors.grey.shade600),  
  
  label: Text('Home',  
  
    style: TextStyle(  
  
      color: Colors.grey.shade600,  
  
      fontSize: 13)),  
  
),  
  
],  
  
),  
  
),  
  
],  
  
),  
  
),  
  
),  
  
);  
  
}  
  
}
```

```
// -----  
  
// VIDEO CARD WIDGET  
  
// -----  
  
class _VideoCard extends StatelessWidget {  
  
  final String title;  
  
  final String duration;  
  
  final bool locked;  
  
  const _VideoCard({  
  
    required this.title,  
  
    required this.duration,  
  
    required this.locked,  
  
  });  
  
  @override  
  
  Widget build(BuildContext context) {  
  
    return Container(  
  
      decoration: BoxDecoration(  
  
        color: Colors.white,  
  
        borderRadius: BorderRadius.circular(16),  
  
        boxShadow: [  
  
          BoxShadow(  

```

```
color: Colors.black.withOpacity(0.05),

blurRadius: 10,

offset: const Offset(0, 2),

),

],

),

child: Column(

crossAxisAlignment: CrossAxisAlignment.start,

children: [

// — Thumbnail / player area —————

ClipRRect(

borderRadius: const BorderRadius.vertical(

top: Radius.circular(16)),

child: AspectRatio(

aspectRatio: 16 / 9,

child: Container(

color: locked

? Colors.grey.shade200

: const Color(0xFF1A1A2E),

child: locked

? Column(
```

```
mainAxisAlignment: MainAxisAlignment.center,  
  
children: [  
  
  Icon(CupertinoIcons.lock_fill,  
  
    color: Colors.grey.shade400, size: 36),  
  
  const SizedBox(height: 10),  
  
  Text('Locked',  
  
    style: TextStyle(  
  
      color: Colors.grey.shade500,  
  
      fontSize: 14,  
  
      fontWeight: FontWeight.w500)),  
  
  const SizedBox(height: 4),  
  
  Text('Upgrade to unlock',  
  
    style: TextStyle(  
  
      color: Colors.grey.shade400,  
  
      fontSize: 12)),  
  
],  
  
)  
  
: Stack(  
  
  alignment: Alignment.center,  
  
  children: [  
  
    // Fake gradient background simulating video
```

```
Container(  
  
  decoration: BoxDecoration(  
  
    gradient: LinearGradient(  
  
      begin: Alignment.topLeft,  
  
      end: Alignment.bottomRight,  
  
      colors: [  
  
        const Color(0xFF1A73E8)  
  
          .withOpacity(0.6),  
  
        const Color(0xFF1A1A2E),  
  
      ],  
  
    ),  
  
  ),  
  
  ),  
  
  ),  
  
  ),  
  
  // Play button  
  
  Container(  
  
    width: 54,  
  
    height: 54,  
  
    decoration: BoxDecoration(  
  
      color: Colors.white.withOpacity(0.15),  
  
      shape: BoxShape.circle,  
  
      border: Border.all(  

```

```
color:

Colors.white.withOpacity(0.6),

width: 2),

),

child: const Icon(

CupertinoIcons.play_fill,

color: Colors.white,

size: 22),

),

// Duration badge bottom right

Positioned(

bottom: 10,

right: 12,

child: Container(

padding: const EdgeInsets.symmetric(

horizontal: 8, vertical: 3),

decoration: BoxDecoration(

color: Colors.black54,

borderRadius:

BorderRadius.circular(6),

),
```



```
style: TextStyle(  
  
  fontSize: 15,  
  
  fontWeight: FontWeight.w600,  
  
  color: locked  
    ? Colors.grey.shade400  
    : const Color(0xFF1A1A2E),  
),  
,  
,  
,  
  
  if (locked)  
  
    Container(  
  
      padding: const EdgeInsets.symmetric(  
  
        horizontal: 10, vertical: 4),  
  
      decoration: BoxDecoration(  
  
        color: Colors.amber.shade50,  
  
        borderRadius: BorderRadius.circular(8),  
  
        border:  
  
          Border.all(color: Colors.amber.shade200),  
  
      ),  
  
      child: Text('Pro',  
  
        style: TextStyle(  

```

```
color: Colors.amber.shade800,  
  
fontSize: 12,  
  
fontWeight: FontWeight.w600)),  
  
) ,  
  
] ,  
  
) ,  
  
) ,  
  
] ,  
  
) ,  
  
) ;  
  
}  
  
}
```

**Conclusions/action items:**

Deploy app, update configurations to save login credentials until manual log out, work on BLE connection.

Claudia Beckwith - Mar 18, 2026, 3:47 PM CDT



[Download](#)

**main.dart (46.3 kB)**



## 2026/03/08 main UI updated code - ShaRx Tank

Claudia Beckwith - Apr 08, 2026, 1:00 PM CDT

**Title:** Updated main.dart code

**Date:** 3/8/26

**Content by:** claudia

**Present:** Claudia

**Goals:** I wanted to update main.dart to include the tiers that match our client's request, and also change the brightness slider to update the microcontroller along with the slider instead of waiting until back to the home page to update. Also this code reflects the latest BLE connection button to help establish the BLE connection.

**Content:**

Code attached below (functionally almost identical to last revision):

```
// lib/main.dart

import 'dart:async';

import 'package:flutter/material.dart';

import 'package:flutter/cupertino.dart';

import 'package:flutter_secure_storage/flutter_secure_storage.dart';

import 'api_service.dart';

import 'ble_service.dart';

import 'dexcom_session.dart';

import 'glucose_reading.dart';

void main() => runApp(const MyApp());

final _api = ApiService();

const _storage = FlutterSecureStorage();

const _kUsername = 'dexcom_username';

const _kPassword = 'dexcom_password';
```

```
const _kCountry = 'dexcom_country';

const _kPlan = 'dexcom_plan';

// -----

// APP ROOT

// -----

class MyApp extends StatelessWidget {

const MyApp({super.key});

@override

Widget build(BuildContext context) {

return MaterialApp(

title: 'WGASM',

debugShowCheckedModeBanner: false,

theme: ThemeData(

colorScheme: ColorScheme.fromSeed(

seedColor: const Color(0xFF1A73E8),

brightness: Brightness.light,

),

useMaterial3: true,

scaffoldBackgroundColor: const Color(0xFFF5F7FA),

appBarTheme: const AppBarTheme(
```

```
backgroundColor: Color(0xFFF5F7FA),

elevation: 0,

foregroundColor: Color(0xFF1A1A2E),

),

),

home: const SplashScreen(),

);

}

}

// -----

// SPLASH – checks Keychain for saved credentials

// -----

class SplashScreen extends StatefulWidget {

const SplashScreen({super.key});

@override

State<SplashScreen> createState() => _SplashScreenState();

}

class _SplashScreenState extends State<SplashScreen> {

@override

void initState() {
```

```
super.initState();

_check();

}

Future<void> _check() async {

final username = await _storage.read(key: _kUsername);

final password = await _storage.read(key: _kPassword);

if (!mounted) return;

if (username != null && password != null) {

_api.configure(username: username, password: password);

try {

await _api.getLatestReading();

if (!mounted) return;

Navigator.pushReplacement(context,

MaterialPageRoute(builder: (_) => const GlucoseScreen()));

} catch (_) {

await _storage.delete(key: _kUsername);

await _storage.delete(key: _kPassword);

if (!mounted) return;

Navigator.pushReplacement(context,

MaterialPageRoute(builder: (_) => const LoginScreen()));
```

```
}

} else {

Navigator.pushReplacement(context,

MaterialPageRoute(builder: (_) => const LoginScreen()));

}

}

@override

Widget build(BuildContext context) {

return const Scaffold(

backgroundColor: Color(0xFFF5F7FA),

body: Center(child: CircularProgressIndicator()),

);

}

}

// -----

// LOGIN SCREEN

// -----

class LoginScreen extends StatefulWidget {

const LoginScreen({super.key});

@override

State<LoginScreen> createState() => _LoginScreenState();
```

```
}

class _LoginScreenState extends State<LoginScreen> {

  final _userCtrl = TextEditingController();

  final _passCtrl = TextEditingController();

  bool _busy = false;

  bool _obscure = true;

  String? _error;

  @override

  void dispose() {

    _userCtrl.dispose();

    _passCtrl.dispose();

    super.dispose();

  }

  Future<void> _login() async {

    final username = _userCtrl.text.trim();

    final password = _passCtrl.text;

    if (username.isEmpty || password.isEmpty) {

      setState(() => _error = 'Please enter both username and password.');
```

```
setState(() { _busy = true; _error = null; });

_api.configure(username: username, password: password);

try {

  await _api.getLatestReading();

  await _storage.write(key: _kUsername, value: username);

  await _storage.write(key: _kPassword, value: password);

  if (!mounted) return;

  Navigator.pushReplacement(context,

  MaterialPageRoute(builder: (_) => const GlucoseScreen()));

} on DexcomAuthException catch (e) {

  setState(() { _busy = false; _error = e.message; });

} catch (e) {

  setState(() { _busy = false; _error = e.toString(); });

}

}

@override

Widget build(BuildContext context) {

  return Scaffold(

    backgroundColor: const Color(0xFFF5F7FA),

    body: SafeArea(

      child: Center(
```

```
child: SingleChildScrollView(

padding: const EdgeInsets.all(32),

child: ConstrainedBox(

constraints: const BoxConstraints(maxWidth: 400),

child: Column(

mainAxisSize: MainAxisSize.min,

crossAxisAlignment: CrossAxisAlignment.start,

children: [

// Logo / title block

Container(

padding: const EdgeInsets.all(14),

decoration: BoxDecoration(

color: const Color(0xFF1A73E8),

borderRadius: BorderRadius.circular(16),

),

child: const Icon(CupertinoIcons.waveform_path_ecg,

color: Colors.white, size: 32),

),

const SizedBox(height: 20),

const Text(

'Wearable Glucose\nAlerting System\nMonitor',
```

```
style: TextStyle(

fontSize: 30,

fontWeight: FontWeight.w800,

color: Color(0xFF1A1A2E),

height: 1.15,

),

),

const SizedBox(height: 8),

Text(

'Sign in with your Dexcom credentials',

style: TextStyle(

fontSize: 14, color: Colors.grey.shade500),

),

const SizedBox(height: 36),

// Username

_buildField(

controller: _userCtrl,

label: 'Username',

icon: CupertinoIcons.person),

const SizedBox(height: 12),
```

```
// Password

_buildField(

controller: _passCtrl,

label: 'Password',

icon: CupertinoIcons.lock,

obscure: _obscure,

suffix: IconButton(

icon: Icon(

_obscure

? CupertinoIcons.eye_slash

: CupertinoIcons.eye,

color: Colors.grey.shade400,

size: 20,

),

onPressed: () =>

setState(() => _obscure = !_obscure),

),

),

if (_error != null) ...[

const SizedBox(height: 12),

Container(
```

```
padding: const EdgeInsets.all(12),

decoration: BoxDecoration(

color: Colors.red.shade50,

borderRadius: BorderRadius.circular(10),

border: Border.all(color: Colors.red.shade200),

),

child: Row(children: [

Icon(CupertinoIcons.exclamationmark_circle,

color: Colors.red.shade600, size: 16),

const SizedBox(width: 8),

Expanded(

child: Text(_error!,

style: TextStyle(

color: Colors.red.shade700,

fontSize: 13))),

]),

),

],

const SizedBox(height: 24),

SizedBox(

width: double.infinity,
```

```
height: 52,  
  
child: ElevatedButton(  
  
  onPressed: _busy ? null : _login,  
  
  style: ElevatedButton.styleFrom(  
  
    backgroundColor: const Color(0xFF1A73E8),  
  
    foregroundColor: Colors.white,  
  
    shape: RoundedRectangleBorder(  
  
      borderRadius: BorderRadius.circular(14)),  
  
      elevation: 0,  
  
    ),  
  
    child: _busy  
  
    ? const SizedBox(  
  
      height: 20, width: 20,  
  
      child: CircularProgressIndicator(  
  
        strokeWidth: 2, color: Colors.white))  
  
    : const Text('Sign In',  
  
      style: TextStyle(  
  
        fontSize: 16,  
  
        fontWeight: FontWeight.w600)),  
  
    ),  
  
  ),  
  
),
```

```
[,
),
),
),
),
),
),
);
}

Widget _buildField({
  required TextEditingController controller,
  required String label,
  required IconData icon,
  bool obscure = false,
  Widget? suffix,
}) {
  return TextField(
    controller: controller,
    obscureText: obscure,
    style: const TextStyle(color: Color(0xFF1A1A2E)),
    decoration: InputDecoration(
      labelText: label,
```

```
labelStyle: TextStyle(color: Colors.grey.shade500),

prefixIcon:

Icon(icon, color: Colors.grey.shade400, size: 20),

suffixIcon: suffix,

filled: true,

fillColor: Colors.white,

border: OutlineInputBorder(

borderRadius: BorderRadius.circular(12),

borderSide: BorderSide(color: Colors.grey.shade200),

),

enabledBorder: OutlineInputBorder(

borderRadius: BorderRadius.circular(12),

borderSide: BorderSide(color: Colors.grey.shade200),

),

focusedBorder: OutlineInputBorder(

borderRadius: BorderRadius.circular(12),

borderSide: const BorderSide(

color: Color(0xFF1A73E8), width: 1.5),

),

),

);
```

```
}  
  
}  
  
// -----  
  
// GLUCOSE SCREEN  
  
// -----  
  
class GlucoseScreen extends StatefulWidget {  
  
  const GlucoseScreen({super.key});  
  
  @override  
  
  State<GlucoseScreen> createState() => _GlucoseScreenState();  
  
}  
  
class _GlucoseScreenState extends State<GlucoseScreen> {  
  
  GlucoseReading? _reading;  
  
  Timer? _pollTimer;  
  
  Timer? _tickTimer;  
  
  bool _loading = true;  
  
  String? _error;  
  
  double _ledBrightness = 50;  
  
  // — BLE state -----  
  
  final _ble = BleService();  
  
  bool _bleConnected = false;
```

```
bool _bleConnecting = false;

@override

void initState() {

  super.initState();

  _fetch();

  _pollTimer = Timer.periodic(

    DexcomSession.recommendedPollInterval, (_) => _fetch());

  _tickTimer = Timer.periodic(

    const Duration(seconds: 30), (_) => setState(() {}));

}

@override

void dispose() {

  _pollTimer?.cancel();

  _tickTimer?.cancel();

  _ble.disconnect();

  super.dispose();

}

// — BLE connect / disconnect toggle —————

Future<void> _toggleBle() async {

  if (_bleConnected) {
```

```
await _ble.disconnect();

setState(() => _bleConnected = false);

return;
}

setState(() => _bleConnecting = true);

final ok = await _ble.connect();

if (!mounted) return;

setState(() {

  _bleConnected = ok;

  _bleConnecting = false;

});

if (!ok) {

  ScaffoldMessenger.of(context).showSnackBar(

    SnackBar(

      content: const Text('Could not find XIA0_ESP32C6. Make sure it is powered on and nearby.'),

      backgroundColor: Colors.red.shade700,

      behavior: SnackBarBehavior.floating,

      shape: RoundedRectangleBorder(borderRadius: BorderRadius.circular(10)),

    ),

  );
```

```
} else {

// Send current glucose and brightness immediately after connecting

if (_reading != null) await _ble.sendValue(_reading!.value);

await _ble.sendBrightness(_ledBrightness.round());

}

}

Future<void> _fetch() async {

if (!mounted) return;

setState(() { _loading = _reading == null; _error = null; });

try {

final r = await _api.getLatestReading();

if (!mounted) return;

setState(() { _reading = r; _loading = false; });

// Forward glucose to microcontroller if connected

if (_bleConnected) await _ble.sendValue(r.value);

} on DexcomAuthException catch (e) {

if (!mounted) return;

setState(() { _error = e.message; _loading = false; });

} catch (e) {

if (!mounted) return;

setState(() { _error = e.toString(); _loading = false; });

}
```

```
}  
  
}  
  
Future<void> _logout() async {  
  
  await _storage.delete(key: _kUsername);  
  
  await _storage.delete(key: _kPassword);  
  
  _api.logout();  
  
  await _ble.disconnect();  
  
  if (!mounted) return;  
  
  Navigator.pushAndRemoveUntil(context,  
  
  MaterialPageRoute(builder: (_) => const LoginScreen()),  
  
  (_) => false);  
  
}  
  
Future<void> _goToSettings() async {  
  
  final result = await Navigator.push<double>(  
  
  context,  
  
  MaterialPageRoute(  
  
  builder: (_) => SettingsScreen(  
  
  ledBrightness: _ledBrightness,  
  
  onLogout: _logout,  
  
  onBrightnessChanged: (v) async {  
  
  setState(() => _ledBrightness = v);  
  
}
```

```
if (_bleConnected) await _ble.sendBrightness(v.round());

},

),

),

);

if (result != null && mounted) {

setState(() => _ledBrightness = result);

if (_bleConnected) await _ble.sendBrightness(result.round());

}

}

void _goToEducation() {

Navigator.push(context,

MaterialPageRoute(

builder: (_) => EducationScreen(onLogout: _logout)));

}

Color _colorFor(int mg) {

if (mg < 55) return const Color(0xFFD32F2F);

if (mg <= 65) return const Color(0xFFE64A19);

if (mg <= 80) return const Color(0xFFFF57C0);

if (mg <= 139) return const Color(0xFF2E7D32);
```

```
if (mg <= 200) return const Color(0xFF1565C0);

return const Color(0xFF6A1B9A);

}

String get _tzAbbr {

final offset = DateTime.now().timeZoneOffset.inHours;

const map = {-5: 'ET', -6: 'CT', -7: 'MT', -8: 'PT'};

return map[offset] ?? DateTime.now().timeZoneName;

}

@override

Widget build(BuildContext context) {

return Scaffold(

backgroundColor: const Color(0xFFF5F7FA),

body: SafeArea(

child: _loading

? const Center(child: CircularProgressIndicator())

: (_error != null && _reading == null)

? _buildError()

: _buildBody(),

),

);

}
```

```
Widget _buildError() {  
  
  return Center(  
  
    child: Padding(  
  
      padding: const EdgeInsets.all(32),  
  
      child: Column(mainAxisSize: MainAxisSize.min, children: [  
  
        Icon(CupertinoIcons.exclamationmark_circle,  
  
          color: Colors.red.shade400, size: 48),  
  
        const SizedBox(height: 16),  
  
        Text(_error!,  
  
          style: TextStyle(  
  
            color: Colors.grey.shade700, fontSize: 15),  
  
            textAlign: TextAlign.center),  
  
        const SizedBox(height: 24),  
  
        ElevatedButton(  
  
          onPressed: _fetch,  
  
          style: ElevatedButton.styleFrom(  
  
            backgroundColor: const Color(0xFF1A73E8),  
  
            foregroundColor: Colors.white,  
  
            shape: RoundedRectangleBorder(  
  
              borderRadius: BorderRadius.circular(12)),  
  
            ),
```

```
child: const Text('Retry'),
),
]),
),
);
}

Widget _buildBody() {
  final reading = _reading!;

  final glColor = _colorFor(reading.value);

  return Padding(
    padding: const EdgeInsets.symmetric(horizontal: 24, vertical: 8),
    child: Column(children: [
      // — Top bar —————
      Row(
        mainAxisAlignment: MainAxisAlignment.spaceBetween,
        children: [
          // Settings (left)
          IconButton(
            onPressed: _goToSettings,
            icon: Icon(CupertinoIcons.settings,
```

```
color: Colors.grey.shade500, size: 26),
```

```
tooltip: 'Settings',
```

```
),
```

```
// BLE connect button (centre-right)
```

```
_BleButton(  
  connected: _bleConnected,
```

```
  connecting: _bleConnecting,
```

```
  onTap: _toggleBle,
```

```
),
```

```
// Education (right)
```

```
GestureDetector(  
  onTap: _goToEducation,
```

```
  child: Container(  
    padding: const EdgeInsets.symmetric(  
      horizontal: 16, vertical: 8),  
    decoration: BoxDecoration(  
      color: Colors.grey.shade200,  
      borderRadius: BorderRadius.circular(20),  
    ),  
    child: Text('Education',  
      style: TextStyle(  
        color: Colors.grey.shade500, size: 26),  
      tooltip: 'Settings',  
    ),  
  ),  
),
```

```
  child: Container(  
    padding: const EdgeInsets.symmetric(  
      horizontal: 16, vertical: 8),  
    decoration: BoxDecoration(  
      color: Colors.grey.shade200,  
      borderRadius: BorderRadius.circular(20),  
    ),  
    child: Text('Education',  
      style: TextStyle(  
        color: Colors.grey.shade500, size: 26),  
      tooltip: 'Settings',  
    ),  
  ),  
),
```

```
padding: const EdgeInsets.symmetric(  
  horizontal: 16, vertical: 8),  
  decoration: BoxDecoration(  
    color: Colors.grey.shade200,  
    borderRadius: BorderRadius.circular(20),  
  ),  
  child: Text('Education',  
    style: TextStyle(  
      color: Colors.grey.shade500, size: 26),  
      tooltip: 'Settings',  
    ),  
  ),  
),
```

```
horizontal: 16, vertical: 8),  
  decoration: BoxDecoration(  
    color: Colors.grey.shade200,  
    borderRadius: BorderRadius.circular(20),  
  ),  
  child: Text('Education',  
    style: TextStyle(  
      color: Colors.grey.shade500, size: 26),  
      tooltip: 'Settings',  
    ),  
  ),  
),
```

```
decoration: BoxDecoration(  
  color: Colors.grey.shade200,  
  borderRadius: BorderRadius.circular(20),  
),  
  child: Text('Education',  
    style: TextStyle(  
      color: Colors.grey.shade500, size: 26),  
      tooltip: 'Settings',  
    ),  
  ),  
),
```

```
color: Colors.grey.shade200,  
  borderRadius: BorderRadius.circular(20),  
),  
  child: Text('Education',  
    style: TextStyle(  
      color: Colors.grey.shade500, size: 26),  
      tooltip: 'Settings',  
    ),  
  ),  
),
```

```
borderRadius: BorderRadius.circular(20),  
),  
  child: Text('Education',  
    style: TextStyle(  
      color: Colors.grey.shade500, size: 26),  
      tooltip: 'Settings',  
    ),  
  ),  
),
```

```
),  
  child: Text('Education',  
    style: TextStyle(  
      color: Colors.grey.shade500, size: 26),  
      tooltip: 'Settings',  
    ),  
  ),  
),
```

```
child: Text('Education',  
  style: TextStyle(  
    color: Colors.grey.shade500, size: 26),  
    tooltip: 'Settings',  
  ),  
),
```

```
style: TextStyle(  
  color: Colors.grey.shade500, size: 26),  
  tooltip: 'Settings',  
),
```

```
color: Colors.grey.shade600,

fontSize: 14,

fontWeight: FontWeight.w500)),

),

),

],

),

const Spacer(),

// — Caution banner —————

Container(

margin: const EdgeInsets.only(bottom: 14),

padding:

const EdgeInsets.symmetric(horizontal: 14, vertical: 8),

decoration: BoxDecoration(

color: Colors.amber.shade50,

borderRadius: BorderRadius.circular(10),

border: Border.all(color: Colors.amber.shade200),

),

child: Row(

mainAxisSize: MainAxisSize.min,
```

```
children: [

const Text('△', style: TextStyle(fontSize: 13)),

const SizedBox(width: 6),

Flexible(

child: Text(

'Consult Dexcom App before treatment decision',

style: TextStyle(

fontSize: 12,

color: Colors.amber.shade900,

fontWeight: FontWeight.w500),

),

),

],

),

),

// — Glucose card —————

Container(

width: double.infinity,

padding: const EdgeInsets.symmetric(

horizontal: 32, vertical: 44),

decoration: BoxDecoration(
```

```
color: glColor.withOpacity(0.08),

borderRadius: BorderRadius.circular(28),

border:

Border.all(color: glColor.withOpacity(0.35), width: 2),

boxShadow: [

BoxShadow(

color: glColor.withOpacity(0.15),

blurRadius: 30,

spreadRadius: 2,

offset: const Offset(0, 6),

),

],

),

child: Row(

mainAxisAlignment: MainAxisAlignment.center,

crossAxisAlignment: CrossAxisAlignment.center,

children: [

Expanded(

child: Center(

child: Text(

'${reading.value}',

style: TextStyle(
```

```
fontSize: 100,  
  
fontWeight: FontWeight.w800,  
  
color: glColor,  
  
height: 1.0,  
  
),  
  
),  
  
),  
  
),  
  
Text(  
  
reading.trendArrow,  
  
style: TextStyle(  
  
fontSize: 52,  
  
color: glColor.withOpacity(0.8),  
  
height: 1.0),  
  
),  
  
],  
  
),  
  
),  
  
const SizedBox(height: 28),  
  
// — Refresh button —————
```

```
    SizedBox(
      height: 40,
      child: OutlinedButton.icon(
        onPressed: _fetch,
        icon: Icon(CupertinoIcons.refresh,
          size: 15, color: Colors.grey.shade500),
        label: Text('Refresh',
          style: TextStyle(
            fontSize: 14, color: Colors.grey.shade600)),
        style: OutlinedButton.styleFrom(
          side: BorderSide(color: Colors.grey.shade300),
          shape: RoundedRectangleBorder(
            borderRadius: BorderRadius.circular(20)),
          padding: const EdgeInsets.symmetric(
            horizontal: 20, vertical: 0),
        ),
      ),
    ),
  ),
),
),
const SizedBox(height: 14),
// — Last reading timestamp —————
Text(
```

```
'Last reading: ${reading.timeText} $_tzAbbr',

style: TextStyle(

fontSize: 13, color: Colors.grey.shade500),

),

if (_error != null)

Padding(

padding: const EdgeInsets.only(top: 8),

child: Text('Last refresh failed – retrying',

style: TextStyle(

color: Colors.orange.shade600, fontSize: 12)),

),

const Spacer(),

// — Sign out —————

Align(

alignment: Alignment.bottomLeft,

child: TextButton.icon(

onPressed: _logout,

icon: Icon(CupertinoIcons.square_arrow_left,

size: 16, color: Colors.grey.shade400),

label: Text('Sign Out',
```

```
style: TextStyle(
color: Colors.grey.shade400, fontSize: 13)),
),
),
]),
);
}
}

// -----

// BLE BUTTON WIDGET

// -----

class _BleButton extends StatelessWidget {
final bool connected;
final bool connecting;
final VoidCallback onTap;

const _BleButton({
required this.connected,
required this.connecting,
required this.onTap,
});
```

```
@override

Widget build(BuildContext context) {

final Color bg = connected

? const Color(0xFF2E7D32).withOpacity(0.1)

: Colors.grey.shade200;

final Color fg = connected

? const Color(0xFF2E7D32)

: Colors.grey.shade600;

final Color border = connected

? const Color(0xFF2E7D32).withOpacity(0.4)

: Colors.grey.shade300;

return GestureDetector(

onTap: connecting ? null : onTap,

child: AnimatedContainer(

duration: const Duration(milliseconds: 250),

padding: const EdgeInsets.symmetric(horizontal: 14, vertical: 8),

decoration: BoxDecoration(

color: bg,

borderRadius: BorderRadius.circular(20),

border: Border.all(color: border),
```

```
),  
  
child: Row(  
  
mainAxisSize: MainAxisSize.min,  
  
children: [  
  
if (connecting)  
  
  SizedBox(  
  
width: 14,  
  
height: 14,  
  
child: CircularProgressIndicator(  
  
strokeWidth: 2,  
  
color: Colors.grey.shade500,  
  
),  
  
)  
  
else  
  
  Icon(  
  
connected  
  
? CupertinoIcons.bluetooth  
  
: CupertinoIcons.bluetooth,  
  
size: 15,  
  
color: fg,  
  
),  
  
const SizedBox(width: 6),
```

```
Text(  
  
  connecting  
  
  ? 'Connecting...'  
  
  : connected  
  
  ? 'Connected'  
  
  : 'Connect',  
  
  style: TextStyle(  
  
    color: fg,  
  
    fontSize: 14,  
  
    fontWeight: FontWeight.w500,  
  
  ),  
  
),  
  
],  
  
),  
  
),  
  
);  
}  
}  
  
// _____  
  
// SETTINGS SCREEN  
  
// _____
```

```
class SettingsScreen extends StatefulWidget {

  final double ledBrightness;

  final Future<void> Function() onLogout;

  final ValueChanged<double> onBrightnessChanged;

  const SettingsScreen({

    super.key,

    required this.ledBrightness,

    required this.onLogout,

    required this.onBrightnessChanged,

  });

  @override

  State<SettingsScreen> createState() => _SettingsScreenState();

}

class _SettingsScreenState extends State<SettingsScreen> {

  late double _brightness;

  String _country = 'USA';

  String _plan = 'Tier 1';

  static const _countries = ['USA', 'Canada', 'Mexico'];

  static const _plans = [
```

```
'Tier 1',

'Tier 2',

'Tier 3',

'Tier 4',

];

static const _planPrices = {

'Tier 1': '\$15.00 / mo',

'Tier 2': '\$28.00 / mo',

'Tier 3': '\$58.00 / mo',

'Tier 4': '\$99.00 / mo',

};

@override

void initState() {

super.initState();

_brightness = widget.ledBrightness;

_loadSaved();

}

Future<void> _loadSaved() async {

final country = await _storage.read(key: _kCountry);

final plan = await _storage.read(key: _kPlan);

if (!mounted) return;
```

```
setState(() {  
  
  if (country != null) _country = country;  
  
  if (plan != null) _plan = plan;  
  
});  
  
}  
  
Future<void> _saveCountry(String v) async {  
  
  setState(() => _country = v);  
  
  await _storage.write(key: _kCountry, value: v);  
  
}  
  
Future<void> _savePlan(String v) async {  
  
  setState(() => _plan = v);  
  
  await _storage.write(key: _kPlan, value: v);  
  
}  
  
void _goHome() => Navigator.pop(context, _brightness);  
  
@override  
  
Widget build(BuildContext context) {  
  
  return Scaffold(  
  
    backgroundColor: const Color(0xFFF5F7FA),  
  
    body: SafeArea(  
  
      child: Padding(  

```

```
padding:

const EdgeInsets.symmetric(horizontal: 24, vertical: 12),

child: Column(

crossAxisAlignment: CrossAxisAlignment.start,

children: [

// Title

const Padding(

padding: EdgeInsets.only(top: 12, bottom: 28),

child: Text('Settings',

style: TextStyle(

fontSize: 32,

fontWeight: FontWeight.w800,

color: Color(0xFF1A1A2E))),

),

Expanded(

child: ListView(

children: [

// — LED Brightness —————

_sectionCard(children: [

_sectionHeader(
```

```
CupertinoIcons.lightbulb, 'LED Brightness'),
```

```
const SizedBox(height: 12),
```

```
Row(  
  mainAxisAlignment:  
    MainAxisAlignment.spaceBetween,  
  children: [  
    Text('Brightness',  
      style: TextStyle(  
        color: Colors.grey.shade700,  
        fontSize: 15)),  
    Container(  
      padding: const EdgeInsets.symmetric(  
        horizontal: 10, vertical: 4),  
      decoration: BoxDecoration(  
        color: const Color(0xFF1A73E8)  
          .withOpacity(0.1),  
        borderRadius: BorderRadius.circular(8),  
      ),  
      child: Text('${_brightness.round()}%',  
        style: const TextStyle(  
          color: Color(0xFF1A73E8),  
          fontSize: 14,
```

```
fontWeight: FontWeight.w600)),
),
],
),

SliderTheme(

data: SliderTheme.of(context).copyWith(

activeTrackColor: const Color(0xFF1A73E8),

inactiveTrackColor:

Colors.grey.shade200,

thumbColor: const Color(0xFF1A73E8),

overlayColor: const Color(0xFF1A73E8)

.withOpacity(0.1),

thumbShape: const RoundSliderThumbShape(

enabledThumbRadius: 10),

trackHeight: 4,

),

child: Slider(

value: _brightness,

min: 0,

max: 100,

onChanged: (v) {
```

```
setState(() => _brightness = v);

widget.onBrightnessChanged(v); // live update + BLE send

},

),

),

Padding(

padding:

const EdgeInsets.symmetric(horizontal: 4),

child: Row(

mainAxisAlignment:

MainAxisAlignment.spaceBetween,

children: [

Text('0%',

style: TextStyle(

color: Colors.grey.shade400,

fontSize: 11)),

Text('100%',

style: TextStyle(

color: Colors.grey.shade400,

fontSize: 11)),

],
```

```
),  
  
),  
  
]),  
  
const SizedBox(height: 16),  
  
// — Country —————  
  
_sectionCard(children: [  
  
  _sectionHeader(  
  
    CupertinoIcons.globe, 'Country'),  
  
    const SizedBox(height: 12),  
  
    Container(  
  
      padding: const EdgeInsets.symmetric(  
  
        horizontal: 14, vertical: 4),  
  
      decoration: BoxDecoration(  
  
        color: Colors.white,  
  
        borderRadius: BorderRadius.circular(12),  
  
        border: Border.all(  
  
          color: Colors.grey.shade200),  
  
        ),  
  
      child: DropdownButtonHideUnderline(  
  
        child: DropdownButton<String>(
```

```
value: _country,  
  
isExpanded: true,  
  
icon: Icon(  
  
  CupertinoIcons.chevron_down,  
  
  color: Colors.grey.shade400,  
  
  size: 16),  
  
style: const TextStyle(  
  
  color: Color(0xFF1A1A2E),  
  
  fontSize: 15),  
  
items: _countries  
  
  .map((c) => DropdownMenuItem(  
  
    value: c,  
  
    child: Text(c)))  
  
  .toList(),  
  
onChanged: (v) {  
  
  if (v != null) _saveCountry(v);  
  
},  
  
,  
  
,  
  
,  
  
]),
```

```
const SizedBox(height: 16),

// — Plan —————

_sectionCard(children: [

_sectionHeader(

CupertinoIcons.star, 'Plan'),

const SizedBox(height: 12),

..._plans.map((p) {

final selected = _plan == p;

return GestureDetector(

onTap: () => _savePlan(p),

child: Container(

margin: const EdgeInsets.only(bottom: 8),

padding: const EdgeInsets.symmetric(

horizontal: 16, vertical: 14),

decoration: BoxDecoration(

color: selected

? const Color(0xFF1A73E8)

.withOpacity(0.08)

: Colors.white,

borderRadius:

BorderRadius.circular(12),
```

```
border: Border.all(

color: selected

? const Color(0xFF1A73E8)

: Colors.grey.shade200,

width: selected ? 1.5 : 1,

),

),

child: Row(

mainAxisAlignment:

MainAxisAlignment.spaceBetween,

children: [

Row(children: [

Icon(

selected

? CupertinoIcons

.checkmark_circle_fill

: CupertinoIcons.circle,

color: selected

? const Color(0xFF1A73E8)

: Colors.grey.shade300,

size: 20,

),
```

```
const SizedBox(width: 12),

Text(p,

style: TextStyle(

fontSize: 15,

fontWeight: selected

? FontWeight.w600

: FontWeight.w400,

color: selected

? const Color(0xFF1A73E8)

: const Color(0xFF1A1A2E),

)),

]),

Text(

planPrices[p] ?? '',

style: TextStyle(

fontSize: 14,

fontWeight: FontWeight.w600,

color: selected

? const Color(0xFF1A73E8)

: Colors.grey.shade500,

),
```

```
),  
],  
),  
),  
);  
}),  
]),  
  
const SizedBox(height: 24),  
],  
),  
),  
  
// — Bottom bar —————  
  
Row(  
  
  mainAxisAlignment: MainAxisAlignment.spaceBetween,  
  
  children: [  
  
    TextButton.icon(  
  
      onPressed: widget.onLogout,  
  
      icon: Icon(CupertinoIcons.square_arrow_left,  
  
        size: 16, color: Colors.grey.shade400),  
  
      label: Text('Sign Out',
```

```
style: TextStyle(

color: Colors.grey.shade400,

fontSize: 13)),

),

IconButton.icon(

onPressed: _goHome,

icon: Icon(CupertinoIcons.house,

size: 16, color: Colors.grey.shade600),

label: Text('Home',

style: TextStyle(

color: Colors.grey.shade600,

fontSize: 13)),

),

],

),

],

),

),

),

);

}
```

```
Widget _sectionCard({required List<Widget> children}) {  
  
  return Container(  
  
    padding: const EdgeInsets.all(18),  
  
    decoration: BoxDecoration(  
  
      color: Colors.white,  
  
      borderRadius: BorderRadius.circular(18),  
  
      boxShadow: [  
  
        BoxShadow(  
  
          color: Colors.black.withOpacity(0.04),  
  
          blurRadius: 12,  
  
          offset: const Offset(0, 2),  
  
        ),  
  
      ],  
  
    ),  
  
    child: Column(  
  
      crossAxisAlignment: CrossAxisAlignment.start,  
  
      children: children),  
  
    );  
}
```

```
Widget _sectionHeader(IconData icon, String title) {  
  
  return Row(children: [  
  

```

```
Icon(icon, color: const Color(0xFF1A73E8), size: 18),

const SizedBox(width: 8),

Text(title,

style: const TextStyle(

fontSize: 16,

fontWeight: FontWeight.w700,

color: Color(0xFF1A1A2E))),

]);

}

}

// -----

// EDUCATION SCREEN

// -----

class EducationScreen extends StatelessWidget {

final Future<void> Function() onLogout;

const EducationScreen({super.key, required this.onLogout});

static const _videos = [

{

'title': 'App Setup & Use',

'duration': '6:42',

'locked': false,
```

```
},  
  
{  
  
  'title': 'Diabetes: A Comprehensive Guide',  
  
  'duration': '18:15',  
  
  'locked': false,  
  
},  
  
{  
  
  'title': 'Guide to Hyperglycemia',  
  
  'duration': '11:30',  
  
  'locked': true,  
  
},  
  
{  
  
  'title': 'Guide to Hypoglycemia',  
  
  'duration': '9:55',  
  
  'locked': true,  
  
},  
  
];  
  
@override  
  
Widget build(BuildContext context) {  
  
  return Scaffold(  
  
    backgroundColor: const Color(0xFFFF5F7FA),
```

```
body: SafeArea(  
  
  child: Padding(  
  
    padding:  
  
    const EdgeInsets.symmetric(horizontal: 24, vertical: 12),  
  
    child: Column(  
  
      crossAxisAlignment: CrossAxisAlignment.start,  
  
      children: [  
  
        const Padding(  
  
          padding: EdgeInsets.only(top: 12, bottom: 24),  
  
          child: Text('Education',  
  
            style: TextStyle(  
  
              fontSize: 32,  
  
              fontWeight: FontWeight.w800,  
  
              color: Color(0xFF1A1A2E))),  
  
        ),  
  
        Expanded(  
  
          child: ListView.separated(  
  
            itemCount: _videos.length,  
  
            separatorBuilder: (_, __) =>  
  
              const SizedBox(height: 14),  
  
            itemBuilder: (context, i) {
```

```
final v = _videos[i];

final locked = v['locked'] as bool;

return _VideoCard(

  title: v['title'] as String,

  duration: v['duration'] as String,

  locked: locked,

);

},

),

),

Padding(

  padding: const EdgeInsets.only(top: 8),

  child: Row(

    mainAxisAlignment: MainAxisAlignment.spaceBetween,

    children: [

      TextButton.icon(

        onPressed: onLogout,

        icon: Icon(CupertinoIcons.square_arrow_left,

          size: 16, color: Colors.grey.shade400),

        label: Text('Sign Out',

          style: TextStyle(
```

```
color: Colors.grey.shade400,  
  
fontSize: 13)),  
  
),  
  
TextButton.icon(  
  
onPressed: () => Navigator.pop(context),  
  
icon: Icon(CupertinoIcons.house,  
  
size: 16, color: Colors.grey.shade600),  
  
label: Text('Home',  
  
style: TextStyle(  
  
color: Colors.grey.shade600,  
  
fontSize: 13)),  
  
),  
  
],  
  
),  
  
),  
  
],  
  
),  
  
),  
  
),  
  
);  
  
}
```

```
}

// -----

// VIDEO CARD WIDGET

// -----

class _VideoCard extends StatelessWidget {

  final String title;

  final String duration;

  final bool locked;

  const _VideoCard({

    required this.title,

    required this.duration,

    required this.locked,

  });

  @override

  Widget build(BuildContext context) {

    return Container(

      decoration: BoxDecoration(

        color: Colors.white,

        borderRadius: BorderRadius.circular(16),

        boxShadow: [
```

```
BoxShadow(  
  
color: Colors.black.withOpacity(0.05),  
  
blurRadius: 10,  
  
offset: const Offset(0, 2),  
  
),  
  
],  
  
),  
  
child: Column(  
  
crossAxisAlignment: CrossAxisAlignment.start,  
  
children: [  
  
ClipRRect(  
  
borderRadius: const BorderRadius.vertical(  
  
top: Radius.circular(16)),  
  
child: AspectRatio(  
  
aspectRatio: 16 / 9,  
  
child: Container(  
  
color: locked  
  
? Colors.grey.shade200  
  
: const Color(0xFF1A1A2E),  
  
child: locked  
  
? Column(  
  

```

```
mainAxisAlignment: MainAxisAlignment.center,
```

```
children: [
```

```
Icon(CupertinoIcons.lock_fill,
```

```
color: Colors.grey.shade400, size: 36),
```

```
const SizedBox(height: 10),
```

```
Text('Locked',
```

```
style: TextStyle(
```

```
color: Colors.grey.shade500,
```

```
fontSize: 14,
```

```
fontWeight: FontWeight.w500)),
```

```
const SizedBox(height: 4),
```

```
Text('Upgrade to unlock',
```

```
style: TextStyle(
```

```
color: Colors.grey.shade400,
```

```
fontSize: 12)),
```

```
],
```

```
)
```

```
: Stack(
```

```
alignment: Alignment.center,
```

```
children: [
```

```
Container(
```

```
decoration: BoxDecoration(

gradient: LinearGradient(

begin: Alignment.topLeft,

end: Alignment.bottomRight,

colors: [

const Color(0xFF1A73E8)

.withOpacity(0.6),

const Color(0xFF1A1A2E),

],

),

),

),

),

Container(

width: 54,

height: 54,

decoration: BoxDecoration(

color: Colors.white.withOpacity(0.15),

shape: BoxShape.circle,

border: Border.all(

color:

Colors.white.withOpacity(0.6),
```

```
width: 2),
),
child: const Icon(
  CupertinoIcons.play_fill,
  color: Colors.white,
  size: 22),
),
Positioned(
  bottom: 10,
  right: 12,
  child: Container(
    padding: const EdgeInsets.symmetric(
      horizontal: 8, vertical: 3),
    decoration: BoxDecoration(
      color: Colors.black54,
      borderRadius:
        BorderRadius.circular(6),
    ),
    child: Text(duration,
      style: const TextStyle(
        color: Colors.white,
```



```
? Colors.grey.shade400

: const Color(0xFF1A1A2E),

),

),

),

if (locked)

Container(

padding: const EdgeInsets.symmetric(

horizontal: 10, vertical: 4),

decoration: BoxDecoration(

color: Colors.amber.shade50,

borderRadius: BorderRadius.circular(8),

border:

Border.all(color: Colors.amber.shade200),

),

child: Text('Pro',

style: TextStyle(

color: Colors.amber.shade800,

fontSize: 12,

fontWeight: FontWeight.w600)),

),
```

```
[,  
) ,  
) ,  
[ ,  
) ,  
) ;  
}  
}
```

**Conclusions/action items:**

We'll now have to test with the BLE making sure everything runs smoothly.

---

Claudia Beckwith - Apr 08, 2026, 1:00 PM CDT



[Download](#)

**main.dart (50.6 kB)**



## 2026/03/18 Establishing C6 Microcontroller as a BLE Device

---

Claudia Beckwith - Mar 18, 2026, 4:02 PM CDT

**Title:** Establish the C6 microcontroller as a BLE device so we can start to communicate with the phone

**Date:** 3/16

**Content by:** Claud

**Present:** claudia

**Goals:** I want to download the necessary packages to make the microcontroller exist as a BLE device to my phone

**Content:**

What it does:

makes the C6 identifiable through the nFR connect app on my phone. I can upload data to be read from my phone to confirm selection (in this case "Claud is a beast")

Arduino code and packages:

```
#include <BLEDevice.h>
```

```
#include <BLEUtils.h>
```

```
#include <BLEServer.h>
```

```
#define SERVICE_UUID "4fafc201-1fb5-459e-8fcc-c5c9c331914b"
```

```
#define CHARACTERISTIC_UUID "beb5483e-36e1-4688-b7f5-ea07361b26a8"
```

```
void setup() {
```

```
  Serial.begin(115200);
```

```
  BLEDevice::init("XIAO_ESP32C6"); // BLE device name
```

```
  BLEServer *pServer = BLEDevice::createServer();
```

```
  BLEService *pService = pServer->createService(SERVICE_UUID);
```

```
  BLECharacteristic *pCharacteristic = pService->createCharacteristic(
```

```
    CHARACTERISTIC_UUID,
```

```
    BLECharacteristic::PROPERTY_READ |
```

```
BLECharacteristic::PROPERTY_WRITE

);

pCharacteristic->setValue("Claud is a beast");

pService->start();

BLEAdvertising *pAdvertising = BLEDevice::getAdvertising();

pAdvertising->addServiceUUID(SERVICE_UUID);

pAdvertising->start();

Serial.println("BLE ready! Connect with nRF Connect app.");

}

void loop() {

delay(2000);

}
```

**Conclusions/action items:**

Now that this works, Ill program it to receive numbers from my phone.



## 2026/03/18 Configuring C6 Microcontroller to Receive

---

Claudia Beckwith - Mar 18, 2026, 4:13 PM CDT

**Title:** Configuring C6 Microcontroller to Receive

**Date:** 3/16

**Content by:** Claud

**Present:** claudia

**Goals:** I want to download the necessary packages to make the microcontroller receive a value through BLE from the phone and display it on the computer to confirm

**Content:**

What it does:

makes the C6 identifiable through the nFR connect app on my phone. I can the send UTF8 encoded messages to the microcontroller to and they show up on Arduino serial monitor

Arduino code and packages:

```
#include <BLEDevice.h>

#include <BLEUtils.h>

#include <BLEServer.h>

#define SERVICE_UUID "4fafc201-1fb5-459e-8fcc-c5c9c331914b"

#define CHARACTERISTIC_UUID "beb5483e-36e1-4688-b7f5-ea07361b26a8"

BLECharacteristic *pCharacteristic;

// This runs automatically when your phone writes a value

class MyCallbacks : public BLECharacteristicCallbacks {

void onWrite(BLECharacteristic *pCharacteristic) {

String value = pCharacteristic->getValue().c_str();

if (value.length() > 0) {

Serial.print("Received: ");
```

```
Serial.println(value);

}

}

};

void setup() {

Serial.begin(115200);

BLEDevice::init("XIAO_ESP32C6");

BLEServer *pServer = BLEDevice::createServer();

BLEService *pService = pServer->createService(SERVICE_UUID);

pCharacteristic = pService->createCharacteristic(

CHARACTERISTIC_UUID,

BLECharacteristic::PROPERTY_READ |

BLECharacteristic::PROPERTY_WRITE

);

pCharacteristic->setCallbacks(new MyCallbacks());

pCharacteristic->setValue("Waiting...");

pService->start();

BLEAdvertising *pAdvertising = BLEDevice::getAdvertising();

pAdvertising->addServiceUUID(SERVICE_UUID);
```

```
pAdvertising->start();
```

```
Serial.println("BLE ready! Waiting for a number...");
```

```
}
```

```
void loop() {
```

```
  delay(1000);
```

```
}
```

**Conclusions/action items:**

Now that this works, Ill program it to change colors based on the number received (corresponding to our glucose colors)



## 2026/03/18 Configuring C6 Microcontroller to Receive a number and Change color

Claudia Beckwith - Mar 18, 2026, 4:31 PM CDT

**Title:** Configuring C6 Microcontroller to Receive a number and change color accordingly

**Date:** 3/16

**Content by:** Claud

**Present:** claudia

**Goals:** I want to download the necessary packages to make the microcontroller receive a value through BLE from the phone and display it on the computer to confirm, then have the connected LED change color to match

**Content:**

What it does:

makes the C6 identifiable through the nFR connect app on my phone. I can the send UFT8 encoded messages to the microcontroller to and they show up on Arduino serial monitor and also changes the LED color though the D3 pin on the microcontroller.

Arduino code and packages:

```
#include <BLEDevice.h>
```

```
#include <BLEUtils.h>
```

```
#include <BLEServer.h>
```

```
#include <Adafruit_NeoPixel.h>
```

```
#define SERVICE_UUID "4fafc201-1fb5-459e-8fcc-c5c9c331914b"
```

```
#define CHARACTERISTIC_UUID "beb5483e-36e1-4688-b7f5-ea07361b26a8"
```

```
#define PIN D3
```

```
#define NUMPIXELS 7
```

```
Adafruit_NeoPixel jewel(NUMPIXELS, PIN, NEO_GRB + NEO_KHZ800);
```

```
BLECharacteristic *pCharacteristic;
```

```
void setAllPixels(uint32_t color) {
```

```
for (int i = 0; i < NUMPIXELS; i++) {

jewel.setPixelColor(i, color);

}

jewel.show();

}

uint32_t getColorForValue(int val) {

if (val < 55) return jewel.Color(255, 0, 0); // Red

else if (val >= 55 && val < 65) return jewel.Color(255, 100, 0); // Orange

else if (val >= 65 && val < 80) return jewel.Color(255, 200, 0); // Yellow

else if (val >= 80 && val < 139) return jewel.Color(0, 255, 0); // Green

else if (val >= 139 && val < 200) return jewel.Color(0, 0, 255); // Blue

else return jewel.Color(128, 0, 128); // Purple

}

class MyCallbacks : public BLECharacteristicCallbacks {

void onWrite(BLECharacteristic *pCharacteristic) {

String value = pCharacteristic->getValue().c_str();

if (value.length() > 0) {

int number = value.toInt();

Serial.print("Received: ");

Serial.println(number);

}
```

```
    setAllPixels(getColorForValue(number));

}

}

};

void setup() {

    Serial.begin(115200);

    // NeoPixel setup

    jewel.begin();

    jewel.setBrightness(100);

    jewel.show(); // Start off

    // BLE setup

    BLEDevice::init("XIAO_ESP32C6");

    BLEServer *pServer = BLEDevice::createServer();

    BLEService *pService = pServer->createService(SERVICE_UUID);

    pCharacteristic = pService->createCharacteristic(

        CHARACTERISTIC_UUID,

        BLECharacteristic::PROPERTY_READ |

        BLECharacteristic::PROPERTY_WRITE

    );

    pCharacteristic->setCallbacks(new MyCallbacks());
```

```
pCharacteristic->setValue("Waiting...");

pService->start();

BLEAdvertising *pAdvertising = BLEDevice::getAdvertising();

pAdvertising->addServiceUUID(SERVICE_UUID);

pAdvertising->start();

Serial.println("BLE ready! Send a number to control the LEDs.");

}

void loop() {

delay(1000);

}
```

**Conclusions/action items:**

Now that this works, want to integrate it to receive numbers through my created flutter app and not the nRF app.



## 2026/03/08 Arduino Continuously Advertising for BLE connection

---

Claudia Beckwith - Apr 08, 2026, 1:03 PM CDT

**Title:** Upgrading Arduino to continuously display the microcontroller as an active BLE connection device

**Date:** 4/8/26

**Content by:** claudia

**Present:** claudia

**Goals:** Following the feedback received from show and tell, I want to update the Arduino code so that our C6 is shown as available for the entire duration of use, not just the initial connection. This will help with pairing/unpairing of the device without the need for a total reset.

**Content:**

```
#include <BLEDevice.h>
```

```
#include <BLEUtils.h>
```

```
#include <BLEServer.h>
```

```
#include <Adafruit_NeoPixel.h>
```

```
#define SERVICE_UUID "4fafc201-1fb5-459e-8fcc-c5c9c331914b"
```

```
#define CHARACTERISTIC_UUID "beb5483e-36e1-4688-b7f5-ea07361b26a8"
```

```
#define PIN D3
```

```
#define NUMPIXELS 7
```

```
Adafruit_NeoPixel jewel(NUMPIXELS, PIN, NEO_GRB + NEO_KHZ800);
```

```
BLECharacteristic *pCharacteristic;
```

```
bool deviceConnected = false;
```

```
// — Helpers —————
```

```
void setAllPixels(uint32_t color) {
```

```
for (int i = 0; i < NUMPIXELS; i++) {

    jewel.setPixelColor(i, color);

}

jewel.show();

}

uint32_t getColorForValue(int val) {

    if (val < 55) return jewel.Color(255, 0, 0); // Red

    else if (val >= 55 && val < 65) return jewel.Color(255, 65, 0); // Orange

    else if (val >= 65 && val < 80) return jewel.Color(255, 200, 0); // Yellow

    else if (val >= 80 && val < 139) return jewel.Color(0, 255, 0); // Green

    else if (val >= 139 && val < 200) return jewel.Color(0, 0, 255); // Blue

    else return jewel.Color(128, 0, 128); // Purple

}

// — BLE Characteristic Callback —————

class MyCallbacks : public BLECharacteristicCallbacks {

    void onWrite(BLECharacteristic *pCharacteristic) {

        String value = pCharacteristic->getValue().c_str();

        if (value.length() == 0) return;

        if (value.startsWith("B")) {

            int brightness = value.substring(1).toInt();
```

```
int mapped = map(brightness, 0, 100, 0, 255);
```

```
jewel.setBrightness(mapped);
```

```
jewel.show();
```

```
Serial.print("Brightness set to: ");
```

```
Serial.print(brightness);
```

```
Serial.println("%");
```

```
} else {
```

```
int glucose = value.toInt();
```

```
Serial.print("Glucose received: ");
```

```
Serial.println(glucose);
```

```
setAllPixels(getColorForValue(glucose));
```

```
}
```

```
}
```

```
};
```

```
// — BLE Server Callbacks (FIX) —————
```

```
class MyServerCallbacks : public BLEServerCallbacks {
```

```
void onConnect(BLEServer* pServer) {
```

```
deviceConnected = true;
```

```
Serial.println("Client connected");
```

```
}
```

```
void onDisconnect(BLEServer* pServer) {

deviceConnected = false;

Serial.println("Client disconnected");

// Restart advertising so it shows up again

BLEDevice::startAdvertising();

Serial.println("Advertising restarted");

}

};

// — Setup —————

void setup() {

Serial.begin(115200);

// NeoPixel init

jewel.begin();

jewel.setBrightness(100);

jewel.show();

// BLE init

BLEDevice::init("XIAO_ESP32C6");

BLEServer *pServer = BLEDevice::createServer();

pServer->setCallbacks(new MyServerCallbacks()); // <-- important
```

```
BLEService *pService = pServer->createService(SERVICE_UUID);
```

```
pCharacteristic = pService->createCharacteristic(
```

```
CHARACTERISTIC_UUID,
```

```
BLECharacteristic::PROPERTY_READ |
```

```
BLECharacteristic::PROPERTY_WRITE
```

```
);
```

```
pCharacteristic->setCallbacks(new MyCallbacks());
```

```
pCharacteristic->setValue("Waiting...");
```

```
pService->start();
```

```
// Advertising setup
```

```
BLEAdvertising *pAdvertising = BLEDevice::getAdvertising();
```

```
pAdvertising->addServiceUUID(SERVICE_UUID);
```

```
pAdvertising->setScanResponse(true);
```

```
pAdvertising->setMinPreferred(0x06);
```

```
pAdvertising->setMinPreferred(0x12);
```

```
BLEDevice::startAdvertising();
```

```
Serial.println("BLE ready – waiting for glucose values.");
```

```
}
```

```
// — Loop —————
```

```
void loop() {  
  
  delay(1000);  
  
}
```

**Conclusions/action items:**

We need to make sure this code is still running and compatible with the new circuitry configuration.



## 2026/04/15 BLE Updates for Failure Detection

---

Claudia Beckwith - Apr 15, 2026, 2:46 PM CDT

**Title:** BLE Arduino Updates for failure detection

**Date:** 4/15/2026

**Content by:** claudia

**Present:** claudia

**Goals:** I want to update our microcontroller for the added feature of pulsing white after 12 minutes with no new signal. This will show a malfunction to anyone supervising a child wearing this device. I also want to tweak the yellow and purple colors to make them a little clearer to understand.

**Content:**

```
#include <BLEDevice.h>
```

```
#include <BLEUtils.h>
```

```
#include <BLEServer.h>
```

```
#include <Adafruit_NeoPixel.h>
```

```
#define SERVICE_UUID "4fafc201-1fb5-459e-8fcc-c5c9c331914b"
```

```
#define CHARACTERISTIC_UUID "beb5483e-36e1-4688-b7f5-ea07361b26a8"
```

```
#define PIN D3
```

```
#define NUMPIXELS 7
```

```
#define TIMEOUT_MS 720000 // 12 minutes is 900_000
```

```
Adafruit_NeoPixel jewel(NUMPIXELS, PIN, NEO_GRB + NEO_KHZ800);
```

```
BLECharacteristic *pCharacteristic;
```

```
bool deviceConnected = false;
```

```
unsigned long lastDataTime = 0;
```

```
bool timeoutActive = false;
```

```
// — Helpers —————
```

```
void setAllPixels(uint32_t color) {
```

```
for (int i = 0; i < NUMPIXELS; i++) {
```

```
    jewel.setPixelColor(i, color);
```

```
}
```

```
jewel.show();
```

```
}
```

```
uint32_t getColorForValue(int val) {
```

```
if (val < 55) return jewel.Color(255, 0, 0);
```

```
else if (val < 65) return jewel.Color(255, 65, 0);
```

```
else if (val < 80) return jewel.Color(255, 255, 0);
```

```
else if (val < 139) return jewel.Color(0, 255, 0);
```

```
else if (val < 200) return jewel.Color(0, 0, 255);
```

```
else return jewel.Color(180, 0, 180);
```

```
}
```

```
// — Pulse Animation —————
```

```
void pulsewhite() {
```

```
    static int brightness = 0;
```

```
    static int fadeAmount = 5;
```

```
brightness += fadeAmount;

if (brightness <= 0 || brightness >= 230) { // ~90% max (255 * 0.9 ≈ 230)

fadeAmount = -fadeAmount;

}

uint32_t color = jewel.Color(brightness, brightness, brightness);

setAllPixels(color);

delay(30); // controls pulse speed

}

// — BLE Characteristic Callback —————

class MyCallbacks : public BLECharacteristicCallbacks {

void onWrite(BLECharacteristic *pCharacteristic) {

String value = pCharacteristic->getValue().c_str();

if (value.length() == 0) return;

// Reset timeout timer on ANY valid write

lastDataTime = millis();

timeoutActive = false;

if (value.startsWith("B")) {

int brightness = value.substring(1).toInt();

int mapped = map(brightness, 0, 100, 0, 255);
```

```
jewel.setBrightness(mapped);

jewel.show();

Serial.print("Brightness set to: ");

Serial.print(brightness);

Serial.println("%");

} else {

int glucose = value.toInt();

Serial.print("Glucose received: ");

Serial.println(glucose);

setAllPixels(getColorForValue(glucose));

}

}

};

// — BLE Server Callbacks —————

class MyServerCallbacks : public BLEServerCallbacks {

void onConnect(BLEServer* pServer) {

deviceConnected = true;

Serial.println("Client connected");

}
```

```
void onDisconnect(BLEServer* pServer) {

deviceConnected = false;

Serial.println("Client disconnected");

BLEDevice::startAdvertising();

Serial.println("Advertising restarted");

}

};

// — Setup —————

void setup() {

Serial.begin(115200);

jewel.begin();

jewel.setBrightness(100);

jewel.show();

lastDataTime = millis(); // start timer

BLEDevice::init("XIAO_ESP32C6");

BLEServer *pServer = BLEDevice::createServer();

pServer->setCallbacks(new MyServerCallbacks());

BLEService *pService = pServer->createService(SERVICE_UUID);

pCharacteristic = pService->createCharacteristic(
```

```
CHARACTERISTIC_UUID,  
  
BLECharacteristic::PROPERTY_READ |  
  
BLECharacteristic::PROPERTY_WRITE  
  
);  
  
pCharacteristic->setCallbacks(new MyCallbacks());  
  
pCharacteristic->setValue("Waiting...");  
  
pService->start();  
  
BLEAdvertising *pAdvertising = BLEDevice::getAdvertising();  
  
pAdvertising->addServiceUUID(SERVICE_UUID);  
  
pAdvertising->setScanResponse(true);  
  
pAdvertising->setMinPreferred(0x06);  
  
pAdvertising->setMinPreferred(0x12);  
  
BLEDevice::startAdvertising();  
  
Serial.println("BLE ready - waiting for glucose values.");  
  
}  
  
// — Loop —————  
  
void loop() {  
  
  unsigned long currentTime = millis();
```

```
// Check for timeout
```

```
if ((currentTime - lastDataTime) > TIMEOUT_MS) {
```

```
    timeoutActive = true;
```

```
}
```

```
if (timeoutActive) {
```

```
    pulseWhite(); // run animation continuously
```

```
} else {
```

```
    delay(100); // normal idle
```

```
}
```

```
}
```

#### Conclusions/action items:

I need to test this feature to make sure it works at the correct intervals.

---

Claudia Beckwith - Apr 15, 2026, 2:47 PM CDT



[Download](#)

**BLE\_with\_failure\_detection.ino (5.08 kB)**



## 2026/02/17 BLE, Wi-Fi, or Combo (feasibility and replication)

---

Claudia Beckwith - Feb 17, 2026, 4:15 PM CST

**Title:** BLE, wifi, or combo, assessing feasibility and replication potential

**Date:** 2/17/2026

**Content by:** claudia

**Present:** claudia

**Goals:** I want to evaluate our three software design ideas based on how feasible and replicable they are. This information will go into our design matrix to help determine our final design that we work towards for the rest of the semester. I will use my research to make informed decisions on each criteria.

**Content:**

Feasibility:

Between the three designs, implementing BLE 5.0 connectivity is the most straightforward. It does not require a backend, and iOS provides native BLE support through CoreBluetooth, making device discovery and Generic Attribute Profile (GATT) communication well-defined and standardized. A Wi-Fi 6 design increases complexity because the microcontroller must first be provisioned with network credentials and then maintain a reliable IP connection. It may also encounter issues on managed networks that use captive portals or client isolation policies, where embedded devices are often blocked [1][2]. The hybrid model is the most complex, requiring both BLE and Wi-Fi implementation plus connection-state management logic to allow the system to seamlessly jump between BLE and Wi-Fi, adding more edge cases and testing.

Replicability:

In terms of replication, a BLE 5.0 system is the most scalable when deploying many XIAO microcontrollers, each paired to its own iPhone. Because BLE does not rely on shared network infrastructure or backend coordination, each device/phone pair operates independently. Additionally, by assigning each microcontroller with a unique BLE identifier, the iOS app can easily scan, select, and store the device for easy reconnection. In contrast, a Wi-Fi 6 system makes replication much more difficult, as each device must be configured to the local network. A hybrid model further complicates replication because both communication stacks must be maintained and tested across multiple units [3].

**Sources:**

[1] K. Oliynyk, "Bluetooth vs WiFi for IoT Projects: Which is Better?," WebbyLab, Mar. 25, 2025. [Online]. Available: <https://webbylab.com/blog/bluetooth-vs-wifi-for-iot-project/>. [Accessed: Feb. 9, 2026].

[2] M. Afaneh, "Bluetooth LE for Wi-Fi Onboarding and IoT Provisioning," Novel Bits, Feb. 11, 2026. [Online]. Available: <https://novelbits.io/ble-wifi-onboarding-provisioning/>. [Accessed: Feb. 9, 2026].

[3] B. Marnat, "BLE or Wi-Fi: What You Need to Know," ELA Innovation, Sep. 8, 2025. [Online]. Available: <https://elainnovation.com/en/ble-vs-wi-fi-what-you-need-to-know/>. [Accessed: Feb. 9, 2026].

**Conclusions/action items:**

Based on these criteria, I will encourage my team to move forward with a BLE only design. It is going to be the easiest to create and replicate. I didn't realize how big of a limitation the captive portals would be for IoT devices on school networks, which would not work for our project.

**2025/03/04 Lab Training**

Claudia Beckwith - Mar 04, 2025, 4:4

**Title:** lab training**Date:** 3/4/25**Content by:** claudia**Present:** claudia**Goals:** complete lab trainings**Content:**

This certifies that Claudia Beckwith has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	9/8/2024	9/8/2029
Chemical Safety: The OSHA Lab Standard	Final Quiz	9/8/2024	

Data Last Imported: 03/03/2025 11:27 PM

**Conclusions/action items:**

do labs



# 2026/03/16 LinkedIn Learning Six Sigma Foundations Training

Claudia Beckwith - Mar 17, 2026, 4:59 PM CDT

**Title:** Six Sigma Foundations Training - LinkedIn Learning

**Date:** 3/16/2026

**Content by:** claudia

**Present:** claudia

**Goals:** I want to learn about the foundations of six sigma and how they can be applied to the BME design process.

**Content:**



pdf attached below

**Conclusions/action items:**

Now that I have an understanding of how different processes are evaluated, tested, and improved, I can apply these principles to my own life.

Claudia Beckwith - Mar 17, 2026, 4:54 PM CDT





[Download](#)

**CertificateOfCompletion\_Six\_Sigma\_Foundations\_Applying\_Design\_for\_Six\_Sigma.pdf (64 kB)**



## 2026/01/28 Lecture 2

---

Claudia Beckwith - Jan 28, 2026, 1:55 PM CST

### **Title: Article Searching, source evaluation, and citation management**

**Date:** 1/28/26

**Content by:** claudia

**Present:** 301

**Goals:** I want to learn about how to find and evaluate sources for the purposes of researching for our project. I want to learn about the use of AI in searching as well, as I understand it can be a super valuable tool when used properly. I also am interested on how to find similar articles when I find one that is helpful/resonating.

### **Content:**

AI in research:

- don't evaluate for accuracy
- can make up sources
- don't respond consistently
- don't assess bias, may not be current
- can't always access paid databases (which wisconsin provides)

Evaluate/finding sources:

- can search/narrow down databases on the library webpage
- scopus is a good place to start, very broad, not restrained to engineering specific
  - typically an abstract only database, can link to other databases that could
- search tips:
  - narrowing down
    - add more key words
    - narrow down range of years
    - selecting document type
  - expanding
    - checking referenced/similar articles
- evaluating
  - relevant: what is it about
  - authority: who made it, what are their credentials
  - quality: why was it written and how does it affect the information
    - trade journals are often more positive/bias
  - currency: when was it created

Citation manager:

- "save to zotero" extension on webpages
- can add tags/folders
- option to start a group library for group projects
- makes it super easy to format the sources

Technical Reports:

- usually the result of federal funds, timely updates on the research
- produced by companies, universities, and government labs
- includes things that went wrong
- not usually peer reviewed
- database examples (DTIC - defense, NTRL - commerce, OSTI - energy)
- free

**Conclusions/action items:**

---

Claudia Beckwith - Feb 04, 2026, 8:55 AM CST

**Conclusions:**

Based on the information in this lecture, I have a really strong idea of searching using provided databases. This gives me a solid start when I start my additional research about the impacts of T1D on children and their families. My part of the PDS focuses on more of the global impacts along with the safety/accuracy requirements, and I think the literature will be strong on these topics.

**Action Items:**

- cover letter, resume, job posting
- 4 research articles
- order materials



## 2026/02/04 Lecture 3

---

Claudia Beckwith - Feb 04, 2026, 2:29 PM CST

**Title:** Lecture 3 - peer resume feedback

**Date:** 2/4/26

**Content by:** claudia

**Present:** 301s

**Goals:** I want to give and receive feedback about my resume and cover letter that will help me prepare for real-world experiences.

**Content:**

BME Students' Focus:

- internships
- networking
- professional writing
- communication
- research

Peer Review:

- focus on how the cover letter/resume relate to the job posting
- specificity is helpful
- abide to the rubric

Comments on my resume and cover letter:

- combine company/job position/date onto one line
- bold or otherwise indicate the start of new roles
- cover letter gets straight to the point, which is good
- lots of references to buzz words in the job posting
- add spaces between engineering experience section in resume
- internship first because more relevant?
- make sure gaps are consistent between sections

**Conclusions/action items:**

I think my feedback was really helpful and I have a good idea of the things I need to change. Visually, my resume could be improved a little bit, but my cover letter was strong. Also good skills emphasis.

- upload photos of my marked up resumes/cover letters
- update resume and cover letter



## 2026/02/11 Lecture 4

Claudia Beckwith - Feb 11, 2026, 2:31 PM CST

### Title: Presentation tips and job interviews

Date: 2/11/2026

Content by: claudia beckwith

Present: 301s

**Goals:** I want to get some advice about how to interview well and tips on presenting. Our preliminary presentations are next week, so it would be helpful to learn how to be a better presenter. I also want to learn how to better market myself in a job interview.

### Content:

Presentation tips:

- layout and content
  - never have a single hanging bullet
  - top bullets align
  - consistent font style
  - logical flow
    - not always chronological
    - design ideas should be presented in the same order in all places (intl designs and design matrix)
  - don't use pictures you will not discuss
  - 6x6 rule
    - 6 words x 6 lines per slide
    - 1 minute per slide
- audience engagement
  - so what? use impact to stimulate interest
  - attitude, don't talk down
  - be excited
  - mannerisms
    - talk to audience, not looking at screen
  - design matrix
    - hit on highlights!
    - most important stuff first
    - cannot cover everything
  - short titles, capture attention
- figures
  - images: Figure X. [What it is], showing/highlighting [key features], [cite if needed]
  - ex. Figure 4. Dimensioned engineering drawing of the blade carriage (units:mm), highlighting tolerance- controlled guide rail spacing.
  - graphs: Figure X
  - no CAD drawings, do the nice images
  - not everything needs to be a CAD drawing, detailed sketch is fine, background removed
  - graph results, never raw data
  - appropriate font sizes
  - comparable axis values
  - use stats
    - appropriate sample size
    - p value, averages, etc
  - "visualize, and describe context of use"
    - tell stories through figures
    - exploded view showing components
    - use block diagrams

## Interviewing

- bring a small portfolio
  - design projects
  - resume
  - even bringing physical designs
- ways to stand out
  - projects
  - societies
  - conferences
  - student assistant roles
  - technical skills
  - soft skills
  - industry shadowing
- be prepared to ask common questions
- ask thoughtful questions
- reference specific products and/or company policies

Job interview activity:

see attached PDF

### **Conclusions/action items:**

I have a better idea of some technical key details to consider as I make my presentation. These slides will be really helpful in planning. I also liked the access to all the interview questions that were not just the usual "tell me about yourself" type. It will be helpful to reference in the future.

- submit job interview responses
- printout slides of prelim presentation slides
- notebook check #3 due friday
- finish design matrix

BME 301: Job Interviewing

## Job Interviewing

### Prior to class

Read the guidance provided by ECS: <https://ecs.uvic.ca/education/industry/industry/> including the ECS Job Search Guide – INTERVIEWING pdf found at the link above. (You do not have to do so professionally for this activity.)

Read/like the interview questions provided below and prepare for a conversation with your peers based on the in-class activity.

### During class

1. Form groups of 3. You will each pick 3 questions off of the list of example interview questions below. Each person must pick different questions within your group.
2. Type a brief answer to each chosen question (a 1-minute copy of this guide and type your responses below).
3. Take turns sharing your answers with your group members (omit 1 with one of the questions each, then keep taking turns until everyone has a chance to go). After listening to your group members' answers, note what you liked about their responses, and add to their response (both verbally and in your notes) if you have suggestions.
4. Each answer should be no more than 1-2 minutes in length.
5. Each post-answer discussion should be no more than 2 minutes in length.

## Interview questions

While engineering recruits will often ask you a number of technical questions to ensure you have the skills that they need, they will often choose a set of behavioral questions to determine what kind of employee you might be and how you handle non-technical situations. Familiarize yourself with these sorts of questions so that you are not surprised by them in an interview.

1. **Talk about a weakness or challenge you've had to overcome in your life.**

One challenge I have needed to overcome is public speaking. I used to struggle with how public speaking or presenting in front of others. I always felt my voice getting really shaky and I didn't feel prepared ideas. Then my speech fully memorized and could essentially zone out and recite my notes word-for-word. I challenged myself to high school by taking an advanced speech class that helped me start to develop confidence in creating them a script, but I still only felt comfortable speaking in front of people I knew well. After struggling in a presentation in an internship, I made it a goal of mine to get more comfortable in front of audiences I didn't know. I challenged myself to run for president of my club, a role I knew would require leading and presenting at meetings to large groups. While initially intimidating, the experience strengthened my confidence and adaptability. I also started teaching fitness classes, which helped me feel

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1

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Claudia\_Beckwith\_BME\_301\_-\_Job\_interview\_activity.pdf (106 kB)



## 2026/02/13 BPAG meeting

Claudia Beckwith - Feb 13, 2026, 12:22 PM CST

**Title:** BPAG

**Date:** 2/13/2026

**Content by:** claudia

**Present:** BPAGS

**Goals:** I want to get a refresher of the policies for BPAG, even though I already have an established system with our client in regards to making purchasing requests. I want to know what I need to add in my notebook as BPAG.

**Content:**

easiest method:

- client orders for you

my job

- expenses approved by client
- anything over 1k needs department approval and client approval
- keep track of purchases
- all original detailed receipts in the notebook
- table of expenses in the notebook, prog report, and actual reports

client and project type (affiliation)

- not UW funds is easier
- UW funds is ok if client buys, hard to get reimbursed
- 90 day reimbursement rule
- check preferred vendors on shop uw +
  - applies to UW funds
  - link on [shopuwplus.wis.edu/catalog-supplies](http://shopuwplus.wis.edu/catalog-supplies)
  - client must order
  - \*\*\*\*check NEWARK for electrical components
- we are tax exempt
- if no UW affiliation, submit request for BME funding (not applicable for our project)
- shipping
  - client sends to themselves, we've been getting them from our client

Design Lab

- 3D printing
- expertise
- \$50/team already set up
  - account name is BMEDesign
- mini-mart, arduinos, electronic components, plastics, wires, etc
- if \$50 budget is exceeded, clients can set up an account with a funding string
  - needs to be UW affiliated
  - you complete the tem info excel sheet for your client and send to client
- can also buy myself and seek reimbursement
- ECB room has a lot of random tools, can charge to BMEDesign account or sometimes its free

non-reimbursed expenses

- notebook

- poster presentation

accounting table

- include all vital info
- break up into last semester's and this semester's project
- break up in prototyping and final
- make it visually appealing

can request funding from BME if client isn't able to

**Conclusions/action items:**

I have a better understanding of the rules for a BPAG. Our client makes it really easy for us by ordering everything and then they give it to us. I need to remember to add the receipts in LabArchives from our purchases.



## 2026/02/18 Lecture 5

---

Claudia Beckwith - Feb 20, 2026, 11:38 AM CST

**Title:** Lecture 5 - prelim presentation review

**Date:** 2/18/26

**Content by:** claudia

**Present:** 301s

**Goals:** I want to get and implement feedback on our prelim presentation slides before we present on Friday. We will also give feedback to another group.

**Content:**

General feedback of things to change on our slides:

- make problem statement into bullets
- no side view of old circuit
- change wording on PDS
- shorten PDS slide
- some format issues (em dash vs hyphen, colon vs no colon)

**Conclusions/action items:**

We have implemented the necessary changes for our presentation and will be ready to go for friday. We will have to rehearse plenty before we actually present, but we're in a really good place right now.



## 2026/02/25 Lecture 6

Claudia Beckwith - Feb 25, 2026, 1:52 PM CST

### Title: Diversity and inclusion in design

Date: 2/25/26

Content by: claudia

Present: 301s

Goals: I want to understand how I can be more mindful of diversity and inclusion in regards to our design.

### Content:

What does diversity mean to my team and me:

- being mindful of people from different backgrounds
- making acomodations for different sizes of people
- targeting to a larger demographic
- being mindful of cost of material, can be a barrier for some people
- invitiiing other perspectives in the design process
- having a wide variety of skillsets of the team
- taking cultural and religious beliefs into consideration

what does universal design mean

- targeting different cultures, races, ethnicities, religions, ability statuses, socioeconomic statuses, gender statuses, sizes
- using a broad demographic in testing
- adding additional text or captioning for people who are hard of hearing or sight
- designing for all people, to the greatest extent possible, without the need for adaptation
- not designing for the "average user"

principles of universal design

1. equitable use - aesthetics, safety, privacy, appealing
2. flexibility in use - choice in use or pase
3. simple and intuitive use - easy regardless of users knowledge, language, eliminate unnecessary complexity, providing effecive feedback during use
4. perceptible info - design communicates regardless of ambient conditions
5. tolerance for error - minimizing hazards from unintended use
6. low physical effort - ergonomical
7. size and space for approach and use - works regardless of body size, posture, or mobility

how does this all relate to ethics

- its ethical to target to as many as possible and not exclude or discriminate
- ethically we should be helping as many people as possible

### Conclusions/action items:

We want to see how the 7 principles of universal design can apply to our project specifically. We'll look at what we've done and what else can be done to make our device as intuitive and accessable to our target demographic of wearers and users. We'll then share our work with others in the class.



## 2026/03/04 Lecture 7

Claudia Beckwith - Mar 04, 2026, 2:16 PM CST

**Title:** lecture 7

**Date:** 2/4/26

**Content by:** claudia

**Present:** 301s

**Goals:** I want to learn about patenting and how to find relevant patents. I will need to do some research for our project and I think it will be helpful to learn about tips, tricks, resources, and strategies in doing so.

**Content:**

standards:

- ASTM
- ASABE
- IEEE
- option to request a standard form through library

business databases for more info on companies and consumer trends

library research databases

patents and prior art:

- patent examiners evaluate applications against prior art
  - inventions disclosed in US and foreign patents and applications
  - inventions in publications
  - inventions currently for sale or in public use
- Ex. spondee
  - patent for a bouncing squirrel feeder
  - lens.org is a good database for finding patents
- expanding the search
  - AND / OR statements
  - cited by
  - biological search
  - sorting options
  - filters
  - CPC classifications
    - categorize inventions
    - find related ones
    - search within this group using key words
- patents evaluate for
  - usefulness, is it actually working and stuff
  - novelty
  - non-obviousness
- patent claims
  - define legally enforceable aspects of patent
  - every utility patent has at least one claim
  - each claim is 1 sentence
  - independent claims and dependent claims
    - independent = standalone
    - dependent = must refer to another claim
  - other patents can often sneak around existing patents with their different wording of claims
    - the second one focuses more on the squirrel-ness of it

- the spring mechanism are slightly different

We found the patent for the glowcose, one of our competitors. Attached below.

**Conclusions/action items:**

It was interesting to learn about all the patenting stuff because it will become applicable when we start looking into the Tong award. We also will need to be mindful of what can and cannot be advertised for the purposes of sharx tank competition as well.

Claudia Beckwith - Mar 04, 2026, 2:10 PM CST

United States Patent Application Publication

Pat. No. US 2024/0032876 A1

Pub. No.	Pub. Date	Pub. No.	Pub. Date
2024/0032876 A1	Feb. 1, 2024	2024/0032876 A1	Feb. 1, 2024

710, 720, 730, 750

700

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US20240032876A1.pdf (1.03 MB)



## 2020/03/6 Tong Lecture

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Claudia Beckwith - Mar 11, 2026, 3:29 PM CDT

**Title:** Tong Lecture Reflection by Justin Williams

**Date:** 3/6/2026

**Content by:** claudia

**Present:** all bme!

**Goals:** I want to understand the story of Justin Williams and how he got to the successful position he's in today.

**Content:**

grew up in a small town

college because of track scholarship

working on scoreboards, wanted to do more

lots of startups, failed a lot!

companies got bought out to be destroyed, bought one back

working with surgeon to develop epilepsy tracker and cure that is flexible to the brain

using mechanics of materials to think about increasing flexibility

**Conclusions/action items:**

The main takeaways I got from his lecture were the importance of persistence and seeing opportunities as the chance to improve. despite setback after setback, he continued building new companies and startups based on things he saw could be improvements in the medical field. He also surrounded himself with a great team of people that helped him to expand and capitalize even more on his own thoughts. I think who you surround yourself with says a lot about who you are and what kind of things you'll be capable of, so that is a lesson I will keep in mind. I also really liked the story of how his patent drawings ended up in Grey's Anatomy!



## 2026/03/11 Lecture 8

---

Claudia Beckwith - Mar 11, 2026, 1:51 PM CDT

**Title: Fabrication Plans**

**Date:** 3/11/2026

**Content by:** claudia

**Present:** 301

**Goals:** I want to learn about making fabrication plans including the process of documenting and executing.

**Content:**

Low fidelity is good to start early, making cardboard prototypes and such

circuit diagrams and circuit testing

testing fittings/connection points

simple calculations

free body diagrams

mechanics of materials

materials:

- keep detailed list and expense table
- starting metrics
- manufacturer and part number
- material purpose
- list of equipment used in manufacturing
- must be repeatable by unfamiliar reader
- include gCode file for 3D printed parts

methods

- be super specific
- ex. mix vigor, time, ending consistency
- ex cut tool, size, machine,
- must be repeatable by unfamiliar reader
- differentiate the sections/components
- add sketches for each component
- testing plan should match fabrication plan
- $n \geq 3$
- controls
  - negative
  - positive
  - experimental
- consult PDS for critical criteria to be tested
- each fabricated component must be tested (software, light, backend flow)

results:

- add photos
- physical descriptions
- labels
- units
- measurements

considerations:

- not everything that can be made in 3d printing can be made with other methods
- ask for help, seek professional advice
- use field experts
- 

**Conclusions/action items:**

We want to develop a fabrication protocol that includes the things we learned about in lecture. We're going to focus on the protocol for soldering the battery, microcontroller, and LED together. We will need this done before next week's lecture.



## 2026/03/18 Lecture 9

Claudia Beckwith - Mar 18, 2026, 1:39 PM CDT

**Title:** Lecture 9

**Date:** 3/18/2026

**Content by:** claudia

**Present:** 301

**Goals:** We want to learn about how to get the most out of show and tell, happening this Friday. We need to come up with a 1 minute pitch for show and tell and 5 minutes at the final presentation.

**Content:**

Elevator pitch:

- succinctly and effectively communicate your ideas
- goals
  - capture attention
  - generate interest
  - leave memorable impression
- prep
  - know audience
  - practice
  - be authentic
  - keep it simple
  - adapt and iterate
- structure
  - attention grabber
  - intro: were working on project X
  - value proposition: that is trying to solve (customer, specific problem)
  - benefits
  - call to action

Tong award:

- intro: hi my name is and our project is the ....
- attention grabber: we developed a device to do X
- value proposition: currently there isn't a device to do X as existing technologies and patents fail because of Y
- benefits: it's estimated that Z people would benefit from this device which has a potential market of \$, we've filed with WARF.  
\*demonstrate prototype fully"
- call to action: do you have any questions
- overall goals
  - how big is the market
  - how are we unique and novel, what corner of the market do we have

Overall skills:

- enthusiasm
- eye contact
- tailor pitch to different audiences
- don't overwhelm with unnecessary details (no one gaf)
- listen and engage
- don't be too rehearsed

executive summary (later in the sem):

- concise overview
- captures attention and conveys key info
- enables quick understanding
- no references
- outline
  - intro
  - prob statement
  - solution
  - benefits
  - recommendations
- tips
  - know audience
  - focus on essentials
  - clear and concise
  - key points
  - professional

#### abstract

- purpose
  - clear, concise, specific summary
  - 150-300 words, usually 250
  - write it last
- structure
  - background/context
  - objective
  - methods
  - results and analysis
  - discussion/conclusion
  - future work?

#### reports

- make them shorter
- don't explain the obvious
- avoid conversational text
- spell out acronyms when first introduced
- don't include raw data
- proofread thoroughly
- no prelim designs in final report

#### **Conclusions/action items:**

I will have to decide which award to run for in award selection on the website (done)

We should develop an elevator pitch for show and tell and have a general outline



## 2026/03/25 Lecture 10

---

Claudia Beckwith - Apr 28, 2026, 11:31 AM CDT

**Title:** Lecture 10

**Date:** 3/25/26

**Content by:** claudia

**Present:** 301s

**Goals:** I want to learn about ethics in engineering and how it relates to our project and design process.

**Content:**

ethics can stem from

- personal values
- cultural/societal norms
- professional standards

Important distinction:

- Personal ethics = what YOU believe is right
- Professional ethics = what you are expected to do as an engineer

applications:

- communication
- teamwork
- leadership
- ethics itself

BME Code of Ethics: Exists to guide decision making in real scenarios

Important for:

- patient safety
- honesty in reporting data
- responsibility to society

Steps (same mindset as design):

1. Identify the problem (is there an ethical dilemma?)
2. Understand the situation fully
3. Brainstorm possible actions
4. Evaluate solutions
5. Choose + implement

Ethical Decision-Making Framework

-First step = awareness

Then consider:

- Stakeholders: patients, doctors, engineers, companies, public
- Options: multiple possible actions (not just yes/no)

Core Tests

- Publicity test: would I be okay if this decision was public?
- Reversibility test: would I be okay if I was the one affected?
- Universality test: what if EVERYONE did this?

#### Additional Tests

- Respect for persons: does this respect rights/dignity?
- Utilitarian: greatest good for greatest number?
- Social justice: does this unfairly impact vulnerable groups?

#### Application to Design Project

- Every design has ethical dimensions
- safety vs cost
- performance vs accessibility
- risk vs innovation

#### What we need to do

- Identify: where ethical issues could arise in our design
- Develop: plan for addressing them

#### **Conclusions/action items:**

- Ethics in Engineering Assignment
- Executive Summary due on Thursday
- Shark Tank presentation Thursday



## 2026/04/08 Lecture 11

---

Claudia Beckwith - Apr 08, 2026, 1:40 PM CDT

**Title:** Lecture 11

**Date:** 4/08/26

**Content by:** claudia

**Present:** 301s

**Goals:** I want to understand what engineering judgment is and how it applies to BME and our project.

**Content:**

What is engineering judgement: getting an idea of approximately the magnitude of something based on thing you already you know

- abet outcome #6

ways to learn engineering judgement

- communication
- solving problems
- asking questions
- intuition
- critical thinking
- teamwork
- open ended problems

3 domain model for identifying common terms/elements:

1. attitude: what you feel and believe
2. behaviors: what you do
3. cognitive: what you know and are able to do about it

**Conclusions/action items:**

- complete the google sheets form going over the ABC's and ranking clarity and applicability of each goal



## 2026/04/15 Lecture 12

---

Claudia Beckwith - Apr 15, 2026, 1:56 PM CDT

### **Title: Lecture 12 - Poster presentations**

**Date:** 4/15/26

**Content by:** claudia

**Present:** 301s

**Goals:** Prepare for the poster presentation making sure we have all our final deliverables ready.

### **Content:**

good posters:

- visuals
- clear figures
- color
- limit white space
- show best results
- minimize text
- captions clear and succinct
  - figure number
  - title
  - description
  - cite if necessary
- readable from 3ft (not ack or ref)
  - 24-28 font size
  - can range
- explain how user interfaces with the product
- handouts
  - business cards
  - poster copies
  - surveys

bad posters:

- raw data
- small text
- hanging single bullets
- wordy

### **Conclusions/action items:**

before next week, we need to finish our poster and bring in one printed copy to get peer feedback. We also need to up update our pitch from tong award when we get feedback.



## 2026/04/22 Lecture 13

---

Claudia Beckwith - Apr 22, 2026, 1:27 PM CDT

**Title:** poster presentation

**Date:** 4/22/26

**Content by:** claudia

**Present:** 301s

**Goals:** We want to get peer feedback on our poster so we can have it ready to print tonight and ready to go on friday

**Content:**

Feedback on poster/changes to make:

**Conclusions/action items:**

- poster pres on friday
- report due next wednesday
- surveys
- upload poster to website and canvas



## 01/28/2026 - Microcontrollers with Wifi and BLE Capabilities

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Lauren Klein - Jan 29, 2026, 11:21 AM CST

**Title:** XIAO ESP32 Series Variations

**Date:** 01/28/26

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn more about different Seeed Studio XIAO Microcontrollers that we can upgrade to this semester.

**Search Term:** Microcontrollers with Wifi and BLE capabilities --> XIAO ESP32

**Search Engine:** Google

**Citation:** Seeed studio Xiao esp32 comparison: ESP32-S3, ESP32-C3, and esp32-C6 explained, <https://www.seeedstudio.com/blog/2026/01/14/xiao-esp32-s3-c3-c6-comparison/> (accessed Jan. 29, 2026).

**Content:**

- "Choosing between the XIAO **ESP32-S3**, **ESP32-C3**, and **ESP32-C6** isn't as simple as picking the "newest" or "most powerful" board. On paper, they all look similar. They share the same tiny XIAO form factor, support Wi-Fi and Bluetooth, and target IoT developers"

- "The ESP32-S3 focuses on performance and AI."

- "The ESP32-C3 is designed for low power and cost-sensitive IoT."

- "The ESP32-C6 introduces next-generation wireless standards like Wi-Fi 6, [Thread](#), [Zigbee](#), and [Matter](#)."

- "XIAO ESP32-S3 boards come with generous memory options. Depending on the variant, you get **8 MB PSRAM** and **8–16 MB Flash**. This extra memory makes a big difference when working with images, audio buffers, or complex libraries."

- "The XIAO ESP32-S3 Sense version goes further by adding an onboard **SD card slot**, supporting **FAT-formatted cards** up to 32 GB. This is especially useful for data logging, image storage, or audio recordings."

- "The XIAO ESP32-S3 is a strong choice for:

- - Edge AI and machine learning projects
  - Computer vision and smart cameras
  - Voice-controlled devices
  - IP cameras and multimedia applications

- "XIAO ESP32-S3 Sense also includes a **digital microphone**. This enables voice-triggered applications, sound detection, or basic speech recognition without additional hardware."

- "The XIAO ESP32-C3 is designed for simplicity, efficiency, and low power consumption. It is often the easiest entry point into the ESP32 ecosystem, especially for small IoT devices."

- "The ESP32-C3 uses a single-core 32-bit RISC-V processor running up to 160 MHz. While it is less powerful than the S3, it is more than capable of handling common IoT tasks such as sensor reading, cloud communication, and BLE provisioning."

- "Low power is one of the ESP32-C3's biggest strengths. In deep sleep, XIAO ESP32-C3 boards typically consume around 40  $\mu$ A, making them suitable for battery-powered designs that need long standby times."

- "The ESP32-C3 supports 2.4 GHz Wi-Fi (802.11 b/g/n) and Bluetooth LE 5.0. This covers most everyday IoT needs, from MQTT communication to BLE-based setup flows."

-The XIAO ESP32-C3 works best for:

- - Simple IoT sensors and actuators
  - Battery-powered devices
  - Wearables and compact electronics
  - Cost-sensitive products

-The XIAO ESP32-C6 represents the next generation of ESP32 connectivity. It is built for modern smart home and IoT ecosystems that rely on multiple wireless protocols."

-The ESP32-C6 features two RISC-V cores: a high-performance core running up to 160 MHz and a low-power core running up to 20 MHz. This split allows the chip to handle background tasks efficiently while keeping power consumption low."

-Unlike the S3 and C3, the ESP32-C6 supports 2.4 GHz Wi-Fi 6 (802.11ax). It also includes Bluetooth 5.3 and an 802.15.4 radio for Thread and Zigbee. This combination makes it ideal for devices that need to operate in dense networks or mesh-based environments"

-The XIAO ESP32-C6 is Matter-native. If you are building smart home devices that need to work seamlessly across ecosystems like Apple Home, Google Home, and Alexa, this board is designed for that future"

-The XIAO ESP32-C6 is well suited for:

- - Smart home devices
  - Matter, Thread, and Zigbee projects
  - Next-generation IoT products
  - Multi-protocol gateways

-The ESP32-S3 delivers far more performance, but the ESP32-C3 is simpler and easier to optimize for low-power designs. If your project spends most of its time sleeping, the C3 often makes more sense.

-ESP32-C3 uses Wi-Fi 4, which is stable and widely supported. ESP32-C6 introduces Wi-Fi 6 features that improve efficiency in crowded networks"

-The ESP32-C6 is future-focused with modern wireless protocols. The ESP32-S3 benefits from a mature ecosystem and higher compute performance."

-Choose ESP32-S3 if...

- - You need AI, vision, or audio processing
  - Your project uses a camera or display
  - Performance matters more than power

Choose ESP32-C3 if...

- - You want low power and low cost

- Your project is a simple IoT device
- Battery life is critical

**Choose ESP32-C6 if...**

- - You are building Matter or Thread devices
  - You need Wi-Fi 6 and modern connectivity
  - Your product targets future smart home standards

ESP32S3 vs ESP32C3 vs ESP32C6 Specification Comparison

Feature	XIAO ESP32-S3	XIAO ESP32-C3	XIAO ESP32-C6
Processor	Dual Xtensa LX7 @ up to 240 MHz	RISC-V single-core @ up to 160 MHz	Dual RISC-V (HP 160 MHz + LP 20 MHz)
Memory	On-chip 8M PSRAM & 8MB Flash	400KB SRAM, 4MB onboard Flash	On-chip 512KB SRAM & 4MB Flash
Wi-Fi	Complete 2.4GHz Wi-Fi subsystem	Complete 2.4GHz Wi-Fi subsystem	Complete 2.4GHz Wi-Fi 6 subsystem
BLE	Bluetooth 5, Bluetooth mesh	Bluetooth 5, Bluetooth mesh	Bluetooth 5, Bluetooth mesh
Power Consumption	Modem-sleep Model: ~ 25 mA	Modem-sleep Model: ~ 24 mA	Modem-sleep Model: ~ 30 mA
	Light-sleep Model: ~ 2 mA	Light-sleep Model: ~ 3 mA	Light-sleep Model: ~ 2.5 mA
	Deep Sleep Model: ~ 14 µA	Deep Sleep Model: ~ 44 µA	Deep Sleep Model: ~ 15 µA
USB Support	Yes	Yes	Yes
IEEE 802.15.4 / Thread / Zigbee	No	No	Yes (Thread/Zigbee)
Camera / AI	Strong — camera, audio, edge AI support	Limited	Limited (focused on connectivity)
Ideal for	Vision, edge AI, multimedia UIs	Low-power sensors, cost-sensitive IoT	Matter devices, multi-radio IoT, gateways
MSRP(\$)	\$7.49	\$4.90	\$5.20

**Conclusions/action items: Overall, all 3 XIAO's would do the trick and are cost effective for our purposes. They all include BLE connections and onboard WI-FI. The C3 allows the more battery longevity due to its deep sleep mode.**

1:28:11.30 PM Seed Studio XIAO ESP32 Comparison: ESP32-S3, ESP32-C3, and ESP32-C6 Explained

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**XIAO ESP32-S3 vs ESP32-C3 vs ESP32-C6: Which One Is Best for Your Project?**

By Koenig Lothar · 2 days ago

Choosing between the XIAO ESP32-S3, ESP32-C3, and ESP32-C6 depends on your project requirements. Each module offers unique features and performance characteristics. This guide compares their capabilities to help you make the best choice for your application.

The ESP32-C3 is designed for low power and cost-sensitive IoT. The ESP32-C6 introduces new features like dual-band Wi-Fi and Bluetooth. Understanding these differences is key to choosing the right module for your project.

In this guide, we break down the XIAO ESP32-S3, compare their specifications, and explain when to use each one. Let's dive in!

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https://www.seedstudio.com/blog/2023/11/28/xiao-esp32-s3-vs-esp32-c3-vs-esp32-c6-explained/ · 1/1

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**Seed\_Studio\_XIAO\_ESP32\_Comparison\_ESP32-S3\_ESP32-C3\_and\_ESP32-C6\_Explained.pdf (5.03 MB)**



## 01/28/2026 - Impact of T1D on Parents

Lauren Klein - Jan 29, 2026, 11:51 AM CST

**Title:** Psychological and Overall Impact on Parents of Type 1 Diabetes

**Date:** 01/28/26

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn about how parents are mentally affected when their children have Type 1 Diabetes.

**Search Engine:** Google Scholar

**Search Term:** Mental impact on parents of type 1 diabetic children

**Citation:** A. Alazmi, M. B. Bashiru, S. Viktor, and M. Erjavec, "Psychological variables and lifestyle in children with type1 diabetes and their parents: A systematic review," *Clinical Child Psychology and Psychiatry*, vol. 29, no. 3, p. 135910452311771, May 2023, doi: <https://doi.org/10.1177/13591045231177115>.

**Content:**

-Over the years, diabetes has become a major public health concern globally, affecting not only people with diagnosis, but also their families and caregivers. According to the available literature, this disease is becoming more common in children and their parents"

-"Anxiety, anger, and depression are common emotions experienced by children and their families upon receiving the diagnosis ([Diabetes and Emotions, 2017](#))."

-"In one longitudinal study, primary school-age children with diabetes reported anxiety and mild depression, which resolved 6 months after diagnosis; while depression symptoms increased after one to 2 years, anxiety decreased only for boys, while it increased for girls over the first 6 years"

-"In this situation, children with diabetes may perceive that they are different from their peers and may be at risk for difficulties in social competence. Type 1 diabetes in children can be intense and may lead to behaviour-related disease management problems such as anxiety, depression, social anxiety, and lower self-esteem."

-"Diagnosis often leads to worry and stress-related responses regarding the complex care plan that needs to be adhered to by the patient and delivered by the caregivers ([Silverstein et al., 2005](#)). For example, a child with diabetes may potentially be anxious about how their condition will develop in the future, be fearful of leaving their house or communicating with others, and be prone to avoid social interactions with others ([Diabetes and Anxiety, 2017](#))."

-"It may also affect the household in numerous ways; financially, socially, and emotionally ([McCarthy & Kushner, 2007](#)). Therefore, it is imperative for families to learn management and coping with diabetes, and the effects that the disease might have on their children's life-span development (including normal peer relationships) as early as possible."

-"Yet there are few published studies regarding this situation, especially among younger-aged children (e.g., 8–11 years), who are increasingly likely to report poor mental health, even in the absence of chronic illness"

-"Coping with behavioural changes as a result of the disease can be challenging for both children and families ([Calentine & Porter, 2012](#)). Considering the effects of diabetes diagnosis and illness, it is expected that children's behaviour will have an effect on their diet, education, and lifestyle. If families are not aware of the risks, the situation may become more difficult to manage and control in the future for both parents and children."

-"The area of diabetes and depression in children and adolescents has not been researched extensively. Children with diabetes have a two-fold higher prevalence of depression, and adolescents have a three-fold higher prevalence than their non-diabetic peers ([Grey et al., 2002](#)). The combination of diabetes and depression is influenced by many variables, including gender, family behaviours, and poorer metabolic control."

-"Diabetes and depression co-morbidity is a significant issue in children and adolescents, affecting an estimated 20% of diabetic individuals, compared to less than 7% of youth without diabetes ([Grey et al., 2002](#)). This presents the risk of disability, and negative long-term consequences."

-“Therefore, health practitioners need to pay attention to the emotional functioning and family functioning of children with diabetes, as diabetes can cause a significant impact on families and caregivers in terms of providing support and promoting a healthy family environment.”

-“[Lowes et al. \(2015\)](#) conducted a qualitative study aimed to explore the experience of attending paediatric diabetes services and living with and managing Type 1 diabetes. They recruited children aged 7–15 years old and their parents. Most parents reported that attending the clinic was a source of anxiety. For example, one carer said, “I often feel stressed up to about a week before I go to clinic. I worry about what my son’s HbA1c results will be.” Children also worried about attending the diabetes clinic and reported that their experience is often represented negatively.”

-“Some parents reported feeling exhausted as a result of the responsibility of caring for their child. Children expressed their feelings of fear, unhappiness, anger or distress about the presence of Type 1 diabetes in their lives. For example, one child told the researchers, “I don’t like having diabetes. I don’t like injections (insulin). I don’t like going out with other people for the day cos they don’t understand diabetes. My friends sometimes say they don’t like me because I have diabetes so I feel sad.” The findings of this study also showed that paediatric diabetes nurses interacted with patients and families in a more compassionate manner than medical professionals.”

-“A mother said, “Feeling confident when going to clinic and speaking to members of the team is crucial in the learning process and enables you to ask questions as often as you need to! Parents with diabetic children have lots of questions and fears!” ([Lowes et al., 2015](#)). Similarly, [Hawthorne et al. \(2011\)](#) found that children with Type 1 diabetes and their parents or careers believe that doctors struggle to link the demands of diabetes with daily life, such as school and social activities, in their consultations, and to consider the emotional impact of living with Type 1 diabetes.”

-“However, it is well documented that most parents are likely to experience significant distress (e.g., anxiety and depression symptoms) after their child is diagnosed with Type 1 diabetes ([Kokkonen et al., 1997](#)). [Kovacs et al. \(1997\)](#) and [Jaser et al. \(2008\)](#) reported that increases in parental distress have been linked to higher levels of child distress; maternal depressive symptoms are one of the most powerful risk factors for depressive symptoms and a lower quality of life in children. Ongoing parental involvement in treatment management is linked to improved health and psychosocial outcomes in children with Type 1 diabetes ([Anderson et al., 2002](#)).”

-“Furthermore, observational research may shed light on specific aspects of parent-child interactions that influence diabetes adaptation. One study found that higher levels of observed emotional support, acceptance, and conflict resolution in children and their parents, as well as lower levels of observed parent anger and sadness, were related to better glycaemic control during a diabetes-related task ([Martin et al., 1998](#)).”

-“Another study discovered that higher levels of observed hostility by mothers, as well as lower levels of child-centered behaviour and positive reinforcement, were associated with poorer psychosocial adjustment and glycaemic control in adolescents ([Jaser and Grey, 2010](#)). A higher frequency of negative parent-child interactions has also been linked to a lower quality of life ([Weissberg-Benchell et al., 2009](#)). This intense level of responsibility is likely to increase family stress and conflict, especially as children reach adolescence, which is unique to Type 1 diabetes.”

-“Overall, the relationship between psychological variables and lifestyle in children with Type 1 diabetes and their parents at primary age has not been reviewed in the existing literature. We conducted a systematic review of quantitative studies to investigate what lifestyle and psychological variables influence children with Type 1 diabetes at primary age and their parents.”

-“[Table 2](#) shows the summary of the finding and the characteristics of the studies included in the present review. These clinical trials were performed in several countries, including the United States of America (USA), Italy, Canada, Portugal, and Belgium. Most of the studies were conducted without a comparison group; only one study had a comparison group. Seven studies did not specify the therapy type of the participants. Regarding the haemoglobin (HbA1C) measurements, seven studies specified the mean of the HbA1C, nine studies reported the range of HbA1C, and four studies did not report this measure. All the studies included in this systematic review used self-report questionnaires for both children and their parents. Their data analysis was conducted using IBM SPSS Statistics, and most of the studies were correlational in design.”



-“Children with diabetes often showed symptoms of depression ([Jaser et al., 2008](#); [Whittemore et al., 2003](#); [Mullins et al., 2004](#); [Armstrong et al., 2011](#)). In one of the studies, these depression symptoms related to children’s levels of metabolic control and adherence to medication ([Cohen et al., 2004](#)). Researchers reported that anxiety, aggressive behaviour, and attention showed a high relationship to depression ([Jaser et al., 2014](#); [Jaser and Grey, 2010](#); [Gruhn et al., 2016](#)). Researchers also reported that physical activity, poor glycaemia, higher stress, worrying, and children’s age were related to fear of hypoglycaemia ([Michaud et al., 2017](#); [Jabbour et al., 2016](#); [Patton et al., 2011](#)). Two studies reported that children with diabetes and their parents often showed symptoms of poor sleep quality ([Jaser et al., 2017](#); [Feeley et al., 2019](#)). In one of the studies, children with diabetes had lower self-efficacy scores ([Armstrong et al., 2011](#)).”

-“Parents of children with diabetes also showed an increased incidence of depression symptoms according to several studies ([Patton et al., 2011](#); [Gruhn et al., 2016](#); [Whittemore et al., 2003](#); [Van Gampelaere et al., 2020](#)). Parents of children with diabetes often showed higher parenting stress ([Mullins et al., 2004](#); [Moreira et al., 2014](#); [Viaene et al., 2017](#); [Patton et al., 2011](#); [Sweenie et al., 2014](#)). In one of the studies, over-reactive discipline for the parents was linked to reports of less time spent managing the child’s illness ([Wilson et al., 2009](#)). In one study, according to parental

reports, children with Type 1 diabetes had higher quality of life scores compared with the control group (Van Gampelaere et al., 2020). Children with diabetes and their parents have been shown to suffer from fear of hypoglycaemia (Michaud et al., 2017; Jabbour et al., 2016; Patton et al., 2011; Viaene et al., 2017; Jaser et al., 2017)."

"In this systematic review, 20 research studies reported that children living with Type 1 diabetes suffered from psychological issues such as anxiety, depression, sleep disturbance, and lifestyle adjustment. At present, there is not much empirical evidence to draw inferences on the cause of these psychological issues."

"However, several studies pointed to the interactions and associations between child and parental variables. For example, it has been shown that both children who have diabetes and their parents suffer from a fear of hypoglycemia (Michaud et al., 2017; Jabbour et al., 2016), an increased incidence of depression (Patton et al., 2011; Gruhn et al., 2016), and often show symptoms of poor sleep quality (Michaud et al., 2017; Jabbour et al., 2016). (Jaser et al., 2017)."

"This would be expected because childhood chronic illness affects parents' mental health and life quality, while familial variables have been shown to affect child outcomes (Vonneilich et al., 2016). Furthermore, given the consequences of diabetes diagnosis and illness, it is reasonable to expect that children's behaviour will influence their diet, education, and lifestyle. If families are not aware of the risks, the situation for both parents and children may become more difficult to manage and control in the future."

"The present review has investigated the psychological and lifestyle variables that may impact the health and well-being of primary-age children and their families. Despite the procedural limitations such as the lack of control groups for most of the studies, combining young children with older youth that can be considered adults in one category, and insufficient medical data, we can conclude that children with Type 1 diabetes and their parents are at risk of experiencing a multitude of psychological problems. Lifestyle changes contributing to this may include poorer sleep quality and reduced physical activity."

**Conclusions/action items: Overall, T1D diagnoses drastically affects both children and their parents and everyday activities can feel like a burden. Depression, sleep loss and quality, and anxiety or fear plague these families. Hopefully, our device can be a source of relief in order to help take away some of the stress parents deal with while sending kids to school.**

Lauren Klein - Jan 28, 2026, 10:15 PM CST

Review

**Psychological variables and lifestyle in children with type1 diabetes and their parents: A systematic review**

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**Abstract**  
 Diabetes may impact physical and psychosocial well-being; the diabetes incidence has seen a drastic increase globally. There is also a rise in poor mental health and well-being in children with and without chronic illness; problems are being seen at a younger age. The objective of this review was to understand the determinants of these problems in a family context. We conducted a systematic review to investigate what lifestyle and psychological factors influence children with Type 1 diabetes and their parents. A focused literature search was performed using a combination of keywords that covered the relevant terminology for diabetes, target population, and associated emotional distress, using electronic bibliographic databases containing publications until May 2022. Methodological quality was assessed using the Quality Assessment Tools for Quantitative Studies. Twenty articles met the inclusion criteria. Quality scores were weak because of a lack of comparison groups, information about type of therapy, or adequate sample sizes. Many of the studies included a wide age range in their sample. The majority of the studies reported that parents and their children showed depression symptoms, fear of hypoglycemia, and higher parenting stress. We conclude that sufficiently powered studies employing appropriate control groups and measures are needed to elucidate the psychological variables associated with Type 1 diabetes in children and the effects on parents, especially considering primary-age children who are increasingly reported to suffer from poor mental health, and its implications. This should help to introduce better targeted interventions and improve behavioural outcomes.

**Keywords**  
 Type 1 diabetes, systematic review, children and parents, anxiety, depression

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## 01/28/2026 - Environmental Impact of CGM Waste

Lauren Klein - Jan 29, 2026, 2:40 PM CST

**Title:** The Waste and Environmental Impact of CGMS

**Date:** 01/28/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn how CGMs can affect the environment following their disposal.

**Search Engine:** Google Scholar

**Search Term:** environmental impact of continuous glucose monitors

**Citation:** "Access Library Resource — UW–Madison Libraries," *Wisc.edu*, 2026. <https://ieeexplore-ieee-org.ezproxy.library.wisc.edu/abstract/document/11178288> (accessed Jan. 29, 2026).

**Content:**

"ICT devices and digital services supported the emergence of mobile health (mHealth) in healthcare systems. As illustrated in Fig. 1, mHealth encompasses (i) smartphone-based health applications and (ii) wearable devices that monitor physiological parameters."

"These mobile technologies aim at enhancing medical and public health practices by enabling continuous patient data collection beyond traditional clinical settings [2], [3]. This, in turn, facilitates data-driven insights into medical conditions, supporting a more decentralized and responsive healthcare infrastructure. Typical examples of existing mHealth devices include, among others, cardiac monitors to detect arrhythmias [4], posture monitoring garments [5], fall detection sensors [6], and glucose sensors"

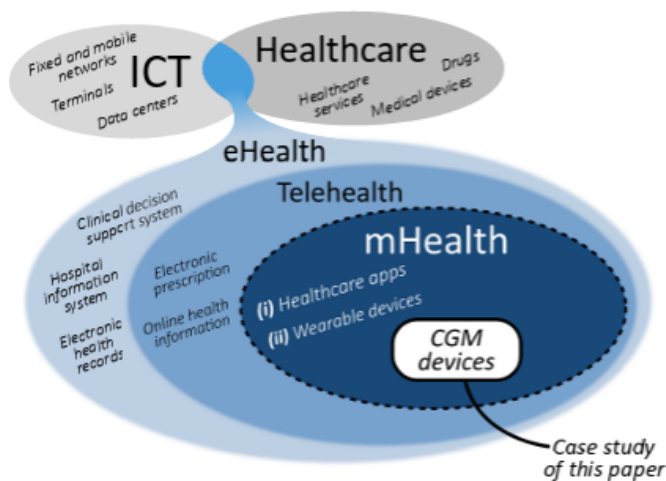


Fig. 1. Mobile Health (mHealth) refers to healthcare solutions integrating ICT through healthcare applications and wearable devices. It operates within the Telehealth and eHealth ecosystems. This paper focuses on continuous glucose monitoring (CGM) devices. Figure adapted from [1].

..

"Indeed, it could help address challenges associated with shrinking healthcare workforce [8], support care for aging populations in Western countries [9], improve access to health services in low-income countries [2], [10], [11], and facilitate managing the growing burden of chronic diseases [12]."

"Second, mHealth is considered a key lever in decreasing the environmental impacts of the healthcare sector, mostly by reducing patient transportation and optimizing resource use [1]. This is of importance, knowing that healthcare contributes between 1% and 5% of global environmental impacts depending on which indicator is considered, e.g., 4.4% for global greenhouse gas emissions [13]."

"A common example of mHealth technologies is continuous glucose monitoring (CGM) devices, which are commercially available for digital diabetes management and serve as the case study for this work. These battery-powered, wearable sensors are placed on the arm or abdomen. They measure glucose levels in the interstitial fluid of the skin via a subcutaneous needle and synchronize with smartphone applications to provide real-time estimates of blood glucose concentration."

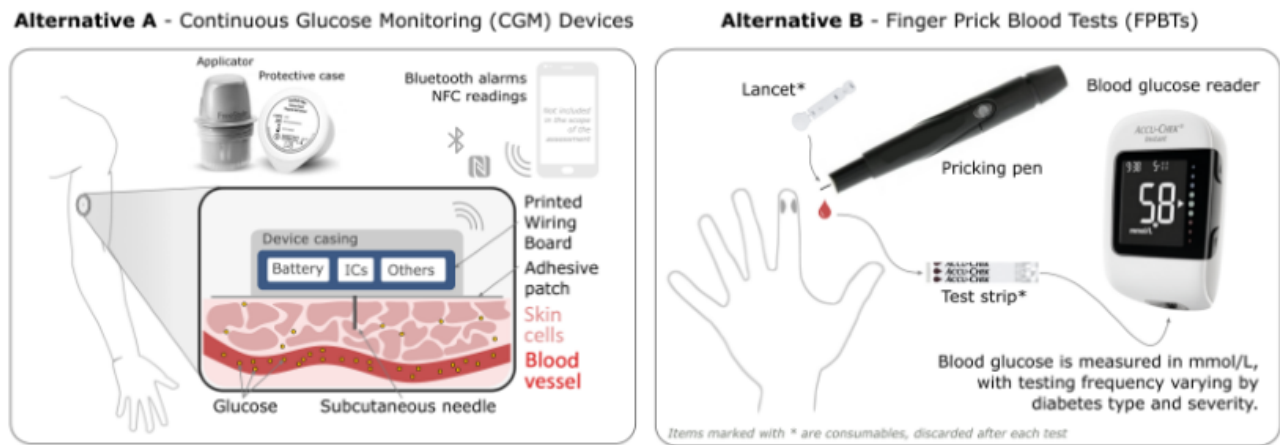


Fig. 2. Comparison between CGM devices (Alternative A) and FPBTs (Alternative B). **Alternative A** shows a CGM system where the battery-powered wearable device is placed on the arm. It measures glucose levels in the interstitial fluid beneath the skin via a subcutaneous needle. The data is processed by integrated circuits and transmitted using NFC or Bluetooth to a dedicated smartphone application. The applicator is used to set the device on the patient's skin. The protective case shields the subcutaneous needle prior to application. Components in 'Others' include passive electronic components and the antenna. The smartphone is shown here for illustrative purpose, but is not included in the scope of the environmental impact assessment. **Alternative B** shows the FPBT. A lancet is used to prick the finger. A blood sample is collected on a test strip, and then the glucose levels are read with an electronic reader.

"This ultimately enables patients to make data-driven decisions. CGM devices also improve patient comfort as they are less invasive than the previous standard monitoring system: the finger prick blood test (FPBT). Indeed, FPBT involves pricking the finger with a lancet to collect a blood sample and measuring glucose levels using a dedicated reader. CGM and FPBT are both illustrated in Fig. 2. Ultimately, clinical trials have demonstrated the clear health benefits of CGM, such as a lower incidence of hypoglycemia and hyperglycemia events [14]. Nevertheless, the service lifetime of most CGM devices is typically limited to 10 to 14 days, mainly due to the body's immune response to the insertion of the subcutaneous needle [15]."

"This short lifespan leads to a high replacement rate, resulting in the manufacturing and disposal of numerous devices. This raises environmental concerns given the global prevalence of CGM devices, with an estimated 230 million units used annually worldwide [16]."

"Hence, CGM devices typically illustrate the dual nature of mHealth technologies. While they provide clear health benefits, their adoption also introduces their own environmental burdens due to the increasing volume of wearable devices in use [17]. The following subsection provides an overview of existing literature on mHealth and CGM device's environmental impacts. It also identifies key limitations and research gaps."

"Several studies have applied impact assessment methods within the healthcare sector, as highlighted in [17] which references a database gathering impact estimates of about 1,288 healthcare products and processes."

"It emphasizes that existing research primarily focuses on substitution and optimization effects, which are generally considered beneficial due to their potential to reduce the environmental impacts of existing systems [21]. Moreover, it highlights that few studies have explored the environmental impacts of mHealth technologies, even though connected devices are known to contribute to environmental degradation mainly due to the production of their electronic components, which is resource-intensive"

"Regarding CGM devices, waste generation has been the main concern, drawing significant attention from users, healthcare professionals, and manufacturers [26]. For instance, the authors in [16] quantified the waste generated by CGM usage, revealing that packaging, applicators, and leaflets account for most of the waste mass. To address these concerns, some manufacturers have adopted eco-design strategies, such as reducing plastic use and incorporating recycled materials [27], [28]."

"Others have instead chosen to focus on recovering valuable metals from used devices [29]. While these initiatives address waste volume and material recovery, they do not account for the environmental impacts of producing the electronics of CGM devices and the device's short service lifetimes. Interestingly, emerging manufacturers have introduced CGM devices designed to last several months [30], [31], which could reduce environmental impacts. Although existing research on the environmental aspects of CGM devices offers valuable insights, three key limitations remain."

"(1) No study has assessed the environmental impacts of CGM devices with a life-cycle perspective across multiple criteria. In particular, the environmental impacts associated with the production of electronic components have been overlooked in the literature."

"(2) To date, no analysis has assessed the environmental impacts of CGM devices across different usage scenarios or compared them with those of other glucose monitoring technologies, such as FPBT."

"(3) Existing studies on the environmental impacts of mHealth technologies remain largely product-oriented, failing to account for the indirect environmental impacts resulting from their integration into healthcare systems and society."

"In this context, we address (1) and (2) by conducting a comparative life-cycle assessment (LCA). The aim is to evaluate the direct environmental impacts of CGM devices relative to the previous standard of care (FPBTs) across multiple impact categories. By employing reverse engineering techniques for high-granularity modeling and performing a numerical uncertainty analysis, we significantly improve the robustness of our results. This LCA also identifies key environmental hotspots, informing the development of ecodesign strategies for CGM devices. To promote transparency and reproducibility of results, a link to an open-source

repository containing the collected data and Python-based code is provided in the appendix of this paper. This enables full execution of the LCA model using the Brightway2 library."

"Second, we address (3) by establishing the limitations of our product-level LCA and clarifying the types of conclusions it does and does not support. We emphasize the importance of a multi-level approach to capture the indirect environmental impacts of mHealth technologies and ultimately inform decision-making at the level of healthcare systems and society. To support this broader perspective, we suggest relevant tools from health economics and systems thinking."

"The goal of this LCA is to provide quantitative environmental impact estimates and identify hotspots of two diabetes monitoring alternatives: (A) CGM and (B) FPBT, representing the previous standard of care."

"It is then necessary to determine the amount of product required in Alternative A and Alternative B to fulfill the functional unit [36], also referred to as the reference flows. For Alternative A, each device lasts 10 to 14 days, so 26 to 37 devices must be produced, packaged, and delivered per year to fulfill the functional unit. In the case of Alternative B, the lifespan of the glucose reader is undetermined: information from the grey literature suggests it could last up to 10 years [37], while other sources recommend replacing it every 4 to 5 years [38]."

"In this study, the reader's operation time ranges from 2 to 3 years, which is considered a conservative assumption. Hence, its total environmental impacts are allocated proportionally throughout its effective lifetime to evaluate its annual environmental impacts. In addition, the number of consumables (e.g., needles and test strips) is adjusted based on the frequency of blood tests performed each year. Since type 1 and type 2 diabetic patients have different needs, consumables range from hundreds to thousands."

"As stated in the literature review, while the issue of waste generation is well-documented for CGM devices, the environmental impacts of the production stage remain unexplored."

"Specifically, the assessment includes the 223 Authorized licensed use limited to: University of Wisconsin. Downloaded on January 29, 2026 at 04:11:16 UTC from IEEE Xplore. Restrictions apply. environmental impacts associated with (i) raw material extraction, (ii) manufacturing, (iii) distribution, and (iv) patient use. The end-of-life stage is excluded from the scope of this study due to the absence of sufficient granularity regarding disposed electronic components in the Ecoinvent database."

"Primary data for Alternatives A and B is obtained through the teardown of an Abbott FreeStyle Libre 2 kit and a Roche Accu-Chek Instant kit, respectively. This data, presented in the next subsection, is used to construct the foreground system. It is then matched to the Ecoinvent datasets, allowing for the calculation of the LCI. Figure 3 summarizes the primary data for both alternatives."

"1) Printed wiring board: Both alternatives rely on passive and active electronic components for their operation. These components are soldered onto a printed wiring board (PWB), connecting them together. For the Freestyle Libre 2, the PWB is thin, single-sided, and disc-shaped to fit within the casing, and it consists of four conductive layers. In contrast, the AccuChek Instant has a rigid, double-sided rectangular PWB, also with four conductive layers."

"2) Integrated circuits: These active components deserve special attention in the inventory analysis as they usually contribute significantly to the cradle-to-gate impacts of ICT devices [42]. The environmental impacts of an individual integrated circuit (IC) are mainly determined by the area of its semiconductor die and the technology node utilized in its fabrication [43]. While determining the technology node without manufacturer data is highly complex, the die area can be easily measured once isolated from its package through decapping [22]. Consequently, in-lab chemical decapping was performed on each IC in the CGM and FPBT devices to reveal their die area. This approach significantly improves the accuracy of the model concerning the environmental impacts of ICs [22], [42]."

"3) Batteries: Battery modeling is another key focus of this study. Alternatives A and B are both powered by a coin cell battery, but they differ in terms of technology. While the Ecoinvent database provides datasets for lithium-ion batteries, such as those used in the Accu-Chek Instant, no equivalent dataset exists for the silver oxide battery in the FreeStyle Libre 2. Consequently, this battery is modeled at the material level. An inductively coupled plasma analysis was performed to determine the composition of the silver oxide battery accurately. Furthermore, it is assumed that the ratio between the primary energy demand needed to produce a coin-cell battery and its capacity is approximately 100-150x [44]."

"4) Passive components: Capacitors and resistors have proper matches with datasets in the Ecoinvent database. Their masses are determined by linking standardized dimensions to known values from datasheets. However, no suitable datasets are available for quartz oscillators and USB connectors. To address this, full material declarations from manufacturers were used to break down these components into their constituent materials."

"5) Glucose transducers: Both alternatives embed glucose transducers. The FreeStyle Libre 2 relies on a transdermal amperometric biosensor (the subcutaneous needle), whereas the Accu-Chek Instant measures glucose through an enzymatic reaction between a blood sample and the test strip [45]. The material composition of the FreeStyle Libre 2 sensor was estimated based on the literature review presented in [46]. For the Accu-Chek Instant, the test strips are modeled based on a breakdown analysis of commercially available strips."

"6) Plastics and metals: Plastic plays both mechanical and protective roles in medical devices. In Alternative A, plastic is mainly found in the applicator and the protective case. Sink-and-burn tests [47] indicate that these components are mainly composed of polypropylene (PP) and acrylonitrile butadiene styrene (ABS). In Alternative B, the blood glucose reader casing primarily consists of polycarbonate (PC) and ABS assemblies. The pricking pen used for blood sample collection is made of polyoxymethylene (POM) and ABS. At the functional unit level, the majority of plastic comes from consumables such as lancets and needles, which are composed of softer plastics like polyethylene (PE) and polyethylene terephthalate (PET). Similar to plastic, small metal components, including springs and needles, are present in both alternatives. The estimated proportions of plastic and metal for each alternative are summarized in Fig. 3."

"7) Papers: For both alternatives, the product packaging is made of bleached paperboard, while the transport cardboard consists of corrugated paperboard. Each product package also includes leaflets, which add a non-negligible weight for Alternative B."

"8) Transport: The transport routes within the supply chains were estimated using available information on product packaging, shipping details, and disclosures from manufacturers. For Alternative A, the wearable device and applicator are produced in the United States, while the subcutaneous needle is likely manufactured in the United Kingdom. For Alternative B, the manufacturer is based in Mannheim, Germany. Regarding electronic components, we assumed that manufacturing takes place in Asia."

-9) Patient use: For Alternative B, lancets and test strips are considered in the scope of the analysis. Although these consumables are associated with patient use, they do not require additional resources or generate emissions during this stage. Consequently, their environmental impacts are attributed to the materials and manufacturing stages, as shown in Fig. 3."

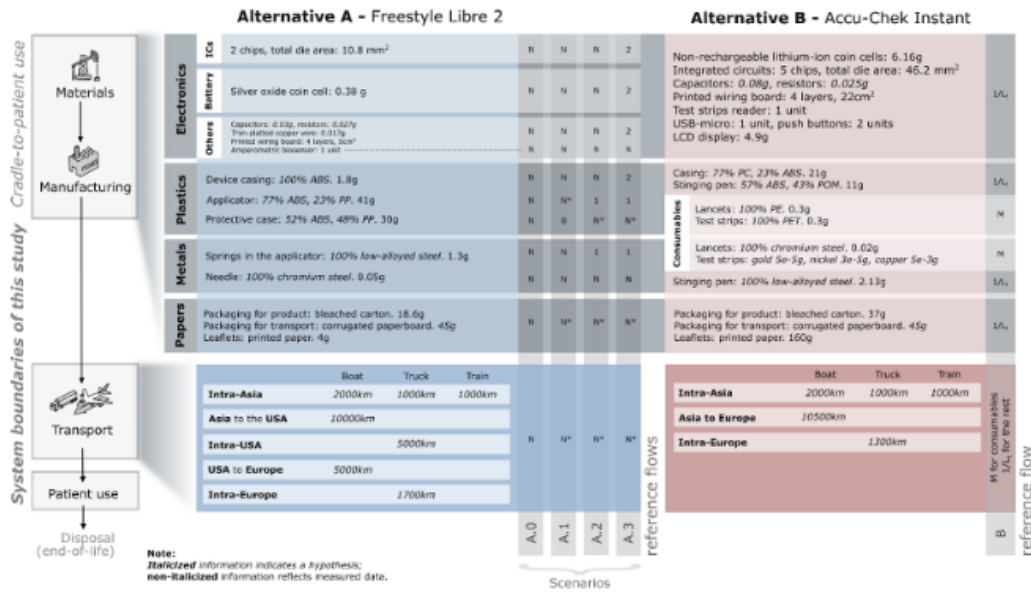


Fig. 3. Summary of the primary data collected for constructing the foreground systems of Alternatives A and B. The data provided for the materials and manufacturing stages is based on a teardown analysis of the FreeStyle Libre 2 (Alternative A) and the Accu-Chek Instant (Alternative B). The values for the transport stage are estimated based on device packaging information. N represents the number of CGM devices required per year to meet the functional unit in Alternative A, ranging from 26 to 37, as each device lasts between 10 and 14 days. An N\* value indicates that a different quantity is used prior to scaling to reflect a specificity of the given scenario with respect to Scenario A.0. For example, in Scenario A.1, the amount of plastic in the applicator differs from that in Scenario A.0, even though the number of devices used per year remains the same. M refers to the annual number of blood tests required in Alternative B, estimated between 365 and 2555, based on a daily requirement of 1 to 7 tests. L<sub>4</sub> refers to the operational lifetime of the blood glucose reader, assumed to range between 2 and 3 years. In Scenario A.3, we assume two CGM devices are required, as one must be charging while the other is in use.

"This study explores different usage scenarios for CGM devices, as listed in Table I. The baseline scenario is referred to as A.0 and represents the current use of Freestyle Libre 2 CGMs. Scenario A.1 is based on the commercial implementation of eco-design guidelines between the Freestyle Libre 2 and Libre 3 CGMs [28]. Scenario A.2 explores the introduction of a reusable applicator. Scenario A.3 assumes both a reusable applicator and a rechargeable CGM device. While not yet commercially implemented by the Abbott company, Scenarios A.2 and A.3 are inspired by emerging manufacturers developing CGM devices with extended service lifetimes"

TABLE I  
DESCRIPTION OF THE FOUR SCENARIOS CONSIDERED IN THIS STUDY FOR ALTERNATIVE A

Scenario	Feature	Description
A.0	CGM, baseline <sup>†</sup>	This baseline scenario represents the existing solution implemented by the Freestyle Libre 2, where a single-use CGM and its applicator are discarded every 10 to 14 days. Consequently, the inventory is scaled using a multiplicative factor within an uncertainty range of 26 to 37 devices packaged and delivered per year.
A.1	CGM, Abbott eco-design <sup>†</sup>	This scenario reflects the product design improvements implemented by Abbott between the Freestyle Libre's second and third generations. The Freestyle Libre 3 device features smaller dimensions and alleviates the need for a protective case, ultimately reducing plastic use by 41% and paper use by 43% [28].
A.2	CGM, reusable applicator*	In this scenario, the applicator is reusable, and only the CGM device is systematically replaced. Abbott does not implement a solution according to this scenario. Moreover, we assume that plastic usage for the protective case of the biosensor is optimized.
A.3	CGM, reusable applicator and extended CGM device lifetime*	This third scenario builds upon Scenario A.2 by making the assumption of a CGM device with an extended service lifetime, in addition to a reusable applicator and optimized plastic usage in the protective case. This scenario assumes that the CGM device is rechargeable, necessitating adjustments to the inventory. Specifically, a rechargeable NiMH battery is included, which charges inductively via a transmitter and receiver coil. The inventory also incorporates the estimated copper required for the coils and the associated charger, ensuring a fair comparison with other scenarios. The device's lifetime is estimated at one year for this scenario. Detailed information on the additional hardware is provided in the appendix.

† : already implemented by Abbott as a commercial solution \* : hypothetical scenario for the Abbott company defined for this study

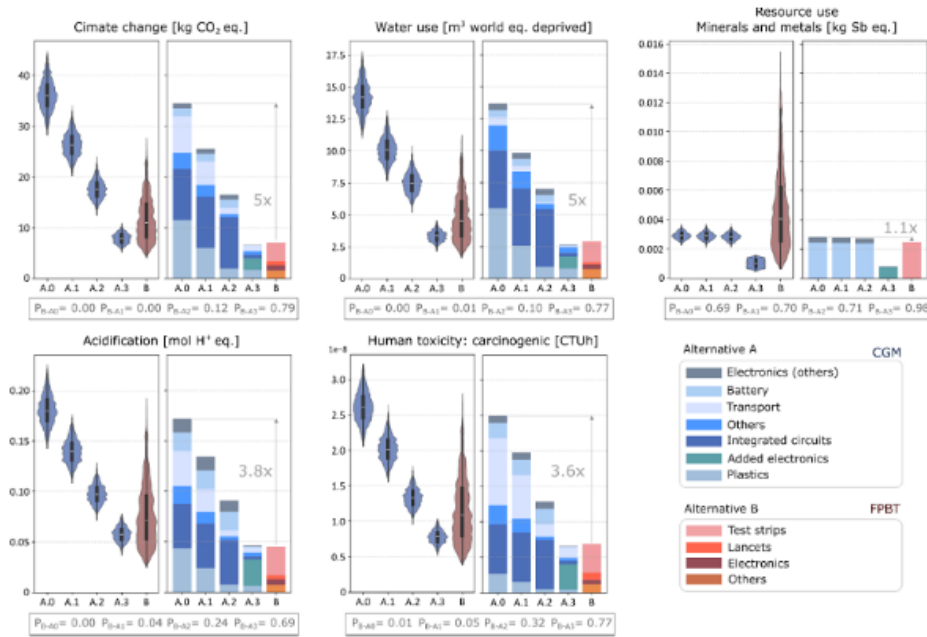


Fig. 4. LCA results. The absolute results are displayed on the left as a violin plot for each impact category. These results reflect how parameter uncertainty propagates to the LCA results. The parameter contributing the most to uncertainty in Alternative A is the number of CGM devices used per year. In Alternative B, uncertainty is mainly driven by the frequency of blood tests and the amount of gold contained in test strips. On the right, a contribution analysis identifies the environmental hotspots for each scenario. The categories are consistent with the inventory breakdown shown in Fig. 3. For CGMs, the 'Others' category includes packaging and metals. For FPBTs, 'Consumables' includes lancets and test strips, and 'Others' includes transport, packaging, device casing, and the pricking pen.

"However, concluding that CGM devices are environmentally sustainable based on this study would be unwarranted, as it would extend the LCA results beyond their intended scope [55], [56]. In fact, product-level assessments generally fail to capture several critical factors necessary for assessing the environmental sustainability of a given technology. These include, among others, the complex interactions between technology and human behavior, long-term technology pervasiveness, socio-economic implications, and technology's safe operating space within absolute planetary boundaries"

"Still, a recent press release from Abbott described the Freestyle Libre 3 CGM as "more environmentally sustainable" than its predecessor [28], highlighting the reductions in plastic and paper."

"We urge caution when generalizing the conclusions of product-level studies to environmental sustainability claims. Moreover, we advocate for a multi-level approach beyond product-level assessments to capture the indirect environmental impacts of mHealth technologies, as illustrated in Fig. 5. This approach would offer a more thorough understanding of environmental sustainability. This echoes recommendations already formulated in the LCA literature"

"To bridge this gap, the following sections explore the indirect environmental impacts of mHealth technologies exemplified by CGM. We distinguish between (A) micro-level and (B) macro-level indirect environmental impacts. Microlevel impacts stem from the interaction between mHealth technologies and structured care processes, commonly referred to as healthcare pathways [59], which are designed for specific patient groups and timeframes. In contrast, macrolevel impacts arise from wider socio-economic changes over space and time. For instance, these include the adoption of mHealth technologies by individuals without underlying health conditions, shifts in dietary habits driven by the growing prevalence of monitoring devices, and changes to healthcare infrastructures, such as lower hospital concentration (which increases the distance between patients and medical facilities)."

**Conclusions/action items: An estimated 230 million CGM units are wasted per year having a negative affect on both the economy and environment. Being conscious of both of these effects when creating our device will be very important as we aim to reduce burdens on customers and the world. The Freestyle Libre was considered more environmentally sustainable than previous versions reducing plastic and paper waste.**

### Exploring the Direct and Indirect Environmental Impacts of Mobile Health - A Case Study on Continuous Glucose Monitoring

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Abstract: ICT increasingly supports healthcare through mobile health (mHealth) technologies. The growing reliance on ICT in the domain suggests that mHealth requires holistic efficiency while reducing its environmental footprint. However, there is still an important lack of studies assessing the direct environmental impacts of mHealth technologies and (2) a lack of research on the indirect environmental impacts resulting from their integration into healthcare systems and society. Hence, the specific goal of mHealth is reducing healthcare's footprint on resource operations. In this paper, we propose the concept of a circular framework for assessing the environmental impacts of mHealth technologies. This is illustrated with the case study of continuous glucose monitoring (CGM) devices, a representative example of mHealth technologies. First, the focus is on their direct environmental impacts, which are assessed through a comparative lifecycle assessment on reducing overall emissions. Results show that CGM devices exhibit higher direct impacts than the monitoring systems they aim to replace by a factor of 1.1 to 1.6. Depending on the device category, CGM reduces their overall CO<sub>2</sub>e footprint by 10% to 20% compared to their replaced devices. Second, this paper points out several data sets in empirical datasets needed to assess health systems and could help diagnose their systems. Making it possible to assess the indirect environmental impacts of CGM devices and other mHealth technologies.

Index Terms: Mobile health, healthcare, ambient glucose monitoring (AGM), glucose management (GCM), indirect environmental impacts, sustainability, ICT.

#### 1. INTRODUCTION

In recent years, ICT services and digital services supported the emergence of mobile health (mHealth) in healthcare systems. As illustrated in Fig. 1, mHealth encompasses (i) smartphone-based health applications and (ii) wearable devices that monitor physiological parameters. These mobile technologies aim at enhancing medical and public health practice by enabling continuous patient data collection beyond traditional clinical settings [1]. This, in turn, facilitates data-driven insights into medical conditions, supporting a more personalized and preventive healthcare infrastructure. Typical examples of existing mHealth devices include: smart watches, contact lenses or smart contact lenses [2], glucose monitoring systems [3], fall detection sensors [4], and glucose sensors [5].

It is often pointed out that mHealth will see main potentials. First, it offers opportunities to improve healthcare



Fig. 1. Mobile health technologies in healthcare systems. mHealth is through health applications and wearable devices. It operates within the broader mHealth ecosystem. The paper focuses on emissions from the monitoring CGM devices. Types adapted from [1].

accessibility and efficiency linked, it could help address challenges associated with chronic diseases such as [6], support care for aging populations in various countries [8], improve access to health services in low-income countries [3], [9], [10], and facilitate managing the growing burden of chronic diseases [12]. Second, mHealth is considered a key lever in decreasing the environmental impacts of the healthcare sector, needed by reducing patient transportation and operating resources [1]. This is of importance, knowing that healthcare contributes between 1% and 2% of global environmental impacts depending on which indicator is considered, e.g., GHG for global greenhouse gas emissions [13].

A common example of mHealth technologies is continuous glucose monitoring (CGM) devices, which are increasingly available for digital diabetes management and care as the case study for this work. These sensors prevent, monitor and can be placed on the skin or subcutaneous. They measure glucose levels in the interstitial fluid of the skin via a microtubular needle and continuously with noninvasive applications to provide real-time estimates of blood glucose concentration.

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## 01/28/2026 - Typical Costs of T1D Affiliated Devices

Lauren Klein - Jan 29, 2026, 3:06 PM CST

### Title: Type 1 Diabetes Primary and Accessory Devices Costs

Date: 01/28/26

Content by: Lauren

Present: Individual

Goals: To learn how much money T1D devices typically costs, directly associating with mental impact on patients/parents.

Search Engine: Google Scholar

Search Term: market costs of typical type 1 diabetes accessory devices

Citation: A. Addala *et al.*, "Cost considerations for adoption of diabetes technology are pervasive: a qualitative study of persons living with type 1 diabetes and their families," *Diabetic Medicine*, vol. 38, no. 10, Apr. 2021, doi: <https://doi.org/10.1111/dme.14575>.

### Content:

"Advances in diabetes technology in the last decade have resulted in a marked rise in diabetes technology use and are associated with improvements in type 1 diabetes outcomes.<sup>1,2</sup> In particular, continuous glucose monitoring (CGM) and hybrid closed-loop systems have emerged as promising new technology.<sup>3-5</sup> CGM use alone, irrespective of type of insulin delivery, is associated with an improvement in HbA<sub>1c</sub>.<sup>6</sup> Hybrid closed-loop systems have consistently demonstrated improvements in HbA<sub>1c</sub> and time in range while decreasing rates of hypoglycaemia, severe hypoglycaemia and diabetic ketoacidosis.<sup>3-5</sup> Additionally, hybrid closed-loop systems have shown improvements in diabetes distress, quality of life and health-related quality of life."

"With increasing government approval of algorithms that allow for automated insulin delivery as well as the increased adoption of do-it-yourself hybrid closed-loop algorithms, it is important to understand barriers in adoption of these technologies in order to facilitate equitable uptake across all persons with type 1 diabetes. While diabetes technology uptake has increased over the last decade, population and registry data suggest that there is a differential uptake in youth from lower socio-economic status families.<sup>8,9</sup> Taken with the fact that the most commonly cited barrier to diabetes technology use is cost,<sup>10,11</sup> financial considerations may play a role in this differential uptake."

"Monetary and non-monetary costs of diabetes technology have been implicated in glycaemic control and adoption of technology. Monetary cost, such as out of pocket costs to secure diabetes technology coverage, may be a barrier to diabetes technology adoption. Non-monetary costs, such as travel to collect prescriptions and time spent coordinating shipment of technology, are also considered barriers to diabetes technology adoption. Cost may affect people across and within countries differently as is seen in the United States with variability in public payer coverage by state and county.<sup>13,14</sup> Similarly, in the United Kingdom, despite payers such as the National Health Service, there is a tenfold variation in access to insulin pump therapy.<sup>15</sup> In addition, a study evaluating insulin pump uptake in Ireland demonstrated that reimbursement alone as a cost consideration does not fully account for uptake of insulin pumps."

"Qualitative studies are foundational in understanding the lived experience of type 1 diabetes as well as factors surrounding diabetes technology uptake and use.<sup>10,16</sup> These evaluations are particularly important when aiming to improve diabetes technology uptake as clinicians often misidentify or over identify barriers to diabetes technology use, which can lead to inadvertent gatekeeping and/or irrelevant solutions that are out of touch with the person's actual barriers.<sup>17</sup> "

"The INSPIRE study was a rigorous mixed-methods evaluation, including extensive qualitative investigation of the psychosocial factors associated with automated insulin delivery systems among persons living with type 1 diabetes and their families ( $n = 284$ ) in the United States and the United Kingdom.<sup>10</sup> Major themes critical for automated insulin delivery uptake included trust and control of the system, features of the systems and barriers to adoption. In addition to these critical considerations, financial aspects of automated insulin delivery systems emerged as a major barrier in the anticipated adoption of these systems. Therefore, the goal of this study is to analyse the qualitative data to further delineate the nuances of cost as a barrier in all of its forms as described by four stakeholder groups: youth, parents, adults and partners."

"In the larger INSPIRE study, 134 qualitative sessions (58 sessions in the United Kingdom and 76 sessions in the United States) were carried out. The mean duration of the qualitative sessions was approximately 45 min with approximately 7 participants per session. The qualitative sessions included 284 total participants (51 youth, 65 parents, 113 adults and 55 partners) and 24 a priori codes were consolidated into 12 thematic clusters."

- "This analysis was completed by nine raters in an iterative consensus-coding process. Participants in this study represent the broader population of people with type 1 diabetes and their views on cost. The qualitative sessions included those who utilized or accessed diabetes technology (such as CGM and insulin pumps) as well as those who utilized or accessed automated insulin delivery systems in particular. Inter-rater agreement of the themes presented was established both quantitatively and qualitatively in the INSPIRE study. A detailed description of study methodology and protocol for the larger INSPIRE study has been previously published.[10](#)"

- "All data were organized by stakeholder groups: (1) *youth*: youth with type 1 diabetes, (2) *parent*: parents or identified caregivers of youth with type 1 diabetes, (3) *adult*: adults with type 1 diabetes and (4) *partner*: partners of adults with type 1 diabetes."

- "The dataset with the cost-related codes was anonymized, and therefore it was not possible to report demographic data. However, these data are presented for the broader INSPIRE study.[10](#) The age range of the adults in the INSPIRE study was 18–77 years of age with a mean age of 39.5 years; 92% of the cohort self-identified as non-Hispanic White and 73% had a bachelor's degree or higher. The age range for youth was 9–21 years. Approximately 80% of the parents who responded were mothers and 90% of the parents identified their child's race as non-Hispanic White. As with the other stakeholder groups, partners were predominantly non-Hispanic White (95%)."



-“We report that monetary and non-monetary cost considerations were important in automated insulin delivery uptake for all four stakeholder groups, spanning the individual, their family and society at large. As diabetes technology becomes more advanced and effective, understanding the lived experience and cost considerations of automated insulin delivery systems is necessary to ensure equitable access and uptake. Participants reported their prior experiences with diabetes technology shaped their perception of automated insulin delivery adoption.”

"The current findings extend prior reports of financial considerations<sup>10,17</sup> to demonstrate a broad consensus that cost, as experienced by stakeholder groups, is not only a monetary issue but also includes non-monetary costs such as time, energy, costs to society, morality and interpersonal relationships. A detailed understanding of the nuances of monetary and non-monetary cost in the uptake of automated insulin delivery offers important insight on strategies to bridge the disparities seen in diabetes technology use."

"Themes such as affordability or a sense that diabetes technology is priceless describe individual-level themes, whereas the concern about the monetary cost of diabetes technology on family finances describes interpersonal themes. Insurance themes discussed the strong relationship between insurance coverage and diabetes technology access. Participants discussed the perception that public payers appear to require an overwhelming amount of evidence before they would reimburse and cover diabetes technology. This perception may stem from the lag time in covering diabetes technology that is particularly common with public insurers.<sup>13-15</sup> The broadest themes that were discussed were organizational themes, such as the business of diabetes, and policy themes, such as access to diabetes technology for all."

"Monetary and non-monetary cost as a stressor was discussed across all thematic levels (from policy-level to individual-level consideration) and by all stakeholder groups. The management of type 1 diabetes carries psychosocial burden, namely an increase in diabetes-related distress.<sup>16,23,24</sup> These data underscore the contribution of cost to the psychosocial burden of type 1 diabetes given that cost as a stressor was discussed across all thematic levels and by all stakeholder groups. Our findings support addressing non-monetary cost for all stakeholders involved in an individual with type 1 diabetes. Incorporating discussions about guilt around type 1 diabetes cost, time spent with payers, taking health risks for coverage and insurance-related barriers during clinical encounters with youth and adults with type 1 diabetes and their families may be yet another way to decrease the psychosocial burden of type 1 diabetes."

"The themes outlined in this study offer healthcare providers important insights on monetary and non-monetary cost concerns among their patients. For example, healthcare providers may overestimate financial cost of device and supplies and the impact of insurance coverage as barriers to device use. These misunderstandings can obstruct shared decision making and limit discussions about newer technologies that may have a clinical benefit.<sup>17</sup> Although monetary cost is a concern for many families, many also report wanting to weigh the pros and cons themselves and in collaboration with their providers in their decision to start diabetes technology. Understanding this can allow medical teams instead to invest in resources to help families access technologies, assist in overcoming insurance barriers and have collaborative discussions with patients regarding their perceptions about cost as a barrier to diabetes technology uptake."

"These data offer insight into the other aspects of non-monetary cost that stakeholders consider such as equity and access, cost to their relationships and time spent on assuring type 1 diabetes coverage. The time lost in phone calls and outreach to insurance companies, pharmacies and doctors' offices to secure covered diabetes devices is itself a non-monetary cost of diabetes technology use. However, it is important to consider that inherent to spending this time required is a certain amount of health literacy to navigate the medical system as well as flexibility to make lengthy phone calls during standard business hours and work hours without threat to job and financial security. In addition to insurance coverage and monetary costs, these non-monetary costs (time spent) as well as health literacy are barriers to equitable care."

"Interestingly, all stakeholder groups discussed the importance of equitable access to advanced diabetes technology as an important ethical principle and consideration in the integration of diabetes technology into the mainstream management of type 1 diabetes. Although equitable access was discussed, many also felt that diabetes technology is worth any monetary cost while acknowledging equitable access for all is limited by finances. Even among families who could more easily afford costs associated with diabetes technology, concerns about equity, accessibility and cost impacts on the overall diabetes community were important."

"Studies have demonstrated that disparities in diabetes technology exist by race/ethnicity<sup>8,9,25</sup> as well as by socio-economic status.<sup>8</sup> The policy-level themes that were discussed underscored the fact that adoption of new technology first occurs by those of higher socio-economic status.<sup>26,27</sup> If cost as a consideration for technology uptake is left unaddressed, risks of widening gaps in diabetes outcomes through disparities in access exist. Our interpretation of these data offers an easy-to-understand framework for making technology accessible, thereby promoting wider diabetes technology incorporation and addressing the multiple dimensions of costs associated with a chronic illness."

"Although nearly all themes were consistently expressed across the stakeholder groups, insurance-level barriers and guilt of type 1 diabetes cost were expressed differently by the parents of youth with type 1 diabetes. Parents reported more insurance concerns including time spent with insurance companies to receive benefits and coverage, which is characterized as a hidden cost of gaining access to diabetes technologies. Parents never reported guilt around type 1 diabetes cost despite the three other stakeholder groups' discussions about guilt. However, excepting these two discrepancies, the remainder of the themes expressed was consistently discussed across the stakeholder groups, indicating that cost considerations were important irrespective of the stakeholder group."

"Overall, there were high levels of inter-rater agreement about the mutual presence of themes in stakeholder accounts as well as mutual absences. We report Kappa coefficients indicating moderate agreement (0.43–0.64). Kappa coefficients account for raters' agreeing by chance and are conservative measures of inter-rater agreement that may result in lower levels of agreement when there is heterogeneity among the possible codes as well as discrepancies in the coding segment size.<sup>28</sup> Given the small sample of segments evaluated in Kappa calculations, near perfect rater agreements are not reflected and more granular considerations of data would likely elevate the Kappa coefficients."

"Therefore, in addition to more standard evaluation of Kappa coefficients, qualitative research may be assessed by methodological and interpretative rigor evaluating research reliability, credibility and trustworthiness. Methodologically, the study sample is adequate and the research question and analyses are valid. Detailed documentation of the analysis process enhances replicability. External credibility and reliability are supported by researchers' engagement with the subject matter, raters' discussion regarding the complexity of the themes identified, and observations of similar

experiences among patients and families served by our research team with rich research and clinical expertise. Our team approach and possibilities for triangulation both across researchers and across theoretical frameworks enhance the analytic generalizability of our model."

"The material and non-material elements of costs surfaced in this study are consistent with, though not identical to, healthcare access, insurance and psychosocial themes discussed in other research.<sup>27,31,32</sup> The interwoven and complex nature of how people with type 1 diabetes and their families experience costs lends credibility to the study findings. Though this study is a secondary analysis, the insights provided here suggest future areas of exploration when trying to assist such families as they cope with their diagnoses and management. The multiple dimensions of costs discussed by stakeholder groups cannot readily be identified by survey or quantitative research, but may help develop scales for future assessment of multidimensional cost impacts among similar stakeholder groups."

"Limitations of this study include the secondary nature of these analyses. While cost and insurance matters emerged consistently during data collection, exhaustive monetary and non-monetary cost questions and follow-up probes did not occur in most focus groups. This limitation is partially mitigated by the variety of stakeholder responses available in the dataset as well as by the pervasiveness of cost and health financing matters across all groups. Representativeness limitations stem from concerns inherent to qualitative research; however, qualitative research is an established method used to highlight and understand patterns of experience and expression across humanity and is especially useful for developing new theories or exploring underappreciated phenomena."

"Generalizability and the potential for sampling bias exist given that our study sample was predominately non-Hispanic white race/ethnicity and had higher levels of both pump and CGM use. The qualitative data were anonymized before we analysed the data and thus, we are not able to differentiate between responses from participants in the United Kingdom versus those in the United States nor by type of technology used. In addition, analyses did not account for participants' geographical location (the United States versus the United Kingdom, or across different states/regions within each country). Findings may have varied based on state- and country-specific policies on insurance coverage and healthcare that may have influenced perceptions of cost. However, the research team's combined experience with this population contributes to their confidence that these data of costs raise important matters worthy of further exploration and discussion among diabetes researchers and practitioners."

"Cost considerations for diabetes technology uptake extend beyond finances alone to include time, energy, insurance and relationship domains. Cost plays a role in contributing to disease management stress and logistics as well as one's attitude and uptake of technological advances in diabetes care. Cost also reflects an important moral principle tied to the shared desire for equitable access to diabetes technology. Knowledge of these considerations can help clinicians and researchers to promote uptake and anticipate barriers to diabetes technology use and is one strategy to bridge disparities in automated insulin delivery uptake for persons living with type 1 diabetes and their families."

-See Results Table in PDF

**Conclusions/action items: Overall Cost can be more than just monetary, it can include time, energy, insurance, stress/mental strain and more. Families shouldn't be burdened by necessary medical costs as much as we are seeing in the US.**

Lauren Klein - Jan 28, 2026, 11:20 PM CST

Received 13 November 2024 | Accepted 20 March 2025
DOI: 10.1111/di.15770

**RESEARCH: CARE DELIVERY**

### Cost considerations for adoption of diabetes technology are pervasive: A qualitative study of persons living with type 1 diabetes and their families

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**Handling editor:** This study was funded by the Leonard and Betty B. Shubert Foundation. Some data were supported from the National Endocrinology Research Institute (NRI) Health Research Institute (HRI) and the Andika Endocrine Endocrinology Fellowship and R15 DK120362-01A001 at Stanford University.

**Abstract**

**Background:** Cost is a major consideration in the uptake and sustained use of diabetes technology. With increasing use of automated insulin delivery systems, it is important to understand the specific cost-related barriers to technology adoption. In this qualitative analysis, we seek to understand the understanding and concern about the decision-making process around cost and diabetes technology use.

**Materials and Methods:** Four focus group transcripts of four stakeholder groups using subject recruiting for each stakeholder group to ensure relevant themes were identified. We applied the Social Ecological Model in the interpretation of five domains: levels of cost.

**Results:** We identified five thematic levels of cost: policy, organizational, insurance, interpersonal and individual. Equitable diabetes technology access was an important policy-level theme. The insurance level theme had multiple subthemes which predominantly centered on a negative balance. Participants also emphasized the psychological burden of cost specifically about living diabetes costs to their families, the goal of diabetes self-care, and frustration in the time and investment required to ensure insurance coverage.

**Conclusions:** We found broad consensus in how cost is experienced by stakeholder groups. Cost considerations for diabetes technology uptake extended beyond finances to include time, cost to society, morality and interpersonal relationships. Cost also reflected an important moral principle tied to the shared desire for equitable access to diabetes technology. Knowledge of these considerations can help clinicians and researchers promote equitable device uptake while anticipating barriers for all persons living with type 1 diabetes and their families.

**KEYWORDS**  
diabetes research, automated insulin delivery, diabetes technology, psychosocial barriers

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**Diabetic\_Medicine\_-\_2021\_-\_Addala\_-\_Cost\_considerations\_for\_adoption\_of\_diabetes\_technology\_are\_pervasive\_A\_qualitative.pdf (257 kB)**



## 02/16/2026 - C6 (Seeed Studio XIAO ESP32)

Lauren Klein - Mar 10, 2026, 8:39 PM CDT

**Title:** ESP32 C6 Summary

**Date:** 02/16/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn more about the C6 as an individual microcontroller (specs, etc)

**Citation:** "Getting Started with Seeed Studio XIAO ESP32C6 | Seeed Studio Wiki," *Seeedstudio.com*, Aug. 05, 2024.  
[https://wiki.seeedstudio.com/xiao\\_esp32c6\\_getting\\_started/](https://wiki.seeedstudio.com/xiao_esp32c6_getting_started/)

**Search Term:** XIAO ESP32 C6

**Search Engine:** Google

**Content:**

Board Overview

- **Seeed Studio XIAO ESP32C6** is a compact IoT development board powered by the **ESP32-C6 SoC**.
- It contains **two 32-bit RISC-V processors**:
  - High-performance processor up to **160 MHz**
  - Low-power processor up to **20 MHz**.
- The chip includes **512 KB SRAM and 4 MB Flash**, providing space for embedded programs and IoT applications.
- Designed for **wireless IoT devices, smart home systems, and embedded control projects**.

Wireless Connectivity

Supported Communication Protocols

The XIAO ESP32C6 supports multiple wireless technologies:

- **2.4 GHz Wi-Fi 6 (802.11ax)**
- **Bluetooth 5.3 / BLE**
- **Zigbee**
- **Thread (IEEE 802.15.4)**

These features allow the board to be used for **Matter-compatible smart home systems and interoperable IoT devices**.

Hardware Specifications

Processing and Memory

- Processor: **ESP32-C6 SoC**
- Architecture: **Dual 32-bit RISC-V cores**
- High-performance core speed: **up to 160 MHz**
- Low-power core speed: **up to 20 MHz**
- Memory:

- **512 KB SRAM**
- **4 MB Flash storage**

#### Physical Characteristics

- Board size: **21 mm × 17.8 mm**
- Compact **thumb-sized design** suitable for:
  - Wearable devices
  - Embedded sensors
  - Small IoT modules.

#### Interfaces and I/O

The board includes multiple interfaces for connecting peripherals:

#### Communication Interfaces

- **UART**
- **LP\_UART**
- **I2C**
- **SPI**
- **SDIO**

#### Input / Output

- **11 GPIO pins**
- **PWM support**
- **7 ADC channels**

#### Additional Hardware

- **Reset button**
- **Boot button**
- **User LED**
- **Charge LED**
- **Onboard antenna**
- **UFL external antenna connector.**

#### Power and Energy Features

##### Power Inputs

- **USB Type-C input:** 5 V
- **Battery input:** 3.7 V lithium battery.

##### Power Modes

The ESP32C6 supports several power modes:

- **Modem sleep:** ~30 mA

- **Light sleep:** ~3.1 mA
- **Deep sleep:** ~15  $\mu$ A.

These low-power modes make it suitable for **battery-powered IoT devices**.

#### RF Antenna Switching

The board allows switching between **two antennas**:

- **Onboard ceramic antenna**
- **External UFL antenna**

Control pins:

- **GPIO3** must be set **LOW** to enable RF switch control.
- **GPIO14 LOW** → use onboard antenna (default).
- **GPIO14 HIGH** → use external antenna.

This allows improved signal performance for different applications.

#### Pin Functions

Common pin assignments include:

- **D0–D2:** Analog input / GPIO
- **D3–D5:** Digital GPIO / I2C
- **D6:** UART TX
- **D7:** UART RX
- **D8:** SPI clock
- **D9:** SPI MISO
- **D10:** SPI MOSI
- **EN:** Reset pin
- **BOOT:** Enter bootloader mode.

Pins can also support alternate functions such as **ADC, SPI, UART, I2C, and JTAG debugging**.

#### Hardware Setup

##### Required Components

To begin using the board, you need:

- **1 × XIAO ESP32C6 board**
- **1 × computer**
- **1 × USB-C cable**

Important note:

- Some USB cables provide **power only and do not support data transfer**, which prevents programming the board.

#### Soldering Headers

- The XIAO ESP32C6 **does not come with pre-installed pin headers**.
- Headers must be **soldered manually** to connect sensors or expansion boards.
- Care must be taken due to the **small size of the board** to avoid short circuits.

### Bootloader Mode

Bootloader mode helps fix issues such as **failed uploads or missing serial ports**.

#### Steps to Enter Bootloader Mode

1. Press and hold the **BOOT button**.
2. Connect the board to the computer via USB.
3. Release the BOOT button after connection.
4. Upload a test program (e.g., Blink).

This mode allows **reprogramming the board when normal uploading fails**.

### Reset Function

- Pressing the **Reset button** restarts the board and reruns the uploaded program.
- Holding **BOOT during startup and pressing Reset** also enters bootloader mode.

### Arduino IDE Setup

#### Required Software

The recommended programming environment is the **Arduino IDE**.

Minimum requirements:

- **Arduino IDE installed**
- ESP32 board package **version  $\geq$  2.0.8**.

#### Setup Steps

1. Install Arduino IDE.
2. Open **Preferences**.
3. Add the board manager URL:  
  
`https://espressif.github.io/arduino-esp32/package_esp32_index.json`
4. Install the **ESP32 board package**.
5. Select **XIAO\_ESP32C6** as the target board.

### Running the First Program

To test the board:

1. Open Arduino IDE.
2. Go to:  
  
File → Examples → 01.Basics → Blink
3. Select **XIAO ESP32C6** as the board.

4. Select the correct **COM port**.
5. Upload the program.

Successful upload causes the **onboard LED to blink**, confirming proper operation.

### Battery Usage

#### Battery Power

- The board supports **3.7 V rechargeable lithium batteries**.
- Battery can be **charged via the USB-C port**.

Important note:

- When using battery power, the **5V pin does not output voltage**.

### Charging Indicator

The board includes a **red charging LED**:

Behavior:

- **No battery connected:** LED turns on when USB is plugged in and turns off after ~30 seconds.
- **Battery charging:** LED flashes.
- **Battery fully charged:** LED turns off.

### Reading Battery Voltage

Battery voltage can be measured using **analog pin A0**.

Implementation details:

- Requires a **200k resistor voltage divider (1:2 ratio)**.
- Voltage must be halved to stay within ADC limits.

Typical code process:

- Read analog voltage multiple times.
- Average the readings.
- Multiply by 2 to compensate for the voltage divider.

### Deep Sleep Mode

The ESP32C6 includes **deep sleep functionality for power saving**.

#### Characteristics

During deep sleep:

- CPUs and most peripherals turn off.
- Only **RTC memory and controller remain active**.

This drastically reduces power consumption.

### Wake-Up Methods

## External Wake-Up

The board can wake from deep sleep using:

- A **GPIO trigger** (e.g., button press).

Example:

- GPIO0 configured as an external wake-up source.

## Timer Wake-Up

The board can also wake up after a **set time interval**.

Example:

- Device sleeps for **5 seconds**, then automatically wakes up.

This is commonly used for **low-power periodic sensor readings**.

## Resources and Documentation

Available hardware design resources include:

- **ESP32-C6 Datasheet**
- **XIAO ESP32-C6 schematic**
- **PCB design files**
- **KiCad libraries**
- **Pinout diagram**
- **3D board models**

These help engineers **design custom hardware and integrate the board into products**.

## Key Takeaways

- The **XIAO ESP32C6** is a **small, powerful IoT development board** with advanced wireless connectivity.
- Supports **Wi-Fi 6, Bluetooth 5.3, Zigbee, and Thread**, making it suitable for **Matter smart home devices**.
- Includes **dual RISC-V processors, multiple interfaces, and low-power modes**.
- Can be programmed using the **Arduino IDE** and supports **deep sleep for battery-powered IoT applications**.

**Conclusions/action items:** The XIAO ESP32C6 used a IoT development board and has advanced wireless connectivity capabilities which can support WIFI and BLE. It can be programmed using Arduino IDE and has a deep sleep option to conserve battery. We need to start fabrication using the parts we ordered.

9:02B, 6:41 PM WiFi Usage | Seed Studio Wiki

XIAO XIAO ESP32C6 Wireless Connectivity WiFi Usage

## WiFi Usage with Seed Studio XIAO ESP32C6

Seed Studio XIAO ESP32C6



Get One Now

The Seed Studio XIAO ESP32C6 is an embedded development board that boasts outstanding RF performance, thanks to its support for both 2.4GHz WiFi - 80/11b/g/n and Bluetooth Low Energy (BLE) S/D dual wireless communication. This capability enables the XIAO ESP32C6 to provide reliable and high-speed wireless connectivity for a wide range of Internet of Things (IoT) applications. The board features an onboard ceramic antenna, which eliminates the need for an external antenna and simplifies the design process. The ESP32C6 chip also offers low power consumption, making it suitable for battery-powered IoT devices. In this tutorial, we will explore how to leverage the XIAO ESP32C6's Wi-Fi capabilities to connect to a Wi-Fi network and perform basic networking tasks.

**TIP**

GPIO14 is used to select between using the built-in antenna or an external antenna. Before that, you need to set GPIO2 low level to turn on this function. If GPIO14 is set low level, it uses the built-in antenna; if it is set to high level, it uses the external antenna. Default is low level. If you want to set it high, you can refer to the code below.

WiFi Usage with Seed Studio Wiki | esp32c6-wifi-usage-wiki

[Download](#)

[WiFi Usage Seed Studio Wiki.pdf \(4.5 MB\)](#)


Lauren Klein - Mar 10, 2026, 8:29 PM CDT

9:02B, 6:28 PM Getting Started with Seed Studio XIAO ESP32C6 | Seed Studio Wiki

XIAO XIAO ESP32C6 Getting Started with Seed Studio XIAO ESP32C6

## Getting Started with Seed Studio XIAO ESP32C6

Seed Studio XIAO ESP32C6



Get One Now

### Introduction

Seed Studio XIAO ESP32C6 is powered by the highly-integrated **ESP32-C6 SoC**, built on **two 32-bit RISC-V processors**, with a high-performance (HP) processor with **running up to 160 MHz**, and a low-power (LP) 32-bit RISC-V processor, which can be clocked up to 20 MHz. There are **512KB SRAM and 4 MB Flash on the chip**, allowing for more programming space, and bringing more possibilities to the IoT control scenarios.

XIAO ESP32C6 is **Matter native thanks to its enhanced wireless connectivity**. The wireless stack supports **2.4 GHz WiFi 6, Bluetooth® 5.3, Zigbee, and Thread (802.15.4)**. As the first XIAO member compatible with Thread, it's a perfect fit for building Matter-compliant projects, thus achieving interoperability in smart-home.

WiFi Usage with Seed Studio Wiki | esp32c6-getting-started-wiki

[Download](#)

[Getting Started with Seed Studio XIAO ESP32C6 Seed Studio Wiki.pdf \(3.03 MB\)](#)



## 03/01/2026 - Soldering Flux

---

Lauren Klein - Mar 10, 2026, 8:07 PM CDT

### Title: Soldering Flux & Usage

Date: 03/01/2026

Content by: Lauren

Present: Individual

Goals: To learn how flux can aid us in soldering our circuit further

Citation: S. Wakeel, A. S. M. A. Haseeb, M. A. Afifi, S. Bingol, and K. L. Hoon, "Constituents and performance of no-clean flux for electronic solder," *Microelectronics Reliability*, vol. 123, p. 114177, Aug. 2021, doi: <https://doi.org/10.1016/j.microrel.2021.114177>.

Search Term: Soldering Flux

Search Engine: Google Scholar

### Content:

#### Article Overview

- The article reviews the **composition, chemistry, and performance of no-clean flux (NCF)** used in electronic soldering.
- NCF was developed to **eliminate the need for post-solder cleaning** while leaving minimal residue on printed circuit boards (PCBs).
- It focuses on **flux components, soldering parameters, and compatibility with packaging materials**.
- Major reliability concerns include **corrosion, leakage current, residue formation, and interactions with underfill materials**.

#### Constituents of No-Clean Flux

##### Activators (Weak Organic Acids)

- Activators remove **oxide layers from metal surfaces**, enabling proper solder joint formation.
- Weak organic acids (especially **carboxylic acids**) are commonly used activators.
- Oxide removal occurs through **acid–base reactions that convert metal oxides into salts** during soldering.
- Poor activator selection can lead to **corrosive residues and increased leakage current**.
- Ideal activators should have:
  - **Low solubility**
  - **High acid dissociation constant (pKa)**
  - **Long carbon chain length**
  - **Few carboxyl functional groups**
  - **Low decomposition temperature**

##### Surfactants

- Surfactants improve **wetting and spreading of molten solder on the PCB surface**.
- They reduce **surface tension**, allowing solder to adhere better to the substrate.
- Weak organic acids can also act as **surfactants in some flux formulations**.
- Wetting performance is evaluated by the **contact angle of solder on the surface**:

- $<30^\circ$  → very good wetting
- $30\text{--}40^\circ$  → good wetting
- $40\text{--}55^\circ$  → acceptable wetting
- $55^\circ$  → *poor wetting*

#### Organic Additives

- Additives improve **adhesion, cleaning efficiency, and corrosion resistance**.
- Organic amines are commonly used as **adhesion promoters**.
- Amines react with epoxy underfill materials and improve **compatibility between flux and packaging materials**.
- Composite activators (amine + organic acid) provide **double cleaning action**, improving oxide removal.
- Some additives act as **corrosion inhibitors**, protecting electronic components.

#### Solvents

- Solvents dissolve flux components and **control viscosity and evaporation behavior**.
- Most of the flux composition consists of solvent to ensure **minimal residue after soldering**.
- Ideal solvent properties include:
  - **Low boiling point for easy evaporation**
  - **Thermal stability at soldering temperatures**
  - **Appropriate viscosity for proper spreading**
- Typical solvent boiling point range: **100–250°C**.
- Solvents may be:
  - **VOC-based (organic solvents like alcohols and ethers)**
  - **VOC-free (water-based)**

#### Composition of No-Clean Flux

Typical ranges for NCF composition include:

- **Activator:** ~0.1–15%
- **Solvent:** ~60–99%
- **Additives:** ~0.2–25%

Higher solvent content helps ensure **low residue formation after soldering**.

#### Effects of Soldering Process Parameters

##### Soldering Method

Common soldering techniques include:

- **Reflow soldering**
- **Wave soldering**
- **Selective wave soldering**

Reflow soldering typically produces **less flux residue and better reliability** compared to other methods.

## Soldering Temperature

- Temperature strongly affects **evaporation of flux components**.
- Higher temperatures generally **reduce residue by evaporating solvents and activators**.
- Optimal soldering temperatures are typically **200–250°C**.
- If flux decomposition temperatures are too high, **residue may remain and cause reliability issues**.

## Interaction Between Flux Residue and Underfill

### Physical Compatibility

- Flux residue can interfere with **underfill flow in flip-chip packaging**.
- Excess residue may block flow paths, causing:
  - **Voids**
  - **Delamination**
  - **Reduced mechanical reliability**

Lower residue flux improves **underfill spreading and package reliability**.

### Chemical Compatibility

- Residue components (especially **carboxylic acids and amines**) can react with **epoxy underfill materials**.
- These reactions can alter **mechanical properties and reliability of electronic packages**.
- Proper flux composition ensures **good chemical compatibility with underfill materials**.

## Major Conclusions

- Proper selection of **activators, solvents, and additives** is critical for high-performance NCF.
- **Low-boiling solvents and optimized acid chemistry** reduce residue formation.
- **Reflow soldering** is the most effective method for minimizing flux residue.
- Minimizing flux residue improves **underfill flow and electronic package reliability**.

**Conclusions/action items: Overall Flux can be very helpful in simplifying the soldering process and reliability. The Makerspace has flux available for use and we will use it when we work on the circuitry. We need to avoid excess flux though to make sure we don't have flow path blockage.**





## 03/04/2026 - Arduino IDE

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Lauren Klein - Mar 10, 2026, 8:07 PM CDT

### Title: Arduino Integrated Development Environment (IDE)

Date: 03/04/2026

Content by: Lauren

Present: Individual

Goals: To learn about Arduino IDE and its connection to microcontrollers

Citation: Arduino, "Arduino Integrated Development Environment (IDE) v1 | Arduino Documentation | Arduino Documentation," *Arduino.cc*, 2022. <https://docs.arduino.cc/software/ide-v1/tutorials/arduino-ide-v1-basics/>

Search Term: Arduino IDE

Search Engine: Google

### Content:

Overview of the Arduino IDE

- The **Arduino Integrated Development Environment (IDE)** is software used to **write, compile, and upload programs to Arduino boards**.
- It includes:
  - A **text editor for writing code**
  - A **message area for feedback and errors**
  - A **console displaying detailed output**
  - A **toolbar with common functions**
  - Several **menus for development tools**.

Arduino Integrated Development ...
- The IDE communicates directly with **Arduino hardware to upload and run programs**.

Arduino Programs (Sketches)

### Sketch Basics

- Programs written in Arduino IDE are called **sketches**.
- Sketch files use the **.ino file extension**.
- Older Arduino versions used **.pde files**, which are automatically converted to **.ino** when opened in newer versions.
- The editor includes standard text editing tools such as:
  - Cut
  - Copy
  - Paste
  - Search and replace.

IDE Interface Components

## Message Area

- Displays feedback during operations such as:
  - Saving files
  - Exporting code
  - Compilation errors.

## Console

- Shows **complete error messages and detailed output information** during compilation and uploading.

## Toolbar Functions

Important buttons in the toolbar include:

- **Verify**
  - Compiles code and checks for errors.
- **Upload**
  - Compiles code and uploads it to the selected Arduino board.
- **New**
  - Creates a new sketch.
- **Open**
  - Opens an existing sketch.
- **Save**
  - Saves the current sketch.
- **Serial Monitor**
  - Opens the serial communication window.

## Main Menu Functions

### File Menu

Provides file management tools including:

- Creating new sketches
- Opening sketches
- Viewing recent sketches
- Accessing example programs
- Saving or renaming sketches
- Printing sketches
- Opening IDE preferences.

### Edit Menu

Provides editing tools such as:

- Undo and redo
- Cut, copy, paste

- Select all
- Comment or uncomment code
- Adjust indentation
- Find and replace text.

#### Sketch Menu

Used for compiling and managing sketches.

Key functions include:

- **Verify/Compile**
  - Checks the sketch for errors and reports memory usage.
- **Upload**
  - Compiles and uploads the program to the board.
- **Upload Using Programmer**
  - Uploads code using an external programmer instead of USB.
- **Export Compiled Binary**
  - Saves a compiled **.hex file**.
- **Include Library**
  - Adds external libraries to the sketch.
- **Show Sketch Folder**
  - Opens the folder containing the sketch files.

#### Tools Menu

Provides tools for working with Arduino boards.

Important functions include:

- **Auto Format**
  - Automatically formats code with proper indentation.
- **Serial Monitor**
  - Opens the serial communication window.
- **Board**
  - Selects the Arduino board type being used.
- **Port**
  - Selects the serial communication port.
- **Programmer**
  - Selects a hardware programmer.
- **Burn Bootloader**
  - Installs the bootloader onto a microcontroller.

#### Help Menu

Provides access to documentation including:

- Getting Started guides
- Arduino reference materials
- IDE tutorials.

Sketchbook

Program Storage

- The IDE uses a **Sketchbook folder** as the main directory for storing sketches.
- The sketchbook is automatically created the first time the IDE runs.
- The location of the sketchbook can be changed in **Preferences**.

Multiple Files and Tabs

Managing Larger Programs

- Sketches can contain **multiple files organized in tabs**.
- Supported file types include:
  - Arduino code files (.ino)
  - C files (.c)
  - C++ files (.cpp)
  - Header files (.h)
- During compilation:
  - All Arduino files are **combined into a single program**.
  - Other file types remain separate.

Uploading Programs to Arduino

Upload Process

Before uploading a sketch:

1. Select the correct **Board** in the Tools menu.
  2. Select the correct **Port** for the connected Arduino device.
  3. Click the **Upload button**.
- The IDE compiles the code and transfers it to the board.
  - Many boards **automatically reset during upload**.

Bootloader Function

- Arduino boards contain a **bootloader**, a small program on the microcontroller.
- The bootloader allows uploading code **without additional programming hardware**.
- When the board resets:
  - The bootloader runs briefly.
  - Then the most recently uploaded sketch starts executing.

## Libraries

### Purpose of Libraries

- Libraries add **extra functionality to sketches**, such as hardware support or advanced data processing.
- Libraries are added using:

`#include <library_name>`

- Libraries increase the **program memory used on the board**.
- Libraries can be installed through:
  - The **Library Manager**
  - ZIP file imports
  - Third-party downloads.

### Third-Party Hardware Support

#### Adding New Boards

- Arduino IDE allows support for **third-party boards and hardware platforms**.
- These platforms can include:
  - Board definitions
  - Core libraries
  - Bootloaders
  - Programmer definitions.
- They are installed in the **hardware folder inside the sketchbook directory**.

## Serial Monitor

### Serial Communication

- The **Serial Monitor** displays data sent between the Arduino board and the computer.
- Used for:
  - Debugging programs
  - Viewing sensor outputs
  - Sending commands to the board.
- The baud rate must match the value used in code:

`Serial.begin(baud_rate);`

- Opening the Serial Monitor usually **resets the board and restarts the program**.

## Preferences and Language Support

### Customization

- The Preferences menu allows customization of IDE settings such as:
  - Editor behavior

- Sketchbook location
- Language settings.

### Language Options

- The Arduino IDE supports **30+ languages**.
- By default, the IDE language matches the **operating system language**.
- Users can manually change the language in the **Preferences menu**.

### Supported Arduino Boards

Arduino IDE includes built-in support for many boards, including:

- Arduino Uno
- Arduino Mega
- Arduino Nano
- Arduino Leonardo
- Arduino Micro
- Arduino Mini
- Arduino Ethernet
- Arduino Yún
- LilyPad Arduino
- Arduino Pro / Pro Mini
- Arduino Robot
- Arduino Gemma.

Additional boards can be added through the **Boards Manager**.

### Key Takeaways

- Arduino IDE is the **primary software used to program Arduino hardware**.
- It provides tools for **writing code, compiling programs, uploading to boards, and debugging through serial communication**.
- The IDE supports **libraries, multiple files, and third-party hardware**, making it flexible for embedded system development.
- Built-in board support and an easy graphical interface make Arduino accessible for **both beginners and advanced embedded developers**.

**Conclusions/action items:** Arduino IDE is the software that runs program Arduino hardware. It can write code, compile programs, and then upload and debug the serial communication to boards. There's some built-in support options but can be used by beginners or advanced developers.



## 03/10/2026 - ESP32 Arduino Packages

---

Lauren Klein - Mar 10, 2026, 8:07 PM CDT

**Title:** ESP32 Arduino Packages

**Date:** 03/10/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn about the necessary Arduino Packages for the ESP32 (C6)

**Citation:** "Installing ESP32 in Arduino IDE (Windows, Mac OS X, Linux) | Random Nerd Tutorials," Jul. 05, 2019.  
<https://randomnerdtutorials.com/installing-the-esp32-board-in-arduino-ide-windows-instructions/>

**Search Term:** ESP32 Arduino Packages

**Search Engine:** Google

**Content:**

Installing ESP32 in Arduino IDE — Key Points

Tutorial Overview

- The tutorial explains how to **install ESP32 board support in the Arduino IDE** so the ESP32 can be programmed using Arduino tools and language.
- The process works for **Windows, Mac OS X, and Linux** operating systems.
- Once installed, the Arduino IDE can compile and upload programs directly to ESP32 boards.

Prerequisites

Arduino IDE Installation

- Arduino IDE must be installed before adding ESP32 support.
- Two IDE versions are available:
  - **Arduino IDE 1.8.X (legacy version)**
  - **Arduino IDE 2.X (newer version)**
- Version **1.8.X is recommended** if you plan to use plugins like the SPIFFS filesystem uploader because some plugins are not yet supported in Arduino 2.

Installing the ESP32 Board Package

Step 1 – Open Preferences

- In the Arduino IDE, go to:  
**File → Preferences**

Step 2 – Add ESP32 Board Manager URL

Add the following link to the **Additional Board Manager URLs** field:

[https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package\\_esp32\\_index.json](https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json)

- This URL allows the Arduino IDE to download the ESP32 board definitions.

- If another board URL (like ESP8266) already exists, separate them with a **comma**.

### Step 3 – Open Boards Manager

Navigate to:

Tools → Board → Boards Manager

- This menu allows installing board support packages.

### Step 4 – Install ESP32 Board Support

- Search for **ESP32** in the Boards Manager.
- Select **“ESP32 by Espressif Systems.”**
- Click **Install**.

After installation, ESP32 boards become selectable in the Arduino IDE.

Testing the Installation

### Step 1 – Connect the ESP32

- Plug the ESP32 board into the computer using a USB cable.

### Step 2 – Select the Board

Navigate to:

Tools → Board

Select your ESP32 board model (example: **DOIT ESP32 DEVKIT V1**).

### Step 3 – Select the COM Port

Navigate to:

Tools → Port

- Choose the correct COM port for the ESP32.
- If no port appears, install **CP210x USB-to-UART bridge drivers**.

### Step 4 – Open Example Program

Open the example sketch:

File → Examples → WiFi (ESP32) → WiFiScan

- This example scans nearby WiFi networks.

### Step 5 – Upload the Code

- Press the **Upload** button in the Arduino IDE.
- The code compiles and uploads to the ESP32.
- When finished, the IDE should display:

Done uploading

### Step 6 – View Results in Serial Monitor

- Open **Tools** → **Serial Monitor**.

- Set the **baud rate to 115200**.
- Press the ESP32 **Enable (EN) button**.
- The ESP32 will display a list of nearby WiFi networks.

#### Troubleshooting

Upload Error: "Failed to connect to ESP32"

- Error message example:

A fatal error occurred: Failed to connect to ESP32: Timed out

- This means the ESP32 is **not in flashing mode**.

#### **Solution:**

1. Hold down the **BOOT button** on the ESP32.
2. Click **Upload** in the Arduino IDE.
3. When the IDE shows **Connecting...**, release the BOOT button.
4. The upload should complete successfully.

#### COM Port Not Found

If the ESP32 COM port does not appear:

- Install **CP210x USB to UART Bridge drivers** for your operating system.
- Restart the Arduino IDE and reconnect the board.

#### Final Setup Result

- After installation and testing, the ESP32 is ready for development.
- The Arduino IDE can now:
  - Compile ESP32 programs
  - Upload sketches
  - Use built-in ESP32 libraries
  - Run IoT and networking examples.

**Conclusions/action items:** There is a **primary Arduino Package (see link)** that directly corresponds to the ESP32 XIAO. We need to make sure the computer is running the most up to date version of Arduino IDE or there can be malfunctions. There are some built-in ESP32 libraries needed as well that might need to be uploaded again if the version isn't up to date as well.

## Installing the ESP32 Board in Arduino IDE (Windows, Mac OS X, Linux)

There's an add-on for the Arduino IDE that allows you to program the ESP32 using the Arduino IDE and its programming language. In this tutorial we'll show you how to install the ESP32 board in Arduino IDE whether you're using Windows, Mac OS X or Linux.

Using Arduino 2.0? Follow this tutorial instead: [Installing ESP32 Board in Arduino IDE 2.0](#)

### Watch the Video Tutorial

This tutorial is available in video format (watch below) and in written format (continue reading this page).



[Download](#)

**Installing\_ESP32\_in\_Arduino\_IDE\_Windows\_Mac\_OS\_X\_Linux\_\_Random\_Nerd\_Tutorials.pdf (1.4 MB)**

**Title: LabVIEW Overview and Summary****Date:** 03/10/2026**Content by:** Lauren**Present:** Individual**Goals:** To learn about LabVIEW and how it can help me in industry for my Training Throughout the Curriculum**Citation:** D. LaVine, "Viewpoint Systems," *Viewpoint Systems*, 2019. <https://www.viewpointusa.com/labview/what-is-labview-used-for/>**Search Term:** LabVIEW usage in industry**Search Engine:** Google**Content:**

## Overview of LabVIEW

- **LabVIEW** is a software development environment created by **National Instruments**.
- It is widely used for **automated testing, measurement, and control applications**.
- LabVIEW programs are created using a **graphical programming approach** instead of text-based code.
- The actual programming language used is called "**G**", though most people simply refer to it as LabVIEW.
- Programs are built by **connecting functional blocks in a data-flow diagram**, similar to drawing a system diagram.

## Main Uses of LabVIEW

## 1. Automated Manufacturing Testing

- LabVIEW is commonly used to **automatically test products during manufacturing**.
- These tests verify that components, subsystems, or full systems **meet specifications before leaving production**.
- Major goals of manufacturing test systems include:
  - **Consistent testing**
  - **Reducing human error**
  - **Increasing testing speed (throughput)**
  - **Improving reliability and uptime**.
- Examples include:
  - Production testing of complex subsystems
  - Automated end-of-line testers
  - Inspection systems for manufacturing lines.

## 2. Automated Product Design Validation

- LabVIEW is used during **product development** to verify that designs work properly before production begins.
- Validation systems test products under **different operating conditions**.
- Typical parameters tested include:

- Temperature
- Power supply voltage
- Pressure
- Environmental conditions.
- Automation allows engineers to **run repeated tests and analyze large datasets efficiently.**
- Examples include:
  - Endurance testing systems
  - Actuator test stands
  - Environmental chamber monitoring systems.

### 3. Control and Monitoring of Industrial Equipment

- LabVIEW can control and monitor **machines, industrial equipment, and manufacturing processes.**
- It is commonly used for **industrial embedded systems.**
- Major advantages include:
  - **Rapid system development**
  - Ability to use **off-the-shelf hardware**
  - **Precise timing control**
  - Acquisition of **high-speed signals.**
- Example applications:
  - Monitoring manufacturing equipment
  - Embedded control systems
  - Remote monitoring of electrical power systems.

### 4. Condition Monitoring of Machines

- LabVIEW can continuously monitor the **health and performance of industrial equipment.**
- The main goals of condition monitoring are:
  - **Improving machine reliability**
  - **Increasing equipment uptime**
  - **Reducing maintenance costs.**
- Example systems include:
  - Remote industrial equipment monitoring
  - Structural health monitoring
  - Monitoring power generation systems.

### Functions LabVIEW Can Perform

#### Mathematical and Logic Operations

LabVIEW contains large libraries of built-in functions that perform:

- Basic arithmetic calculations

- Conditional logic statements (if/then/else)
- Case structures
- Signal processing
- Fast Fourier Transforms (FFT)
- Filtering
- PID control loops.

#### Integration With Other Programming Languages

- LabVIEW can interface with code written in other languages using:
  - **DLL libraries**
  - **.NET assemblies**
  - **Runtime interpreters such as MATLAB.**
- This allows engineers to integrate LabVIEW with existing software systems.

#### Interaction With Real-World Systems

LabVIEW interacts with real-world devices in four primary ways:

##### 1. Graphical User Interfaces (GUI)

- Programs can display **user interfaces on monitors or touch panels.**
- Users can visualize data and control systems interactively.

##### 2. Instrument Communication

LabVIEW can communicate with laboratory instruments using interfaces such as:

- **GPIB**
- **Ethernet**
- **USB**
- **PCI**
- **RS-422**

Examples of connected instruments include:

- Power supplies
- Multimeters
- Oscilloscopes
- Spectrum analyzers
- Signal generators.

##### 3. Measuring Physical Signals

Using National Instruments hardware, LabVIEW can measure signals such as:

- Temperature
- Pressure
- Vibration

- Current
- Voltage
- Flow rate
- Light
- Acoustics
- Force
- Position or orientation
- Humidity
- RF emissions
- Magnetic fields.

#### 4. Controlling Physical Signals

LabVIEW can also **control physical systems**, including:

- Motors
- Actuators
- Mass-flow controllers
- Industrial automation equipment.

#### Hardware Platforms for LabVIEW

LabVIEW software can run on several hardware platforms:

- **Windows-based PCs**
- **PXI systems**
- **NI CompactRIO (cRIO)**
- **NI Single-Board RIO (sbRIO).**

Choice of hardware depends on:

- **System size requirements**
- **Production volume**
- **Required input/output interfaces.**

**Conclusions/action items:** LabVIEW is primarily used in industry in order to look further into testing and measuring. It helps integrate hardware with software and analyze real world circuit systems. It shows the systems graphically and promotes rapid prototyping.





## 03/16/2026 - Poly Lithium Ion Battery Recharging

Lauren Klein - Apr 14, 2026, 4:41 PM CDT

**Title:** Poly Lithium Ion Battery Recharging

**Date:** 03/16/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn how to safely and efficiently recharge our battery

**Search Engine:** Google

**Search Term:** Poly Lithium Ion Batteries and How to recharge them

**Citation:** H. Moshiri and H. Moshiri, "How to correctly charge the lithium-ion/lithium-polymer batteries - Power Electronics News," *Power Electronics News*, Mar. 28, 2024. <https://www.powerelectronicsnews.com/how-to-correctly-charge-the-lithium-ion-lithium-polymer-batteries/>

**Content:**

### Big Picture + Design Philosophy

- **"An efficient charging method increases the battery's lifetime and enhances its performance."**
  - Charging is NOT just delivering energy → it directly impacts:
    - Cycle life (how many times you can recharge)
    - Capacity retention (how much energy remains usable over time)
    - Safety (thermal runaway risk)
  - Poor charging design leads to:
    - Reduced capacity
    - Internal chemical degradation
    - Increased internal resistance
- **Engineering takeaway:**
  - Battery charging must be treated as a **controlled electrochemical process**, not just electrical input

### Fundamental Properties of Lithium Batteries

- **"Lithium is the lightest available metal... provides the largest energy density."**
  - → High energy-to-weight ratio = ideal for portable/wearable systems
- **"Lithium is inherently unstable, especially during charging."**
  - Instability arises from:
    - Reactive lithium ions
    - Sensitivity to voltage and temperature
  - Charging errors can cause:
    - Lithium plating
    - Gas formation
    - Thermal runaway (fire/explosion)

**Key concept:**

Lithium batteries are **energy-dense but fragile systems that require strict electrical control**

### Li-ion vs LiPo

- Lithium-ion:
  - Liquid electrolyte
  - Higher energy density
  - Rigid cylindrical/prismatic packaging
- Lithium-polymer:

- Allows:
  - Thin, flexible shapes → ideal for compact designs
- Tradeoffs:
  - **Higher internal resistance** → **voltage drops under load**
  - Lower peak current capability (important for LEDs/motors)
- **Engineering implication:**
  - LiPo batteries are great for form factor, but:
    - You must carefully manage **current draw spikes**
    - Voltage sag can occur under load

## Charging Curve

The charging process is **state-dependent and nonlinear**, meaning:

- The battery itself dictates how it should be charged
- The charger must respond dynamically

### 1. Pre-Charge (Trickle Phase)

- Trigger:
  - **Voltage < 2.8 V**
- Important quote:
  - **“Battery should not fall below 3.2 V... otherwise dead and needs rejuvenation.”**
- Current:
  - **10–20% of rated capacity**
- Why this stage exists:
  - Deep discharge causes:
    - Chemical instability
    - Increased internal resistance
  - Applying high current immediately would:
    - Overheat the battery
    - Cause irreversible damage

#### Engineering reasoning:

- Battery behaves differently when deeply discharged → must “recover” slowly

### 2. Constant Current (CC Phase)

- Begins when:
  - Battery reaches safe voltage (~2.8V+)
- Current:
  - **0.5C to 1C typical**
- Behavior:
  - Current fixed → voltage increases over time
- What’s happening physically:
  - Lithium ions move from cathode → anode
  - Energy stored increases steadily

#### Key concept:

- This phase delivers **most of the battery’s energy capacity**

### 3. Constant Voltage (CV Phase)

- Voltage fixed at:
  - **4.2 V (critical upper limit)**
- Behavior:
  - Current gradually decreases as battery saturates

- Stop condition:
  - **Current  $\approx$  10% of initial CC current**

#### What's happening physically:

- Battery is nearing full charge  $\rightarrow$  internal resistance increases
- Less current flows naturally

## Critical Safety Constraints

- **"4.20 V is a critical value... otherwise the battery will be damaged or explode."**
- Overvoltage causes:
  - Lithium plating
  - Heat buildup
  - Structural breakdown
- Cheap chargers:
  - Skip CV stage  $\rightarrow$  terminate early  $\rightarrow$  unsafe/inaccurate

#### Engineering takeaway:

- Charging requires **precise voltage regulation ( $\pm 1\%$ )**

## Practical Charger Design

- Two main approaches:
  - Custom control (complex)
  - Dedicated IC (recommended)
- Example:
  - LTC1733:
    - Integrated CC + CV control
    - Accurate voltage regulation
- Additional insight:
  - **"reverse current draw is shallow"**
  - $\rightarrow$  Charger won't drain battery when disconnected

#### This system is:

- Nonlinear
- Time-dependent
- Safety-constrained
- Controlled by feedback (voltage + current sensing)

**Conclusions/action items: Right now our battery is fully drained. Adding back on the JST connectors and being able to attach and reattach it to our microcontroller and to the battery will be our best bet. This is likely caused from over 4.2 Volts shooting in.**





## 03/22/2026 - Boost Converters

Lauren Klein - Apr 14, 2026, 4:41 PM CDT

**Title:** Boost Converters

**Date:** 03/22/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn how boost converters work in shifting DC voltages

**Search Engine:** Google

**Search Term:** Boost Converters in DC circuits

**Citation:** "Client Challenge," *Monolithicpower.com*, 2026. [https://www.monolithicpower.com/en/learning/mpscholar/power-electronics/dc-dc-converters/boost-converters?srsId=AfmBOooQBsaGPMJu\\_4zR232NyKP\\_wM4M95DzrhLiza3PNkaFP1vGXzkK](https://www.monolithicpower.com/en/learning/mpscholar/power-electronics/dc-dc-converters/boost-converters?srsId=AfmBOooQBsaGPMJu_4zR232NyKP_wM4M95DzrhLiza3PNkaFP1vGXzkK) (accessed Apr. 14, 2026).

**Content:**

### Big Picture + Purpose

- **"Boost converters... increase the input voltage to a higher output voltage."**
- Used when:
  - Supply voltage is too low for load
- Example (your system):
  - 3.7V battery → 5V LED

**Core idea:**

- You cannot linearly "create" voltage → must **store and transfer energy dynamically**

### Fundamental Energy Principle

- Boost converters rely on:
  - **Energy storage in magnetic field (inductor)**
  - Controlled release to increase voltage
- This is a **switching system**, not continuous analog amplification

### Two-Phase Operation

#### Switch ON (Energy Storage Phase)

- Inductor connected to input:
  - Current increases linearly
  - Energy stored =  $(1/2) L I^2$
- Diode:
  - Reverse-biased → isolates output
- Load:
  - Powered temporarily by capacitor

**Key insight:**

- Energy is being "saved" in magnetic field

#### Switch OFF (Energy Transfer Phase)

- Inductor current must continue (physics: current continuity)
- Inductor reverses polarity:

- Adds to input voltage
- Diode:
  - Forward-biased → energy flows to output
- Result:
  - Output voltage > input voltage

**Key insight:**

- Inductor acts like a **voltage booster by opposing current change**

## Core Equation

- “ **$V_{out} = V_{in} / (1 - D)$** ”

## Interpretation

- D = duty cycle (fraction of time switch is ON)
- As D increases:
  - Inductor stores more energy
  - Output voltage increases

## Physical Limits

- D cannot reach 1 because:
  - Switch would never turn off → no energy transfer
- Real systems limited by:
  - Losses
  - Component ratings
  - Efficiency constraints

## Components

- Inductor:
  - Stores energy
  - Controls current ripple
- MOSFET switch:
  - High-speed switching
  - Controls duty cycle
- Diode:
  - Prevents reverse current
- Capacitor:
  - **“stabilizes and smooths output voltage”**
- Load:
  - Determines required power

## Conduction Modes

### Continuous Conduction Mode (CCM)

- Inductor current never reaches zero
- Advantages:
  - Lower ripple → smoother output
  - Higher efficiency → less loss
- Disadvantages:
  - Requires larger inductor

### Discontinuous Conduction Mode (DCM)

- Inductor fully discharges each cycle

- Advantages:
  - Smaller, cheaper components
- Disadvantages:
  - **Higher peak currents**
  - **More ripple**
  - Lower efficiency

## Design Tradeoffs

- Switching frequency:
  - High → smaller components
  - Low → higher efficiency
- Inductor size:
  - Larger → smoother current
  - Smaller → more ripple
- Capacitor:
  - Larger → less voltage ripple

Boost converters:

- Convert energy **temporally (store → release)**
- Are:
  - Nonlinear
  - Controlled via PWM (duty cycle)

**Conclusions/action items: A boost converter would work well to fix the voltage issue we are having with our battery and circuit. The primary issue a boost converter would pose is the size as it wouldn't fit in our box. We will continue looking into alternative solutions.**

---

Lauren Klein - Apr 14, 2026, 4:09 PM CDT



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**Boost\_Converters\_Step-Up\_Converter\_.pdf (654 kB)**



## 03/24/2026 - Level Shifters

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Lauren Klein - Apr 14, 2026, 4:40 PM CDT

**Title:** Level Shifters

**Date:** 03/24/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn how Level Shifters work in shifting DC voltages

**Search Engine:** Google

**Search Term:** How do level shifters work in DC circuits

**Citation:** D. Johanneck, "Logic Level Shifting Basics," *DigiKey*, Aug. 05, 2021. <https://www.digikey.com/en/blog/logic-level-shifting-basics>

**Content:**

### Big Picture Problem

- **"Mixing high and low logic voltages... requires predictable behavior."**
- Modern systems:
  - Use multiple voltage standards simultaneously

### Why Direct Connection Fails

- **"3.3V signal on a 5V pin 'should work' but not always."**
- Reasons:
  - Logic HIGH threshold varies by device
  - Noise margins can cause misinterpretation
  - Voltage mismatch can:
    - Cause unreliable switching
    - Damage components

### Purpose of Level Shifting

- Ensures:
  - Correct logic detection
  - Safe voltage compatibility
- Required for:
  - Communication buses
  - Sensor interfaces
  - Microcontroller ↔ peripheral interaction

### MOSFET-Based Level Shifting

- Uses:
  - N-channel MOSFET
  - Pull-up resistors on both sides
- Key principle:
  - Uses **VGS threshold behavior** to control conduction

### Operation

#### Logic HIGH State

- Both sides pulled up to their own voltages

- MOSFET OFF:
  - **VGS < threshold**
- Result:
  - No conduction
  - Separate voltage domains maintained

### Logic LOW (Low-Voltage Side Drives)

- Source pulled LOW
- VGS increases:
  - MOSFET turns ON
- Drain pulled LOW → both sides LOW

### Logic LOW (High-Voltage Side Drives)

- Body diode conducts first:
  - Slight voltage drop (~0.7V)
- Then:
  - VGS increases → MOSFET fully turns ON
- Result:
  - Full LOW transmission

## Key Feature

- **Bidirectional communication**
- Works regardless of which side initiates signal

Critical for:

- I<sup>2</sup>C
- Open-drain communication systems

## Design Parameters

- Pull-up resistors:
  - **4.7kΩ–10kΩ typical**
- MOSFET:
  - Must have low threshold voltage
- Speed:
  - Supports high-frequency signals (~hundreds of kHz)

## Isolation

- Additional MOSFETs:
  - **“prevent random logic levels during power loss”**
- Prevents:
  - Floating signals
  - Unpredictable system behavior

Level shifting:

- Is not just voltage scaling
- It ensures:
  - Signal integrity
  - Reliable digital communication

**Conclusions/action items:** For our particular circuit, a level shifter won't be as ideal as if we were to use a boost converter. It did its job last semester but we already have digital communication reliably established. Hopefully we can figure out a battery solution!

---

Lauren Klein - Apr 14, 2026, 4:08 PM CDT



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**Logic\_Level\_Shifting\_Basics\_\_\_DigiKey.pdf (1.17 MB)**



## 03/24/2026 - JST Connectors

Lauren Klein - Apr 14, 2026, 4:40 PM CDT

**Title:** JST Connectors

**Date:** 03/24/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn about JST Connectors and how they can be useful

**Search Engine:** Google

**Search Term:** JST Connectors

**Citation:** "Fully Understand The JST Connector: Type, Term... - Jhdpcb," *jhdpcb*, Feb. 2024, doi: <https://doi.org/10856849893/ws6DCLyyi6MDEOXD-bgo>.

**Content:**

### Big Picture + Why JST Connectors Matter

- **"JST connectors are widely recognized for their compact size, reliability, and versatility."**
  - These are not just simple connectors → they are:
    - A **standardized interconnect system**
    - Designed for **repeatable, reliable electrical connections**
- **Primary role:**
  - **"establishing secure and efficient electrical connections"**
- Used in:
  - Consumer electronics
  - Automotive systems
  - Industrial equipment
  - Medical devices

#### Engineering takeaway:

- JST connectors are essential for:
  - Modular design
  - Easy assembly/disassembly
  - Reliable power + signal transfer

### What a JST Connector Actually Is

- **"A JST connector... includes various types of electrical connectors following standardized design principles."**
- Consists of:
  - **Male connector (pins)**
  - **Female connector (socket/housing)**
- Function:
  - Allows:
    - **Wire-to-wire connections**
    - **Wire-to-board connections**
- Physical structure:
  - Plastic housing:
    - Provides insulation
    - Protects contacts
  - Metal contacts:
    - Conduct electricity

- Ensure tight mechanical connection

### Key concept:

- JST connectors are **electromechanical interfaces** (mechanical + electrical combined)

## Core Design Features (Expanded)

### 1. Small Size

- **“Known for their compact size... suitable for space-limited applications.”**
- Why this matters:
  - Modern electronics prioritize:
    - Miniaturization
    - Portability
- Tradeoff:
  - Smaller size → lower current capacity

### 2. Reliable Connectivity

- **“Provide a secure and reliable electrical connection.”**
- Achieved through:
  - Tight mechanical fit
  - Spring-loaded contacts
  - Proper contact pressure
- Prevents:
  - Intermittent connections
  - Signal loss
  - Power instability

### 3. Easy to Use

- **“Engineered for convenient connection and disconnection.”**
- Benefits:
  - Fast assembly
  - Easy maintenance
  - Reduced soldering requirements

### 4. Variety of Pitches and Types

- **“Available in diverse series and pitches.”**
- Pitch = distance between pins
- Smaller pitch:
  - More compact
  - Lower current
- Larger pitch:
  - Higher current capability

### Engineering insight:

- Pitch selection = tradeoff between:
  - Size
  - Current capacity
  - Ease of manufacturing

## Advantages (Deep Explanation)

### Standardization

- **“Adhere to industry standards... ensuring compatibility.”**

- Benefits:
  - Interchangeability
  - Easy sourcing
  - Consistent design across products

### Versatility

- **“Used in a wide range of electronic devices.”**
- Works for:
  - Power connections (battery → board)
  - Signal connections (data lines)

### Cost-Effective

- **“Budget-friendly... economical option.”**
- Important for:
  - Mass production
  - Prototyping

### Reliability in Harsh Conditions

- **“Resistant to temperature, vibrations, and moisture.”**
- Why:
  - Strong housing
  - Secure locking mechanisms
- Used in:
  - Automotive
  - Industrial systems

### Easy Installation

- Plug-and-play style:
  - No soldering needed after crimping
- Reduces:
  - Assembly time
  - Human error

## Disadvantages (Very Important)

### Limited Current Capacity

- **“More suitable for low to moderate power applications.”**
- Why:
  - Small contacts → limited conduction area
- Implication:
  - Not ideal for:
    - Motors
    - High-power LEDs (without care)

### Limited Compatibility

- **“May not be compatible with other connector types.”**
- Means:
  - JST ≠ universal standard across all connectors
- May require:
  - Adapters

### Limited Mating Cycles

- **“Can only be connected/disconnected a certain number of times.”**

- Wear mechanisms:
  - Contact fatigue
  - Mechanical loosening
- Important for:
  - Long-term reliability

### Wire Gauge Limitations

- **“May not accommodate larger wires.”**
- Limits:
  - Current carrying capability
- Engineering tradeoff:
  - Smaller connector → thinner wires

## Applications (Expanded Understanding)

### Power + Battery Systems

- **“Used for power supply and battery applications.”**
- Example:
  - LiPo battery → JST connector → microcontroller
- Why:
  - Safe, removable connection
  - Prevents soldering battery directly

### LED Systems

- **“Used in LED lighting.”**
- Benefits:
  - Easy replacement
  - Modular lighting setups

### Automotive + Industrial

- Used in:
  - Sensors
  - Control modules
- Requires:
  - Vibration resistance
  - Reliability

### Renewable Energy

- **“Used in solar panels, batteries, and inverters.”**
- Role:
  - Power transfer between components

## JST Connector Types

### Wire-to-Wire

- Examples:
  - SM, RCY
- Used when:
  - Connecting cables together

### Wire-to-Board

- Examples:
  - **PH (2.0 mm pitch)**

- XH (2.5 mm pitch)
- Used when:
  - Connecting wires → PCB

**Important:**

- Most LiPo batteries use **JST-PH connectors**

### Specialized Types

- High power:
  - J-FAT
- High speed:
  - HYV
- Locking connectors:
  - PBD

## Crimping Process

### Step 1: Strip Wire

- Remove insulation carefully
- Do NOT damage conductor

### Step 2: Insert Wire

- Must:
  - Fully seat inside connector
  - Reach crimp section

### Step 3: Crimp

- Use proper crimping tool
- Two key crimps:
  - Conductor crimp (electrical)
  - Insulation crimp (mechanical support)

### Step 4: Inspect

- Check:
  - Tightness
  - No loose wires
- Perform:
  - Gentle pull test

### Key Insight

- Poor crimping leads to:
  - High resistance
  - Heat generation
  - Intermittent failure

## Connector Terminology

- Pitch → spacing between pins
- Mating → connecting
- Unmating → disconnecting
- Housing → plastic body
- Contacts → metal conductors
- Keying → prevents incorrect insertion

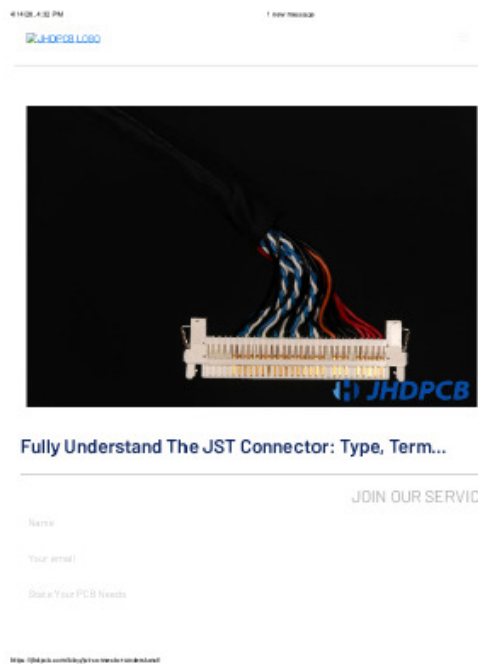
- Locking mechanism → secures connection

JST connectors are:

- Mechanical + electrical systems
- Designed for:
  - Reliability
  - Repeatability
  - Manufacturability

**Conclusions/action items: We will need to either reattach the JST connectors to our old battery or solder a female JST header onto the microcontroller. We will probably just order a new battery and solder on the header cause that will be detachable. We also need to buy a charger for our battery.**

Lauren Klein - Apr 14, 2026, 4:33 PM CDT



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**Fully\_Understand\_The\_JST\_Connector\_\_Type\_Term...-\_Jhdpcb.pdf (3.11 MB)**



## 02/04/2026 - Shortcuts to Launching Mobile Apps

Lauren Klein - Feb 04, 2026, 10:19 PM CST

**Title:** Shortcutting the launch of a Mobile App

**Date:** 02/04/26

**Content by:** Lauren

**Present:** Klein

**Goals:** To look into potential options for turning our website into a mobile app and launching it quickly

**Search Engine:** Google Scholar

**Search Term:** how to make an app using shortcut

**Citation:** C. Sun, J. Zheng, H. Yao, Y. Wang, and D. F. Hsu, "AppRush: Using Dynamic Shortcuts to Facilitate Application Launching on Mobile Devices," *Procedia Computer Science*, vol. 19, pp. 445–452, 2013, doi: <https://doi.org/10.1016/j.procs.2013.06.060>.

**Content:**

"The use of smartphone has seen tremendous growth in recent years. One of the most important features of the smartphone is that users can install and use a large number of various applications (apps). According to a study done in April 2011, an Android phone user has average 35 apps installed on his/her device [1]."

"Another study showed that in 2011, for the first time, people spent more time on mobile apps than desktop and mobile web browsing [2]. It is obvious that the popularity of mobile apps is still on the rise. In September 2012, Google Play (previously known as Android market) hit 25 billion app downloads, and there were more than 675,000 apps available at that time [3]"

"From the users' viewpoint, it is good that they have a huge number of choices on mobile apps, and can install plenty of them with the ample storage capacity of today's smartphone. To help save the user's effort and time to find and launch an app, Android system provides a similar concept of shortcut as in Windows system, or symbolic link as in Unix-like system."

"The user can add shortcuts of favorite apps on the home screen to quickly launch them without looking into the list of all apps. This traditional shortcut solution grants a user the ability to organize certain apps for fast launching according to personal preference, but it suffers the size problem of the smartphone screen."

"The small screen of smartphone can only show a limited number of app shortcuts at a time (for most Android phones available nowadays, at most 16 or 20 shortcuts can be displayed on one screen) that only those apps with shortcuts put on the initial home screen can be launched via one-tap. In most cases, the user may need to swipe the screen multiple times or search the long list of installed apps to find the desired app."

"In this paper, we present AppRush, an adaptive mobile user interface solution, which organizes shortcuts dynamically according to the user's app usage history. Specifically, the AppRush system monitors the user's behavior of app usage, and then predicts the apps most likely to be launched at a certain time."

"According to the predicted app list, the shortcuts on the home screen will be rearranged dynamically. Different from the traditional static shortcut solution, AppRush adapts to the user's usage behavior and does not require the user's effort to organize shortcuts. Ideally, AppRush can provide an unlimited number of app shortcuts on a small screen because the user can always launch an app via just one-tap on the home screen once it is in the predicted app list."

"AppRush as an independent Android app and published it in Google Play1. Our system implementation tries to balance the prediction performance and power consumption as the app is designed to run on battery-driven mobile devices."

"The architecture of AppRush system is shown in Figure 1. The system consists of two major components: a frontend Android widget served as a container to hold dynamic shortcuts, and a background service monitoring app usage, making prediction based on usage history and updating the frontend shortcuts according to any change of the prediction."

"Dynamic shortcuts are hosted in an app widget with which the user directly interacts, which is available since Android 1.5. This means that theoretically our solution can be ported to all current Android devices. On the home screen, a widget can display an application's timely or relevant information at a glance which is a perfect fit to implement our solution, as we can programmably control the content shown in the widget."

"In the current implementation, we provide two different sized widgets: a single-row widget holding 4 shortcuts and a double-row widget holding 8 shortcuts. By default, the widget has a color background to remind the user that it is a widget rather than a set of normal shortcuts. However, AppRush also gives the user the option to select a transparent background so that the user has a natural and smooth substitute for normal shortcuts. Figure 2 shows the appearance of AppRush widgets on the home screen with different size and background."

"The frontend widget is under the control of the background service consisting of three major subcomponents: App Usage Monitor, App Launch Predictor, and Widget Updater. AppUsage Monitor keeps track of when an app is launched and how long it has been used. Detailed time information including month, day of month, day of week, hour, minute, second and duration in millisecond"

"Besides giving users the option to choose a widget with certain size and background, we also implemented an option called Exclusion List to let a user select certain apps that are not going to be shown in AppRush widget. The primary reason of this design is avoiding duplicated shortcuts of a user's favorite apps or system apps which already have static shortcuts on the home screen."

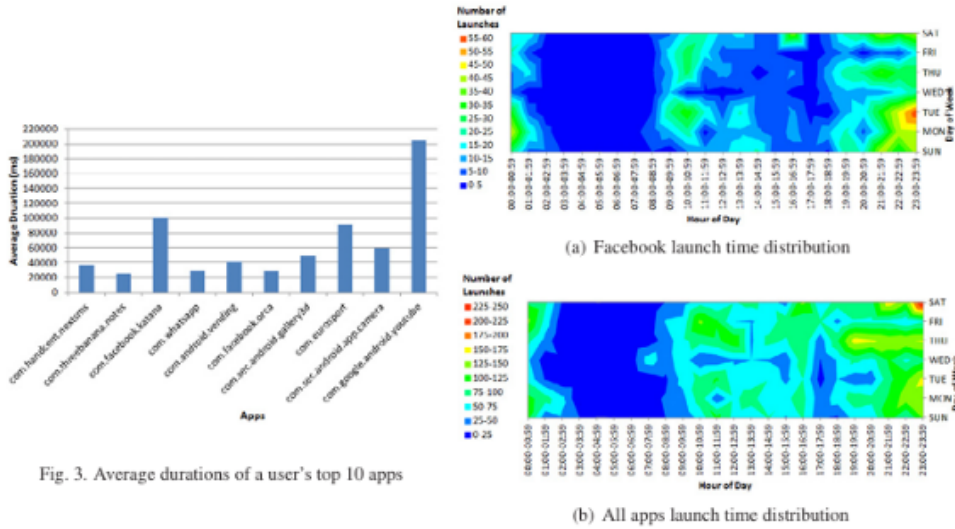


Fig. 3. Average durations of a user's top 10 apps

Fig. 4. Differences in launch time distributions of apps used by the same user

"AppRush is an adaptive user interface solution which uses dynamic shortcuts to facilitate app launching on battery powered mobile devices. The system can achieve a good prediction of the user's app launching behavior with low system overhead. There are several enhancements planned in our future work."

"Currently, the performance evaluation doesn't reflect the user's interest in using dynamic shortcuts. To find out the user's acceptance to our system, we need to count how many times the user launches apps via dynamic shortcuts and how many times through other ways."

"We will also investigate the possibility of incorporating other context features such as battery level and network status which are easy to obtain and low power consuming to achieve better prediction accuracy. Some other options to enhance the proposed dynamic shortcuts solution such as gesture based control will also be explored in future."

**Conclusions/action items:** While this study was outdated (2013). There are definitely shortcuts to how we can create a mobile app and I'll be further researching more current methods similar to this one.



## 02/05/2026 - Current Shortcut Methods for App Creation

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Lauren Klein - Feb 05, 2026, 9:33 PM CST

**Title:** Current Shortcut Methods for App Creation (IOS or Android)

**Date:** 02/05/26

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn about more current shortcut methods stringing from my previous research

**Search Engine:** Google Scholar

**Search Term:** Shortcut Methods for App Creation

**Citation:** B. Hu, Y. Chu, and Z. Liu, "Design and Implementation of Mini-App Shortcuts," *2024 4th International Conference on Electronic Information Engineering and Computer (EIECT)*, pp. 658–662, Nov. 2024, doi: <https://doi.org/10.1109/eiect64462.2024.10866109>.

**Content:**

- "With the widespread use of smartphones, people need to install various mobile applications for work and entertainment, forming an ecosystem around mobile App Stores [1] [2], where Apps are recommended, downloaded, and reviewed, guiding users to use more fitting and feature-rich applications."

- "In this ecosystem, small, long-tail Apps are gradually marginalized [3]. Users are no longer willing to wait for the download process of these Apps, nor do they want these Apps to occupy the limited icon position on the mobile phone desktop. On the other hand, leading Apps have grown rapidly, handling increasing amounts of business, gradually forming an ecosystem of their own, known as Super-Apps "

- "A Super-App can be divided into a Host-App and many Mini-Apps [6]. Among them, Host-App implement core functions such as instant messaging [5], and provides navigation and display for Mini-Apps. Mini-Apps, as modules running on the Host-App, carry personalized mobile services like check-ins"

- "Good installation experience. Users can initially install a lighter Host-App when using a Super-App, avoiding the installation of unused functions. When a Mini-App is used later, there is no obvious perceptible download and installation process."

- "Clear functional boundaries. Since each Mini-App has clear boundaries, the boundaries between functions in different Mini-Apps are also clear."

- "Low-Cost User Acquisition: Super-Apps usually have a large user flow, and Mini-Apps can cultivate its own users from Super-Apps users, reducing the cost of acquiring users."

- "Super-Apps have also brought new challenges: 1) Deep entry. In the process of using Apps, users usually need to go through some navigation pages before you can use specific functions. The Super-Apps aggravate this phenomenon, since Mini-Apps contain extra navigation pages, which are more likely to lead users to abandon the Apps.

2) Entry competition. Due to the limited resources of the Super-App portal, a large number of Mini-App functions cannot be displayed at the portal, which makes it difficult for users who browse the Super-App to know and use it."

- "A Super-App (comprising one Host-App and many Mini-Apps) is similar to a combination of a Mobile Operating System (Mobile OS), an App Store, and Apps. Apps are downloaded from the App Store and run on the Mobile OS, such as Android or iOS, while the Mini-Apps are downloaded and run on the Host-App. Additionally, a Mini-App also has an internal structure similar to traditional Apps. The specific concept comparison is in TABLE I."

**Table I.** Conceptual comparison between super-app and mobile os

Concepts of Super-App	Concepts of Mobile OS
Super-App	Operating System & App Store & Apps
Host-App	Operating System & App Store
Mini-App	App
Mini-App page	App activity
Mini-App main page	App main activity

In terms of technology, the Host-App is written in native language, while Mini-Apps are typically written in scripting languages such as HTML and JavaScript. the hybrid mobile application framework (e.g., Cordova[7]) is used to bridge the two types of code.

"In order to solve the problem that mobile content is enclosed in Apps, Deep Links was introduced. Deep Links allows users to jump directly to specific pages in Apps from external sources (such as email, SMS, social media, web pages, etc.), instead of just starting the main activity of the Apps."

"Deep Links usually use the technology like URL Schemas or App Links [8] (for Android) or Universal Links [9] (for iOS). Some frameworks (e.g., [10]) have further encapsulated Deep Links, endowing them with additional features such as automatic generation."

"Deep Links are mainly used in App Store ecosystem. With the development of Super-App, we need a technology similar to Deep Links to meet the demand that the functions in Mini-App are discovered and accessed by Host-App. We refer to this technology as Mini-App shortcuts, the difference between Deep Links and Mini-App shortcuts are as follows:

- Different initiators. Deep Links are used to enter the specific pages of the Apps from the outside, while Mini-App shortcuts are used to quickly enter the specific pages of the Mini-Apps from the Host-App.
- Different goals. Deep Links usually focus on making the content of Apps discoverable externally. They emphasize improving the ability to be indexed by search engines and provide download and installation services for the Apps when not installed. Mini-App shortcuts, on the other hand, focus on the issues of deep entry and entry competition of Super-Apps."

"Referencing Deep Links, Some Super-Apps have implemented solutions similar to Mini-App shortcuts. For example, WeChat Mini-Programs (a sort of Mini-Apps) provide several ways. URL Schemes [11] used for quick jump in the internal environment of WeChat. URL Links [12] provides a way to guide users to access Mini-Programs from a non-We Chat environment. Short Links [13] solve the problem that URL is too long to share, and maintain the same functionality as URL Links."

"The realization merely addresses the accessibility issues of internal pages within particular Mini-Apps. They do not provide a systematical shortcut management solution similar to Deep Link frameworks"

"A Mini-App typically possesses more than one function. These functions are related to each other to some extent, but also maintain a degree of independence. Therefore, the functional pages of a Mini-App can be considered a collection of multiple atomic functions. We define the characteristics of atomic functions in a Mini-App as follows:

"An atomic function of a Mini-App is dedicated to completing a specific task. An atomic function usually has a main page. Regardless of how the user navigates to this atomic function, the main page must be accessed first, because other pages within the atomic function depend on it. The main page of an atomic function does not heavily rely on information from navigation pages of the Mini-App. That is, atomic function can still be completed when bypassing most of the Mini-App's navigation pages."

"To quickly access frequently used atomic functions, we design Mini-App shortcuts to bypass as many Mini-App navigation pages as possible. A Mini-App shortcut typically includes the following information:

-"Mini-App entry page address. The address from which the Host-App enters the Mini-App. Atomic function home page address. The address of the function page that the user wants to actually reach. Routing method. A description of how to route from the Mini-App entry page to the atomic function home page. Atomic function access data. Information such as the last access time and frequency of access, which is used as a basis for recommending Mini-App shortcuts. Other supplementary information related to Mini-App shortcut, such as icons and descriptions, which are used to display the Mini-App shortcut to the user."

-"To implement Mini-App shortcuts, we have designed a scheme which mainly includes five parts: Mini-App shortcuts discovery, generation, management, presentation, and recommendation. Mini-App shortcut discovery provides potential Mini-App shortcuts reference to the Mini-App development and operation teams. Mini-App shortcut generation creates fast access channels that allow users to enter atomic functions directly from the Host-App. Mini-App shortcut management is used to register and maintain the established Mini-App shortcuts. Mini-App shortcut presentation displays the operational interfaces to the users. Mini - App shortcut recommendation recommends frequently used atomic functions to users."

-"Mini-App shortcut discovery involves identifying the home pages of frequently used atomic functions within Mini-Apps. This process primarily relies on a data monitoring module built into the Host-App, which tracks the number of visits and the duration of stays on each Mini-App page."

-"Typically, the home pages of atomic functions exhibit both a high number of visits and a long dwell time. Pages with only a high number of visits are more likely to be Mini-App navigation pages, while pages with only a long dwell time are more likely to be internal pages of atomic functions. Additionally, if two pages in a hierarchical relationship both meet these criteria, the parent page is more likely to be the home page of the atomic function."

-"These potential home pages of atomic functions are provided to the Mini-App development and operation teams. The teams then determine the pages required as the basis for generating Mini-App shortcuts."

-"Mini - App shortcut generation involves building a fast access channel from the Host-App to the atomic functions. This channel can be achieved in multiple modes. Using Figure 1 as an example, the regular access method for a Mini-App is indicated by the black arrows: first, visit Page1 (Mini-App navigation page), then Page2 (atomic function home page), and finally Page3 (other pages of the atomic function). As for a Mini-App shortcut, there are 3 modes to access Page2, as shown by the red arrows: (a) Direct Access to Page2. (b) Visit Page1 firstly, and then automatically redirect to Page2. (c) Construct a unified Proxy Page that decides whether to automatically redirect to Page2 or to another page."

-"For atomic functions that are completely independent of Mini-App navigation pages, mode A provides a more direct access process. In this case, the Mini-App entry page address is the same as the atomic function home page address, resulting in faster access speeds."

.."

We manage the generated Mini-App shortcuts by a Mini-App shortcut resource pool. After a Mini-App is launched, the corresponding Mini-App shortcuts can be gradually added based on usage. When a Mini-App is taken offline, all associated Mini-App shortcuts must be removed."

-"When displaying Mini-App shortcuts, we need determine which Mini-App shortcuts should be shown and in what order. The recommendation strategies differ between Mini-Apps that users have not fully utilized and those that users have consistently used over a long period."

1) Initial Usage Period Strategy. When a user has never used a Mini-App's atomic functions, it is difficult to determine which shortcuts are needed based on the user's usage habits. Therefore, a default sorting order should be set, or a simple collaborative filtering algorithm can be used to recommend shortcuts commonly used by similar users.

2) Full Usage Period Strategy. Once a user has extensively used a Mini-App, their own data better aligns with their needs for shortcuts. Here we adopt a recency-based recommendation strategy, prioritizing the atomic functions most recently accessed by the user. Alternatively, a frequency-based recommendation strategy can be used, which prioritizes the atomic functions with the highest average access frequency over a recent period. In our actual design, we chose the recency-based strategy because it is easier for users to understand and the changes in recommendation order are more responsive."

-"To evaluate the effectiveness of Mini-App shortcuts, we selected a mobile portal used by an enterprise for assessment. This portal is primarily used by internal employees to handle various office tasks within the company. Due to the diverse business operations of the enterprise, this mobile portal has evolved into a Super-App. In addition to standard Host-App features such as instant messaging and contact lists, it includes hundreds of Mini-Apps."

-“Within this mobile portal, we identified a Mini-App named “Services” that assists employees with daily work tasks. This Mini - App includes multiple atomic functions such as clock in, trip requests, accommodation booking, transportation booking, and expense reimbursement. We modified these functions to provide them as quick access entries to employees.”

-“We added a button within this Mini-App. When an employee clicks this button, the display form of the Mini-App on the Host-App changes from a single icon to an expanded list of quick access entries, as shown in the following figure 2.

**Table III.** Evaluation results of mini-app “services” shortcuts

	Original Mini-App	Mini-App displays 3 shortcuts	Mini-App displays 6 shortcuts
Shortcut Hit Rate	-	91.13%	92.75%
Number of Step	2.92	1.15	1.12

We observed that, since employees need to use the Mini-App's clock-in function daily at the start and end of their shifts, while other functions like trip requests are used only occasionally, the addition of shortcut functionality resulted in a high shortcut hit rate. This significantly reduced the number of steps users need to take to access atomic functions. On the other hand, while displaying more shortcuts can further increase the shortcut hit rate and reduce the number of steps, the marginal effect diminishes. Additionally, displaying too many shortcuts will occupy too much space on the Host-App interface, affecting the display of other Mini-Apps.

-“In this article, we have detailed the situation faced by Apps as they transform into Super-Apps, proposed a model and implementation methods for Mini-App shortcuts, and evaluated the actual effects of enabling Mini-App shortcuts. We found that adding Mini-App shortcuts effectively reduces the number of steps required to use specific Mini-App functions, helping users quickly handle specific tasks within Mini-Apps and significantly improving the user experience.”

-“For the next steps, there is further exploration space in the generation and display of Mini-App shortcuts. In terms of generation, there is currently a significant amount of manual configuration work for Mini-App shortcuts. Future efforts could explore fully automated generation and routing of Mini-App shortcuts. In terms of display, Mini-App shortcuts can be shown not only as icons but also through search, AI conversational interactions, and other methods. We believe that through further exploration, shortcuts will become the mainstream method for addressing the issues of Deep entry and entry competition in Mini-Apps.”

**Conclusions/action items: Super-Apps are a critical service for the mobile device world. Mini-Apps were introduced as a shortcut to enable fast and direct access to atomic functions. Super-App showed how Mini-Apps shortcuts task completion and improve user experience. We might be able to use a similar shortcut for our app!**

# Design and Implementation of Mini-App Shortcuts

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**Abstract**—With the enrichment of mobile application services, the Super-App mode is becoming more and more popular. An application based on Super-Apps, Mini-Apps are faced with the problem that its internal functions are difficult to be discovered and used. In this paper, we propose a new design idea, which is to design Mini-App shortcuts. This paper has conducted in-depth research around the topic, and the main contributions are as follows: (1) We elaborate on the primary tasks of Mini-App shortcuts; (2) We propose a basic model for Mini-App shortcuts; (3) We design an implementation method for Mini-App shortcuts; (4) We conducted experimental tests to measure the effect.

**Keywords**—Super-App; Mini-App; Shortcut

## I. INTRODUCTION

With the widespread use of smartphones, people tend to install various mobile applications for work and entertainment. Among an ecosystem of mobile App Stores [1][2], where Apps are more numerous, diversified, and convenient, gaining users is the main challenge for such applications.

In this ecosystem, small, light-weight Apps are gradually being ignored [3]. There are no longer willing to wait for the download process of these Apps, and do they want these Apps to occupy the limited screen position on the mobile phone desktop. On the other hand, many Apps have grown rapidly, benefiting from the growth of the ecosystem, gradually forming a new system of their own, known as Super-Apps [4][5].

A Super-App can be divided into Mini-App and many Mini-Apps [6]. Among them, Mini-App implement core functions such as social networking [5] and provides navigation and display for Mini-Apps. Mini-Apps, on the other hand, running on the Mini-App ecosystem and provide services like chat, news, etc.

Compared with the traditional App ecosystem, Super-Apps has the following advantages:

- Good installation experience. Users can directly install a lighter Mini-App when using a Super-App, avoiding the installation of traditional functions. When a Mini-App is used later, there is no obvious perceptible download and installation process.
- Clear functional boundaries. Since each Mini-App has clear boundaries, the boundaries between functions in different Mini-Apps are also clear.

- Low-Cost User Acquisition. Super-Apps usually have a large user flow, and Mini-Apps covered there is covered from Super-App users, reducing the cost of acquisition.

However, the Super-Apps have also brought new challenges:

- Deep entry. In the process of using Apps, users usually need to go through one or more pages before you can use specific functions. The Super-Apps require this process, since Mini-Apps or sub-system navigation pages, which are more likely to lead users to abandon the Apps.
- Entry competition. Due to the limited resources of the Super-App portal, a large number of Mini-App functions cannot be displayed at the portal, which makes it difficult for users who browse the Super-App to learn and use it.

In order to solve these challenges, this paper proposes a method to build Mini-App shortcuts, which can meet the internal requirements.

The rest of this article is organized as follows. First, we discuss the basic concepts and some similar works in Section II. In Section III, we discuss the definitions and models related to Mini-Apps. Then a new paradigm of the specific design scheme is described. In Section IV, we evaluate the effect through user experiments. Finally, we summarize the article in Section V.

## II. BACKGROUND

### A. Super-App

A Super-App (also referred to as Mini-App and many Mini-Apps) is a kind of ecosystem of Mobile Operating Systems (Mobile OS), the App Store and AppG. Apps are downloaded from the App Store and run on the Mobile OS, such as Android or iOS, while the Mini-Apps are downloaded and run as the Mini-App. Additionally, a Mini-App also has an internal structure similar to traditional Apps. The specific concept cooperation is in TABLE I.

TABLE I. COOPERATION RELATIONSHIP BETWEEN SUPER-APP AND MINI-APP

Concepts of Super-App	Concepts of Mobile OS
Super-App	Operating System, App Store & AppG
Mini-App	App Store and AppG
Mini-App page	App website
Mini-App icon page	App icon website

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 **02/08/2026 - BLE Connection Distance Ranges**

Lauren Klein - Feb 08, 2026, 6:49 PM CST

**Title:** BLE Connection Distance Ranges

**Date:** 02/08/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn about the connection/distance ranges of BLE connection devices

**Citation Engine:** Google

**Citation Term:** distance connection ranges of ble microcontrollers

**Citation:** "How Far Can BLE Really Transmit? Indoor vs Outdoor Range - BlueIoT (Beijing) Technology Co., Ltd.," *BlueIoT (Beijing) Technology Co., Ltd.*, 2025. <https://www.blueiot.com/blog/how-far-can-BLE-transmit.html> (accessed Feb. 09, 2026).

**Content:**

Wi-Fi Generation	IEEE Standard	Year	Key Advancement
Original Wi-Fi	802.11	1997	First standard, 2 Mbps
Wi-Fi 2	802.11b	1999	11 Mbps on 2.4 GHz
Wi-Fi 3	802.11g	2003	54 Mbps on 2.4 GHz
Wi-Fi 4	802.11n	2009	MIMO, dual-band, up to 600 Mbps
Wi-Fi 5	802.11ac	2014	5 GHz focus, up to 3.5 Gbps
Wi-Fi 6	802.11ax	2019	OFDMA, improved efficiency, up to 9.6 Gbps
Wi-Fi 7	802.11be	2024	Multi-Link Operation (MLO), 320 MHz channel width, 4096-QAM, Multi-RU & preamble puncturing



4

### Core Idea

BLE range is not fixed — it depends on:

1. **Transmit power (“volume”)**
2. **Receiver sensitivity (“hearing”)**
3. **Environmental interference**

### Transmit Power Levels

- **Low Power (-20 dBm to 0 dBm)**
  - Range ≈ **10 m**
  - Used by smartwatches, earbuds
  - Optimized for long battery life
- **Medium Power (4–8 dBm)**
  - Range ≈ **30–50 m**
  - Used by smart home sensors, beacons
- **High Power (10–20 dBm)**
  - Range **100–300 m+ outdoors**
  - Used in industrial tracking, agriculture

### Receiver Sensitivity

- Measured in **dBm** (lower = better)
- Example:
  - -95 dBm > -85 dBm (can hear weaker signals)
- Bluetooth 5.0 **Long-Range (Coded PHY)**:
  - Data rate drops to **125 kbps**
  - Sensitivity improves to **-103 dBm**
  - Theoretical range up to **400 m**

### Environmental Effects

- **Outdoor/open spaces**: minimal attenuation → longest range
- **Indoor environments**: walls, furniture reduce range to **10–20 m**
- **Metal & concrete**: can cut range in half or fully block signals
- **Humidity & dense metal (elevators)**: severe interference

### Practical Mitigation Strategies

- Better antenna design (ceramic, directional)
- Higher beacon density (6–10 m spacing indoors)
- Mesh/relay nodes for coverage extension

### “Elastic Boundary” of BLE Range

- Consumer devices: ~10 m
- Smart home/industrial: **50–100 m**
- Long-range Bluetooth 5.0 setups: **500–1000 m+ outdoors**

### Big Picture

- BLE range is **engineered**, not guaranteed
- Designers trade **battery life vs range vs reliability**

- Bluetooth 5.x fundamentally expanded BLE's application space

How Far Can BLE Really Transmit...

**Key Visuals – BLE Range & Factors**

<https://www.researchgate.net/publication/336690482/figure/fig2/AS%3A11431281390610198%401745285277156/Low-energy-Bluetooth-BLE-beacon-based-indoor-positioning-system-overview.tif>

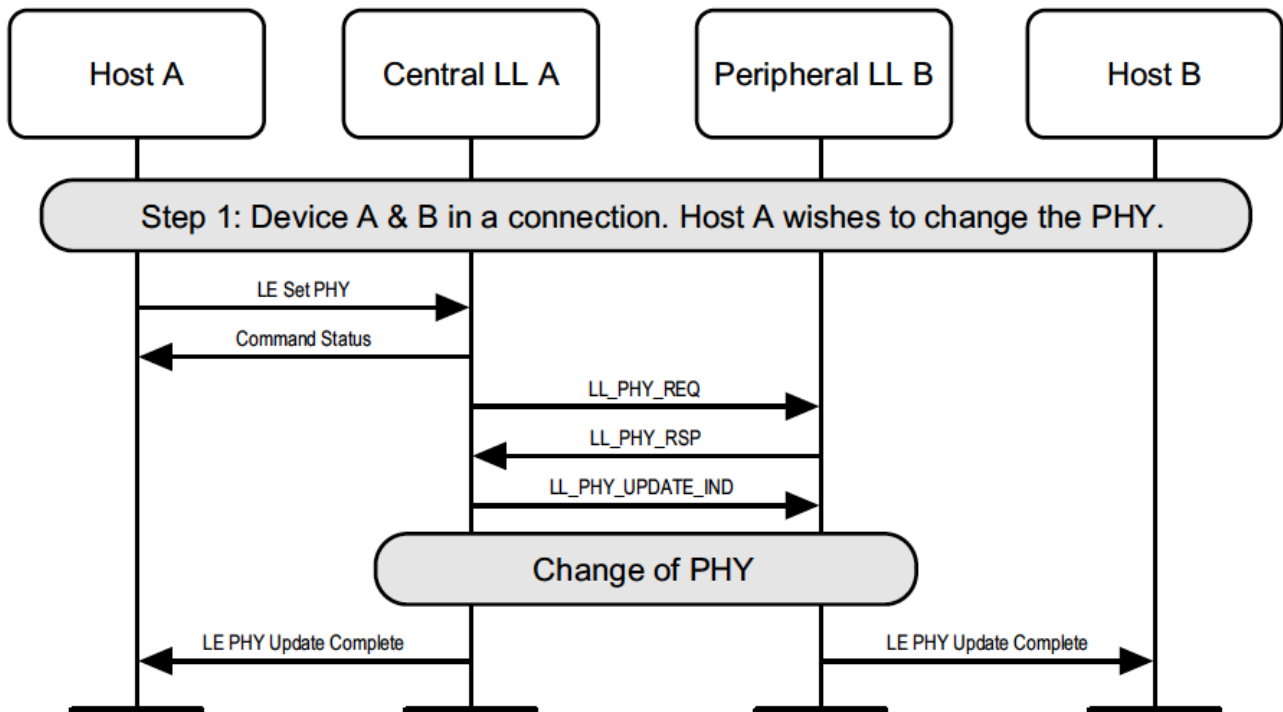
The requirements for a Bluetooth low energy radio are as follows:

Feature	Value
Minimum TX power	0.01 mW (-20 dBm)
Maximum TX power	100 mW (20 dBm)
Minimum RX sensitivity	-70 dBm (BER 0.1%)

The typical range for Bluetooth low energy radios is as follows:

TX power	RX sensitivity	Antenna gain	Range
0 dBm	-92 dBm	-5 dB	160 meters
10 dBm	-92 dBm	-5 dB	295 meters


The range to a smart phone is typically 0-50 meters due to limited RF performance of the phones.



**Conclusions/action items:** Bluetooth Low Energy transmission range depends on a balance between transmit power, receiver sensitivity, and environmental conditions rather than a fixed distance. Indoor obstacles such as walls, metal, and humidity significantly reduce range, while open outdoor environments allow BLE signals to travel hundreds of meters or more. Advances like Bluetooth 5.0's long-range (coded PHY) mode extend BLE's usable distance at the cost of lower data rates, enabling reliable communication for industrial, agricultural, and IoT applications.

Lauren Klein - Feb 08, 2026, 6:37 PM CST

2:02:03 PM How Far Can BLE Really Transmit? Indoor vs Outdoor Range - BlueIoT (Beijing) Technology Co., Ltd.



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## How Far Can E Indoor vs Outdoor range

2025-09-03

Tracking: Manufacturing, Logistics, Healthcare, Entertainment, Safety & Security

Navigation: Hospital, Museum & Exhibition, Parking Space, Airport & Train Station, Sports & Events

In a park early in the morning, an elderly person wearing a smart bracelet goes for a run, his phone simultaneously recording his steps and heart rate. In an office building, an employee uses a Bluetooth headset to answer calls, untethered by cables. In an industrial park, sensors transmit real-time device status data to a monitoring center via Bluetooth Low Energy (BLE). Behind these scenes lies a smart, living network woven by BLE technology, utilizing short-range wireless connections. However, a common question lingers in users' minds:

How far can BLE really transmit? Indoor vs Outdoor Range - BlueIoT (Beijing) Technology Co., Ltd.

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## 02/18/2026 - BLE Capabilities of the C6

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Lauren Klein - Mar 10, 2026, 8:27 PM CDT

### Title: C6 BLE Capabilities

Date: 02/18/2026

Content by: Lauren

Present: Individual

Goals: To learn about the extent of the C6 BLE capabilities.

Citation: "Bluetooth Usage | Seeed Studio Wiki," *Seeedstudio.com*, Apr. 11, 2024. [https://wiki.seeedstudio.com/xiao\\_esp32c6\\_bluetooth/](https://wiki.seeedstudio.com/xiao_esp32c6_bluetooth/)

Search Term: BLE ESP32-C6

Search Engine: Google

### Content:

#### Board Bluetooth Overview

- The **Seeed Studio XIAO ESP32C6** supports **Bluetooth 5, Bluetooth Low Energy (BLE), and mesh networking**.
- It provides **reliable wireless communication for IoT devices** over both short and moderate distances.
- Bluetooth capabilities allow the board to **scan devices, establish connections, and transmit data wirelessly**.
- Typical uses include **device communication, sensor data transmission, and wireless control systems**.

#### Bluetooth Low Energy (BLE)

##### BLE Characteristics

- **BLE (Bluetooth Low Energy)** is a low-power version of Bluetooth designed for **short-range communication with small data packets**.
- BLE devices remain in **sleep mode most of the time**, waking only when communication occurs.
- BLE can consume **up to ~100× less power than traditional Bluetooth** depending on usage.
- It is ideal for **battery-powered devices such as coin-cell powered sensors**.

##### Common BLE Applications

BLE is widely used in:

- Healthcare devices
- Fitness trackers
- Location beacons
- Security systems

- Home automation
- IoT sensor networks.

## BLE Device Roles

### Server and Client Model

BLE communication uses a **client-server architecture**:

#### Server

- Advertises its presence to nearby devices.
- Stores the data that clients can read or modify.

#### Client

- Scans for available BLE devices.
- Connects to a server.
- Reads or writes data from the server.

This communication model is known as **point-to-point communication**.

## BLE Data Structure

### Attributes

- An **attribute** is a single piece of data stored on a Bluetooth device.
- Attributes form a **database of information available to other devices**.
- Each entry in the database represents a specific piece of data.

## GATT Protocol

- **GATT (Generic Attribute Profile)** defines how data is organized and transferred between BLE devices.
- GATT structures Bluetooth data into three main components:

### Services

- Groups of related functionality provided by a device.

### Characteristics

- Individual data values within a service.
- Represent specific properties like sensor readings or control commands.

### Descriptors

- Provide metadata about characteristics such as format or access permissions.

## UUID (Universally Unique Identifier)

- Each **service, characteristic, and descriptor** has a unique **UUID**.
- A UUID is a **128-bit (16 byte) identifier** used to distinguish Bluetooth data elements.
- Standard services have predefined UUIDs, but custom UUIDs can also be generated for custom applications.

## BLE Communication Operations

### Attribute Protocol (ATT)

- The **Attribute Protocol (ATT)** defines how BLE data is exchanged.
- Communication uses **ATT commands**, which include four main operation types:
  - **Read** – retrieves data from a characteristic.
  - **Write** – sends data to a characteristic.
  - **Notify** – automatically sends updates when data changes.
  - **Indicate** – similar to notify but requires acknowledgment.

## BLE Scanner Function

### Scanning for Devices

The ESP32C6 can scan nearby Bluetooth devices using the BLE libraries.

Typical scanning process:

1. Import BLE libraries.
2. Initialize the BLE device.
3. Configure scan parameters (interval, window).
4. Start scanning.
5. Display discovered devices in the serial monitor.

Information detected during scanning includes:

- Device name
- MAC address
- Manufacturer data
- Signal strength.

## BLE Server Implementation

## Creating a BLE Server

A BLE server on the ESP32C6 performs several steps:

1. Initialize the BLE device.
2. Create a BLE server.
3. Create a service with a unique UUID.
4. Create a characteristic within that service.
5. Set characteristic properties (READ / WRITE / NOTIFY).
6. Start advertising the service.

Example behavior:

- The server broadcasts a **“Hello World” characteristic value** that other devices can read.

## BLE Client Implementation

### Connecting to a BLE Server

A BLE client performs the following process:

1. Scan nearby devices.
2. Identify a device advertising the desired service UUID.
3. Connect to that device.
4. Access the service and characteristic.
5. Read or receive data updates.

The client searches for:

- **Service UUID**
- **Characteristic UUID**

These identifiers ensure the correct data source is accessed.

## Sensor Data Transmission via BLE

### Example Application: Light Sensor

The tutorial demonstrates sending **light sensor data using BLE**.

Hardware used:

- XIAO ESP32C6 board
- XIAO expansion base with OLED display

- Grove TSL2561 digital light sensor

## Server Device Tasks

The BLE server device:

1. Reads light intensity from the sensor.
2. Creates a BLE server and service.
3. Advertises sensor values via Bluetooth.
4. Displays the sensor value on the OLED screen.

Data is transmitted using the **notify characteristic property**, which automatically sends updates when values change.

## Client Device Tasks

The BLE client device:

1. Scans for the BLE server by device name.
2. Connects to the server.
3. Locates the correct service and characteristic UUID.
4. Receives sensor values via notifications.
5. Displays the received data on an OLED display.

## GATT Example UUIDs Used

In the example project:

- **Service UUID:** 0x181A
  - Represents **environmental sensing data**.
- **Characteristic UUID:** 0x2A59
  - Represents **analog output values**.

These UUIDs correspond to standard GATT definitions for sensor data.

## NimBLE Library

## Alternative BLE Library

The tutorial also introduces **NimBLE-Arduino**, an alternative BLE library.

Advantages include:

- **Lower memory usage**

- **Improved performance**
- **Better stability compared to the default ESP32 BLE library**

NimBLE is designed to maintain **compatibility with the original ESP32 BLE API** while improving efficiency.

BLE Beacon Scanning

Beacon Detection

Using the NimBLE library, ESP32 devices can detect Bluetooth beacon types such as:

- **iBeacon**
- **Eddystone beacons**

Detected beacon information can include:

- Device ID
- Major and minor values
- Signal power
- Battery voltage
- Temperature
- Advertisement count.

**Conclusions/action items:** The XIAO ESP32 C6 can handle BLE communication for low-power devices using a client-server structure. There are GATT services, characteristics, and UUIDs to structure data communication. The C6 can scan, connect, send, and receive using BLE which directly is used in a variety of devices.

9:02:08 PM Bluetooth Usage | Seed Studio Wiki

» XIAO » XIAO ESP32C6 » Wiring Connections » **Bluetooth Usage**

## Bluetooth Usage with Seed Studio XIAO ESP32C6

Seed Studio XIAO ESP32C6



Get One Now 

The Seed Studio XIAO ESP32C6 is a powerful development board that supports Bluetooth S, BLE, and Mesh networking, making it an ideal choice for a wide range of IoT applications that require wireless connectivity. With its outstanding RF performance, the XIAO ESP32C6 can provide reliable and high-speed wireless communication over a variety of distances, making it a versatile solution for both short-range and long-range wireless applications. In this tutorial, we will focus on the basic features of the XIAO ESP32C6's Bluetooth capabilities, such as how to scan for nearby Bluetooth devices, how to establish a Bluetooth connection, and how to transmit and receive data over a Bluetooth connection.

### Bluetooth Low Energy (BLE) Usage

Bluetooth Low Energy, BLE for short, is a power-conserving variant of Bluetooth. BLE's primary application is short distance transmission of small amounts of data (low bandwidth). Unlike

[View full article on the website: esp32c6.bluetooth](#) 1/33

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## 02/22/2026 - Challenges/Issues with BLE

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Lauren Klein - Mar 10, 2026, 8:23 PM CDT

### Title: Common BLE Challenges and Issues

Date: 02/15/26

Content by: Lauren

Present: Individual

Goals: To learn about common issues that happen with BLE

Citation: angela Hernandez-Solana, D. Perez-Diaz-De-Cerio, M. Garcia-Lozano, A. V. Bardaji, and J.-L. Valenzuela, "Bluetooth Mesh Analysis, Issues, and Challenges," *IEEE Access*, vol. 8, pp. 53784–53800, 2020, doi: <https://doi.org/10.1109/access.2020.2980795>.

Search Term: Common BLE Challenges

Search Engine: Google Scholar

### Content:

Overview of Bluetooth Mesh

- **Bluetooth Low Energy (BLE)** is a widely used **short-range wireless technology** for IoT applications.
- Key advantages of BLE include:
  - **Low power consumption**
  - **Low cost**
  - **High reliability**
  - **Wide adoption in consumer electronics.**
- BLE is commonly used in:
  - Healthcare devices
  - Smart homes
  - Security systems
  - Vehicular communication
  - Asset and people tracking.
- BLE mesh networking was introduced to allow **devices to communicate across large networks by relaying messages through multiple nodes.**

Mesh Networking Basics

What a Mesh Network Is

- A **mesh network** allows devices (nodes) to communicate by **relaying messages through other nodes.**
- Networks are **dynamic and decentralized**, meaning no single central router is required.
- Nodes cooperate to **forward messages across the network.**

Why Mesh Networks Are Useful

- Extends communication **beyond the direct wireless range.**

- Improves **network coverage and scalability**.
- Allows devices to communicate in **large distributed IoT systems**.

#### BLE Mesh Characteristics

##### Managed Flooding Protocol

- BLE mesh uses **managed flooding** to transmit messages.
- Each node that receives a message **rebroadcasts it to nearby nodes**.
- Flooding increases reliability because **multiple nodes forward the same message**.

##### Advantages of Flooding

- **Simple implementation**
- **High redundancy**
- **No need for routing tables**

##### Disadvantages of Flooding

- Can cause:
  - **Network congestion**
  - **Higher energy consumption**
  - **Packet collisions**
- Network performance depends heavily on **parameter configuration and tuning**.

#### Key BLE Mesh Concepts

##### Nodes

- A **node** is a device that participates in the mesh network.
- Nodes can **send, receive, and relay messages**.

##### Provisioning

- **Provisioning** is the process of adding a device to the mesh network.
- During provisioning:
  - Security keys are exchanged.
  - Device configuration is established.

##### Elements

- An **element** is an addressable component within a node.
- A node must contain **at least one element**, but can contain multiple.

##### Examples:

- Light bulbs
- Sensors
- Cameras
- Smart switches.

## Address Types in BLE Mesh

BLE mesh uses **three addressing methods**:

### Unicast Address

- Identifies a **single element within a node**.

### Group Address

- Messages are sent to **multiple subscribed devices**.

### Virtual Address

- Used for **logical groups of devices** defined using labels.

This allows **publish/subscribe communication models**.

## Special Node Types

### Relay Node

- A node that **retransmits received messages** to extend network coverage.

### Low Power Node (LPN)

- A device designed to **minimize power consumption**.
- Operates with **low receiver duty cycles**.

### Friend Node

- Assists **low power nodes** by storing messages for them.

### Proxy Node

- Allows **non-mesh Bluetooth devices** to communicate with the mesh network.

### Provisioner Node

- Responsible for **adding and configuring devices in the mesh network**.

## BLE Mesh Layered Architecture

Bluetooth mesh uses a **layered protocol stack** built on top of BLE.

### Model Layer

- Defines **device behavior and application functionality**.

### Foundation Model Layer

- Manages **network configuration and management functions**.

### Access Layer

- Defines **how applications use the network** and handles application data formatting.

### Upper Transport Layer

- Provides **encryption, authentication, and confidentiality**.

### Lower Transport Layer

- Handles **segmentation and reassembly of messages**.

## Network Layer

- Responsible for:
  - Message routing
  - Addressing
  - Relay decisions
  - Network encryption.

## Bearer Layer

- Transfers messages using BLE communication methods such as:
  - **Advertising bearer**
  - **GATT bearer.**

## BLE Advertising for Mesh Communication

- Mesh messages are transmitted using **BLE advertising packets.**
- Data is sent over **advertising channels 37, 38, and 39.**
- Maximum BLE advertisement size:
  - **47 bytes total**
  - Only **~10 bytes of useful application data.**

This results in **about 21% payload efficiency.**

## Reliability Mechanisms in BLE Mesh

Network reliability is achieved through **multiple retransmission mechanisms.**

### Publish Retransmission

- Repeats application messages.
- Controlled by:
  - **Publish retransmit count**
  - **Publish retransmit interval.**

### Network Transmit

- Repeats network layer packets.
- Controlled by:
  - **Network transmit count**
  - **Network transmit interval steps.**

### Relay Retransmission

- Used when relay nodes forward packets.
- Controlled by:
  - **Relay retransmit count**
  - **Relay retransmit interval steps.**

## Message Transmission Types

### Unacknowledged Messages

- Messages are sent **without confirmation**.
- Reliability relies on **flooding redundancy**.

### Acknowledged Messages

- Receiver sends a **STATUS message** back to the sender.
- Helps guarantee **successful delivery**.

## Performance Challenges in BLE Mesh

### Blind Times

- Devices cannot receive messages during certain operations such as:
  - Switching scanning channels
  - Processing packets
  - Sending advertising messages.
- Blind times can cause **packet loss and reduced reliability**.

### Buffer Limitations

- Devices have **limited memory buffers** for storing packets.
- If buffers fill up:
  - New packets may be **discarded**.
- This can occur when:
  - Too many relay transmissions occur
  - Multiple nodes transmit simultaneously.

## Parameter Configuration Issues

Network performance depends strongly on **configuration parameters**, including:

- Transmission intervals
- Relay retransmission counts
- Publish retransmission settings.

Improper configuration can lead to:

- Network congestion
- High packet loss
- Reduced efficiency.

## Security Features

Bluetooth mesh includes **mandatory encryption and authentication**.

Three main security keys are used:

Network Key (NetKey)

- Secures communication at the network level.

Application Key (AppKey)

- Protects application data.

Device Key (DevKey)

- Used for secure device configuration.

Key Takeaways

- Bluetooth mesh extends **BLE communication to large distributed IoT networks.**
- It uses a **managed flooding protocol** for message propagation.
- Mesh networks allow **scalable, decentralized device communication.**
- Performance depends heavily on **parameter tuning and hardware limitations.**
- Key challenges include:
  - **Packet overhead**
  - **blind times**
  - **buffer limitations**
  - **network congestion.**

**Conclusions/action items:** The mesh of Bluetooth involves BLE and large IoT networks using managed flooding protocols to propagate messages. The mesh side is scalable and decentralized from devices but overall performance is based on the hardware limits. Main issues/challenges are buffering and network congestion or environmental blocks like walls.

Lauren Klein - Mar 10, 2026, 8:16 PM CDT

**IEEE Access**  
Open Access Journal of the IEEE

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### Bluetooth Mesh Analysis, Issues, and Challenges

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**ABSTRACT** BLE is a widely used short-range technology which has gained a relevant position inside the Internet of Things (IoT) paradigm development thanks to its simplicity, low-power consumption, low-cost and robustness. New enhancements over BLE have focused on supporting mesh network topology. Compared to other mesh networks, BLE mesh has only considered a managed flooding protocol in its first version. Managed flooding may generally suffer inefficiency in many contexts, but it is a high desirable option when data transmission is urgent, the network is small or its configuration changes in a very dynamic way. Knowing the impact in many application contexts, this paper analyzes the impact of resolving several features over its flexibility and efficiency of the mesh network. These features are configured and controlled in different layers: message rejection schemes, transmission modernization, the choice of a scheme based on an acknowledged or unacknowledged transmission, etc. In order to estimate the real performance of a mesh network deployment, this paper evaluates the effect of the interaction of the chosen parameters, their appropriate adjustment to relate with the characteristics of real implementations and the true overhead related to the whole protocol stack. The paper identifies configuration challenges, proposes network tuning criteria and real-life possible standard parameters. For this purpose, individual assessment on the implementation on real context or real devices has been performed with their related limitations.

**INDEX TERMS** Bluetooth, low energy, wireless mesh networks, BLE mesh, managed flooding, performance.

**1. INTRODUCTION**  
 Nowadays, there are many wireless communication technologies that can be used for the deployment of IoT applications in domestic, urban, and industrial scenarios. Prominent examples are ZigBee, Z-Wave, Thread, Bluetooth, Wi-Fi, Bluetooth Low Energy (BLE). These technologies are extremely heterogeneous one in terms of protocol, performance, reliability, latency, cost and coverage. Thus, the choice of one specific technology depends on the particularities of the intended service and application scenarios. Each of them may be optimized in some characteristics and be suboptimal in other goals. Therefore, it is not possible to conclude that a technology performs better than another for all conditions [1]–[3].  
 Among them, BLE is a widely used short-range technology, which has gained a dominant position thanks to its simplicity, low-power consumption, low-cost and robustness. BLE is currently present in almost all smartphones, tablets, computers and consumer electronics in general. This has enabled the development of a wide range of new services and applications in sectors such as healthcare, home automation, security or vehicular communications. BLE is particularly efficient in tracking things or people in indoor situations or scenarios with low-power requirements, high scalability and reliability.  
 However, unlike other technologies such as WiFi or ZigBee, until 2017, BLE lacked the capability of mesh networking. Mesh networks allow data transmission between pairs of nodes in a dynamic and non-hierarchical way. Nodes cooperate and allow an efficient relay of messages through other devices. Knowing that mesh topologies are an attractive alternative to traditional centralized or tree-based network topologies, adding mesh functionality to Bluetooth was a necessary step. The Bluetooth Special Interest Group (SIG)

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**Bluetooth\_Mesh\_Analysis\_Issues\_and\_Challenges.pdf (8.59 MB)**



## 02/08/2026 - WIFI Connection Distance Ranges

---

Lauren Klein - Feb 08, 2026, 6:49 PM CST

**Title:** WIFI Connection Distance Ranges

**Date:** 02/08/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn about the connection/distance ranges of 2.4 GHz Wi-Fi 6 (802.11ax) devices

**Citation Engine:** Google

**Citation Term:** distance connection range of 2.4 GHz Wi-Fi 6 (802.11ax) to portable devices

**Citation:** "Micro Center," *Micro Center*, 2025. <https://www.microcenter.com/site/mc-news/article/wifi-5-vs-wifi-6.aspx>

**Content:**

### Core Concepts

- **Wi-Fi standards** are IEEE 802.11 protocols; consumer-friendly names map as:
  - Wi-Fi 5 → **802.11ac** (released 2014)
  - Wi-Fi 6 → **802.11ax** (released 2019)
- Each new generation improves **speed, efficiency, and multi-device handling**.

### Wi-Fi 5 (802.11ac)

- Operates **only on 5 GHz**
- **Maximum theoretical speed:** ~3.5 Gbps
- Uses **256-QAM modulation**
- Supports **single-user MIMO** (one device at a time)
- Introduced **beamforming** to improve directionality and range
- Best suited for:
  - Small homes
  - <10 connected devices
  - HD/4K streaming, casual gaming, basic smart homes

### Wi-Fi 6 (802.11ax)

- Operates on **2.4 GHz + 5 GHz**
- **Maximum theoretical speed:** up to **9.6 Gbps**
- Uses **1024-QAM** → higher data density
- Introduces **MU-MIMO (multi-user)** → up to 8 devices simultaneously
- Adds **OFDMA** → splits channels into sub-channels for efficiency
- Adds **Target Wake Time (TWT)** → reduces battery drain for IoT devices
- Introduces **BSS Coloring** → reduces interference in dense environments

### Performance & Range Realities

- Real-world Wi-Fi 6 improvement is typically **30–40% faster**, not 3×
- Higher speeds often fall back to **2.4 GHz at longer distances**
- Mesh systems improve coverage but can **halve throughput per hop**
- Wired access points offer best consistency in large homes

### Typical Wi-Fi 6 Ranges

- **2.4 GHz:** ~150 ft indoor / 300 ft outdoor
- **5 GHz:** ~75 ft indoor / 200 ft outdoor
- **6 GHz (Wi-Fi 6E):** ~60 ft indoor (poor wall penetration)

### Who Should Upgrade to Wi-Fi 6

- Homes with **many devices (10+)**
- Smart homes with sensors, cameras, IoT
- Remote work, cloud gaming, VR
- Apartments with overlapping networks
- Users planning **gigabit internet**

### Big Picture

- Wi-Fi 5 = still usable for simple setups
- Wi-Fi 6 = **future-proof**, efficient, and essential for modern networks

**Conclusions/action items:** Wi-Fi 6 focuses on high-throughput, multi-device networking, while BLE prioritizes ultra-low power short-to-medium-range communication, making them complementary rather than competing technologies. Wi-Fi 6 significantly improves upon Wi-Fi 5 by increasing maximum data rates, supporting more simultaneous devices, and using efficiency technologies like OFDMA and multi-user MIMO. While Wi-Fi 5 is sufficient for smaller homes with limited devices, it struggles under congestion as device counts increase. Wi-Fi 6 is designed for modern, high-density environments, offering better performance, reliability, and future-proofing for smart homes and high-bandwidth applications.

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### Wi-Fi 6 vs. Wi-Fi 5: Understanding the Differences

As the number of connected devices in our homes grows, understanding the differences between Wi-Fi 5 (802.11ac) and Wi-Fi 6 (802.11ax) is essential for maintaining fast, efficient, and reliable wireless performance. This guide compares the two standards in terms of speed, capacity, range, and use cases—helping you choose the best option for your streaming, gaming, and smart home needs while also providing a look ahead with Wi-Fi 7.

**Microsoft Opinion** - Jan 09, 2025  
Microsoft Technology | [Buying Guide](#)



When it comes to picking the right networking equipment, your choice of Wi-Fi standard makes a bigger difference than you might think. From streaming 4K movies and gaming online to managing dozens of smart devices, your wireless connection affects how smoothly everything runs.

Wi-Fi 5 (also known as 802.11ac) has been the workhorse of home networks for years. But Wi-Fi 6 (802.11ax), introduced in 2019, brings important upgrades—especially in speed, efficiency, and the ability to handle multiple devices at once.

In this guide, we'll break down the key differences between Wi-Fi 5 and Wi-Fi 6 so you can make an informed decision when shopping for networking equipment. Stay tuned, because in our upcoming article, we'll be going into detail about Wi-Fi 7.

#### What Are Wi-Fi Standards?

Wi-Fi standards are the technical blueprints that guide how wireless devices connect and communicate. Created by the Institute of Electrical and Electronics Engineers (IEEE), these standards fall under the 802.11 family and have names like 802.11ac or 802.11ax.

To make things easier for consumers, the Wi-Fi Alliance introduced simpler names. Here's how the modern generations line up:

[Download](#)

**Wi-Fi\_6\_vs.\_Wi-Fi\_5\_Understanding\_the\_Differences.pdf (2.01 MB)**



## 02/23/2026 - WIFI Usage with C6

---

Lauren Klein - Mar 10, 2026, 8:28 PM CDT

**Title:** WIFI Usage with C6

**Date:** 02/23/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To learn about the WIFI capabilities of the C6

**Citation:** "WiFi Usage | Seeed Studio Wiki," *Seeedstudio.com*, Apr. 11, 2024. [https://wiki.seeedstudio.com/xiao\\_wifi\\_usage\\_esp32c6/](https://wiki.seeedstudio.com/xiao_wifi_usage_esp32c6/) (accessed Mar. 10, 2026).

**Search Term:** XIAO ESP32 C6 WIFI capabilities

**Search Engine:** Google

**Content:**

Board Overview

- **Seeed Studio XIAO ESP32C6** is a compact embedded development board designed for IoT applications.
- Supports **dual wireless communication**:
  - **2.4 GHz WiFi (802.11 b/g/n)**
  - **Bluetooth Low Energy (BLE) 5.0**
- Includes an **onboard ceramic antenna**, removing the need for external antennas.
- Designed for **low power consumption**, making it suitable for **battery-powered devices**.
- Used for **wireless connectivity and networking in IoT systems**.

WiFi Usage \_ Seeed Studio Wiki

Antenna Configuration

- **GPIO14** selects the antenna type:
  - **LOW** → **internal antenna**
  - **HIGH** → **external antenna**
- Must first set **GPIO3 LOW** to enable antenna selection.
- Internal antenna is the **default configuration**.

WiFi Usage \_ Seeed Studio Wiki

WiFi Library Overview

ESP32 WiFi functionality is accessed through the **WiFi library**, which provides networking tools.

Generic WiFi Functions

Important configuration functions include:

- `getHostname()`

- Returns the device hostname on the network.
  - `persistent(bool)`
    - Enables/disables storing WiFi settings in **non-volatile memory**.
  - `enableLongRange(bool)`
    - Enables **long-range WiFi connections** with lower data rates.
  - `mode(wifi_mode_t)`
    - Sets WiFi operating mode:
    - `WIFI_MODE_NULL` → disable WiFi
    - `WIFI_MODE_STA` → station mode (connect to router)
    - `WIFI_MODE_AP` → access point mode
    - `WIFI_MODE_APSTA` → both modes
  - `setSleep()`
    - Sets WiFi power-saving mode:
    - `WIFI_PS_NONE`
    - `WIFI_PS_MIN_MODEM`
    - `WIFI_PS_MAX_MODEM`
- WiFi Usage \_ Seeed Studio Wiki

#### Station (STA) Mode

Used when the ESP32 **connects to an existing WiFi network (router)**.

#### Key Functions

- `status()` → returns connection status codes such as:
  - `WL_CONNECTED`
  - `WL_CONNECT_FAILED`
  - `WL_DISCONNECTED`
  - `WL_CONNECTION_LOST`
- `begin()` → connects to a network.
- `reconnect()` → reconnects after disconnection.
- `disconnect()` → disconnects from network.
- `config()` → allows static IP configuration.
- `waitForConnectResult()` → waits until connection succeeds or times out.
- `localIP()` → retrieves device IP address.
- `macAddress()` → returns MAC address.
- `RSSI()` → returns WiFi signal strength.

WiFi Usage \_ Seeed Studio Wiki

#### Access Point (AP) Mode

The ESP32 can **create its own WiFi network**.

#### softAP Function

Creates a hotspot other devices can connect to.

Parameters include:

- SSID (network name)
- password
- WiFi channel
- hidden network option
- maximum number of connected clients (1–4)

Additional functions:

- `softAPIP()` → access point IP address
- `softAPgetStationNum()` → number of connected clients
- `softAPConfig()` → network configuration.

WiFi Usage \_ Seeed Studio Wiki

#### WiFi Network Scanning

The ESP32 can scan nearby WiFi networks.

Important functions:

- `scanNetworks()` → returns number of networks found.
- `SSID(i)` → name of network.
- `RSSI(i)` → signal strength.
- `encryptionType()` → security type.

Possible encryption types:

- `WIFI_AUTH_OPEN`
- `WIFI_AUTH_WEP`
- `WIFI_AUTH_WPA_PSK`
- `WIFI_AUTH_WPA2_PSK`
- `WIFI_AUTH_WPA_WPA2_PSK`
- `WIFI_AUTH_WPA2_ENTERPRISE`.

WiFi Usage \_ Seeed Studio Wiki

#### Connecting to WiFi

Basic process:

1. Include `WiFi.h`.
2. Set device to **station mode**.
3. Use `WiFi.begin(ssid, password)`.

4. Loop until `WiFi.status() == WL_CONNECTED`.
5. Retrieve device IP using `WiFi.localIP()`.

Example workflow:

- Device attempts connection
- Serial monitor shows progress
- IP address printed when connection succeeds.

WiFi Usage \_ Seeed Studio Wiki

#### WiFi Client Functions

Used for communication with servers.

Common functions:

- `connect(ip, port)`
- `write()` → send data
- `read()` → receive data
- `available()` → check available bytes
- `stop()` → disconnect from server
- `setTimeout()` → connection timeout settings.

WiFi Usage \_ Seeed Studio Wiki

#### WiFi Server Functions

ESP32 can also act as a **server**.

Important functions:

- `begin(port)` → start server
- `hasClient()` → detect incoming connections
- `stopAll()` → stop all server instances
- `end()` → stop the server.

WiFi Usage \_ Seeed Studio Wiki

#### MQTT Integration

The ESP32C6 supports **MQTT protocol**, widely used for IoT messaging.

Typical workflow:

1. Connect ESP32 to WiFi.
2. Connect to MQTT broker (example: `test.mosquitto.org`).
3. Subscribe to topic.
4. Publish messages periodically.

Example:

- Publish "Hello from XIAO ESP32C6" to topic `test/topic`.

Public brokers should **not be used for sensitive data**.

WiFi Usage \_ Seeed Studio Wiki

WiFi Mesh Networking

ESP32 supports **ESP-MESH**, allowing many devices to communicate.

Characteristics

- Self-organizing network
- Self-healing connections
- No single central router required
- Nodes relay messages between each other.

Benefits:

- Extends network range
- Allows large distributed IoT systems.

Libraries used:

- **painlessMesh**
- Dependencies:
  - ArduinoJson
  - TaskScheduler
  - AsyncTCP.

WiFi Usage \_ Seeed Studio Wiki

Mesh Network Operation

Typical mesh configuration includes:

- MESH\_PREFIX → mesh network name
- MESH\_PASSWORD → network password
- MESH\_PORT → TCP port (default 5555)

Nodes:

- Broadcast messages to all nodes.
- Detect new connections.
- Synchronize time between nodes.

Important functions:

- `sendBroadcast()` → send message to all nodes
- `receivedCallback()` → handle incoming messages
- `newConnectionCallback()` → detect new node joining
- `changedConnectionCallback()` → detect topology changes.

**Conclusions/action items:** Overall the C6 has many varying capabilities that will help us attempt to make a wireless BLE Connection for our device. The commands/functions available in Arduino might be helpful but it should be pretty simple code. I'll need to look into Arduino packages that are compatible with the C6.

Lauren Klein - Mar 10, 2026, 8:27 PM CDT

9:02:04 PM WiFi Usage | Seed Studio Wiki

XIAO XIAO ESP32C6 Wireless Connection WiFi Usage

## WiFi Usage with Seed Studio XIAO ESP32C6



Get One Now

The Seed Studio XIAO ESP32C6 is an embedded development board that boasts outstanding RF performance, thanks to its support for both 2.4GHz WiFi - 802.11 b/g/n and Bluetooth Low Energy (BLE) 5.0 dual wireless communication. This capability enables the XIAO ESP32C6 to provide reliable and high-speed wireless connectivity for a wide range of Internet of Things (IoT) applications. The board features an onboard ceramic antenna, which eliminates the need for an external antenna and simplifies the design process. The ESP32C6 chip also offers low power consumption, making it suitable for battery-powered IoT devices. In this tutorial, we will explore how to leverage the XIAO ESP32C6's Wi-Fi capabilities to connect to a Wi-Fi network and perform basic networking tasks.

**TIP**  
GPIO14 is used to select between using the built-in antenna or an external antenna. Before that, you need to set GPIO3 low level to turn on this function. If GPIO14 is set low level, it uses the built-in antenna; if it set to high level, it uses the external antenna. Default is low level. If you want to set it high, you can refer the code below.

WiFi Usage | Seed Studio Wiki | 1/3

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**WiFi\_Usage\_\_Seed\_Studio\_Wiki.pdf (4.5 MB)**



## 01/21/2026 - Lec #1

---

Lauren Klein - Jan 28, 2026, 8:53 PM CST

**Title:** Lec #1

**Date:** 01/21/26

**Content by:** Lauren

**Present:** Whole Team

**Goals:** To learn what 301 will entail and who will instruct!

**Content:**

- TJP and JP running 301
- 4 different TAs and Advisors
- Friday project selection in Tong
- Objectives: Design Project + Comm B (career/prof development, library resources, Feedback on writing/speaking)
- See Syllabus, same as regular design with small development section
- Be cautious about use of AI
- Did an ice breaker activity and met new people!
- Going to have lots of collaboration this semester as well
- Have access to many resources, need to network as a BME going into industry
  - Pre Library activity coming out in the end of the week
  - Find a job posting that interests you
  - Resume Update
  - Cover Letter for job

**Conclusions/action items:** I need to start looking for a potential job posting that interest me. I'll focus on full time options since I already have a summer internship. I'm excited to get into the professional development aspects of the Com B side of the course.



## 01/28/2026 - Lec #2

---

Lauren Klein - Jan 28, 2026, 8:55 PM CST

**Title:** Lec #2

**Date:** 01/28/26

**Content by:** Lauren

**Present:** Whole Team

**Goals:** To learn how to effectively use the library system and how I can maximize my researching time.

**Content:**

- Anne Glorioso from Science and Engineering Library system to help dive deeper in library searching
- Article searching, source evaluation, and citation management
- Chatbots/AI are trained on internet data and produce text based on input
  - Are not search engines, not credible, can generate factually incorrect statements or make up sources
- Databases pull directly and include index from informational sources
- Evaluating sources
  - Relevance, Authority, Quality, and Currency
  - Read Laterally
- There are specific engineering discipline databases (BME on right hand side)
- Can narrow down year range, use AND or OR searches,
- FindIT button can be really helpful, you can request article
- Zotero is one of 3 citation managers supported by UW
- Chrome Plug In is a paper in the top right of screen which will save to the Zotero app
- Can create a group library for Design Team
- Open up a word doc and you can directly add Zotero citations
- Technical reports publish the results of scientific or technical research, often using federal funds. Should include successes and failures
- Journal Articles don't have to include successes and failures
- Quotation marks will get rid of similar terms and only focus on the one you searched
- Can set up a meeting with them if we need to

**Conclusions/action items:** I need to find 4 research articles related to our project in order to continue with new knowledge. Zotero is a really powerful tool that I have downloaded and put in my browser as an extension. If I have any difficulties, I'll set up an appointment with the library staff!



## 02/04/2026 - Lec #3

---

Lauren Klein - Feb 04, 2026, 2:06 PM CST

**Title: Lec #3 - Resumes & Cover Letters**

**Date:** 02/04/26

**Content by:** Lauren

**Present:** BME 301s

**Goals:** To revise other's resumes & cover letters and get feedback on my own

**Content:**

-Sat with Kate B and Noor A

-Have printed out my necessary documents

-What students last year said they wanted to learn about: skills, research, design, career, future, internships, resume, cover, technical, design, etc

- 1) Job Ready Essentials --> Internship/Co-op pipeline, etc
- 2) Communication & Networking --> Tech Comm, Prof Writing, Strategic Networking
- 3) Project Leadership & Ethics
- 4) Technical & Advanced Pathways

Summer Fall plans:

- 1 co-op
- 18 internships
- 32 actively seeking
- 1 other job, not related to BME
- 8 research experience

Directions:

- 1) Read job ad (note key terms)
- 2) Complete peer review rubric
- 3) Be professional
- 4) Have Empathy
- 5) Offer helpful comments (one positive, one improvement, one area to expand)

Take a single landscape picture for each peer you reviewed (rubric, cover letter, resume)!

**Conclusions/action items:** Reviewed Kate & Violets and they both reviewed mine! Will be making changes to my resume and cover letter and reuploading!



## 02/11/2026 - Lec #4

---

Lauren Klein - Feb 11, 2026, 3:23 PM CST

### **Title: Lec #4 - Presentations and Interviews**

**Date:** 02/11/26

**Content by:** Lauren

**Present:** BME 301s

**Goals:** To learn and practice Interview tips and methods

#### **Content:**

Presentation stuff:

-NO HANGING BULLETS

-Top left bullet should line up

-Consistent fonts

-Legible images and graphs

-Use a logical organization flow

-Not always chronological order

-Design Ideas should be in the same order in all places (initial and then within matrix)

-Use content but don't use pics if not relevant

-Keep audience interested

-Be enthusiastic!

-Talk to audience, not the screen

-Design matrix = hit highlights not everything

-Images = need figure numbers, what it is, show/highlight function/feature, etc

-Using CAD images, use one or two clear images of the 3D model, NEVER use the drawing, labels and scale required

-Results graphs: Axes are not the same, never raw data, fonts need to be big and not fuzzy

Interviews:

-Bring a small portfolio (design projects, resume, etc)

-Completed the cover letter and resume

-Got into a group of 4: Kate, Violet, & Noor (same as last time)

-Picked out questions on the google doc from Canvas

-See Interview Activity for questions and answers

**Conclusions/action items: Myself and my group completed the interview read and revision and it went really well. I will keep in mind all of these practices for future interviews and will implement them where I can. I need to finish my last prompt response and upload to Canvas.**



## 02/18/2026 - Lec #5

---

Lauren Klein - Feb 18, 2026, 1:38 PM CST

**Title: Lecture 5 - Preliminary Presentation Prep**

**Date:** 02/18/2026

**Content by:** Lauren

**Present:** BME 301s

**Goals:** To get ready for Preliminary Presentations

**Content:**

-Went over some friendly reminders

-Individual conferences next Friday

-Prelim Prez on Friday

-Prelim Report and Feedback Fruits due next Wednesday

-Switching with another 3 person team to annotate their slides and give feedback

-Switched with a team with a Co-Op (Dynamic Phantom for Non-Invasive Imaging of Lung Profusion Using Fluoroscopy)

-Left annotations, their slides weren't finished so it was a little hard

**Conclusions/action items: We will make the changes according to the other team's annotations of our slides. We need to practice the presentation. Isabel and I still need to solder the circuit as well**



## 02/25/2026 - Lec #6

---

Lauren Klein - Feb 25, 2026, 1:50 PM CST

### **Title: Diversity and Inclusion**

**Date:** 02/25/26

**Content by:** Lauren

**Present:** BME 301's

**Goals:** To learn about diversity and inclusion in design

### **Content:**

What does Diversity mean in engineering design?

- Making your device applicable to everyone
- Cost Effective
- Adjustable and Size
- Listening to all team member ideas with open minds
- Feedback on design from people outside of group (avoid tunnel vision)
- Inclusive Language
- Quality Consistent for all
- Different Skillsets
- Applicable for all types of people
- Cultural/Religious Beliefs
- Every idea is important!
- Testing individuals from different diversity backgrounds
- Comprehensive team of engineering disciplines

Universal Design means:

- Covered a little bit previously
- Making your device unbiased towards a certain group if it can be helped
- Targeting many different aspects
- Inclusive text/images for blind and deaf
- Pediatrics vs Adults = Age
- Intuitive (don't need a lot of background knowledge)
- Gender Equity
- Broad/Diverse Testing Demographics
- Simplicity/User Friendly

"Universal Design is design usable by all people to the greatest extent possible without the need for adaptation or specialized design." = designing broadly and inclusively to avoid designing for the "average user"

7 Principles of Universal Design: 1) Equitable Use 2) Flexibility in Use 3) Simple and Intuitive Use 4) Perceptible Information 5) Tolerance for Error 6) Low Physical Effort 7) Size and Space for Approach and Use

How does this relate to Ethics?

- Good ethics to make sure to not purposely exclude
- It's our job to design for the betterment of patient lives (shouldn't be uninclusive)
- Making a safe space

Biomedical Engineering Code of Ethics

-In Class Activity = read through 7 principles and identify one that we can improve in our project to make it more of a Universal Design

**Conclusions/action items: We need to do the best we can to make our design universal. It should be accommodating for people from all walks of life. We will complete the In Class Activity!**



## 03/04/2026 - Lec #7

---

Lauren Klein - Mar 04, 2026, 2:03 PM CST

**Title:** Library – Patents, standards and other resources for design

**Date:** 03/04/36

**Content by:** Lauren

**Present:** BME 301s

**Goals:** To learn more about Patents and Standards

**Content:**

-Dave Bloom (Science and Engineering Librarian)

-Works at Steenbock

-Review Reading (Standards Module and Intro to Patents)

-Mapping Design Process to Literature (Standards, Market/Industry Databases, Patents)

Standards:

-Library has Full Text database of ASTM, ASABE, and IEEE

-Freely available

-Historical Print collection

Market/Industry Sources:

-Find info on companies, industries, consumer trends with Business databases

-Library research guides to help you get started on slides

-Data Axle

-IBISWorld

-ProQuest

Patents and Prior Art

-Bouncing Squirrel?

-Searching: inventions disclosed in US and Foreign Patents and Patent Applications, Publications, Sale, or Public Use

-Hypothetical: idea for bouncing squirrel feeder

-Similar Device: The Squngee (Number 6474260)

-Using Lens.org to find the patent

-Comes up as Recoiling-action wildlife feeder

-Probably not the only prior art relevant to the invention, need to find more

-There's some other similar ones like a combined bird and squirrel feeder, gotta look at works cited of original patent too

-15 patents cited the Squngee

-Cited 5 patents itself

-Looking up different keywords in original/similar patent title can be helpful

-Can explore CPC classifications

-Patent Examiners look for Usefulness, Novelty, and Non-obviousness

- Every Utility patent has a claim
- Each claim is at least a single sentence (Preamble, Transition, Antecedent Basis)
- Independent and Dependent Claims
- Independent are standalone and contain all limitations to define an invention

Comparing the Claims sections of the Squegee and Squirrel Bungee

Claims of Squegee:

1. An animal feeding apparatus having a first end and a second end, comprising:
  - a mounting region located at the first end;*
  - a resilient biasing device coupled to the mounting region, the resilient biasing device having a biasing force within a range that is capable of suspending an animal above the ground and moving the animal in a substantially oscillating motion;*
  - a food attachment device coupled to the resilient biasing device, and located at the second end;*
  - a mounting device attached to the mounting region, the mounting device including a length of chain; and*
  - a length of metal cable coupled between the resilient biasing device and the food attachment device.*
2. The animal feeding apparatus of claim 1 , wherein the resilient biasing device includes a coil spring.
3. The animal feeding apparatus of claim 1 , wherein the resilient biasing device includes a biasing force within a range that is capable of suspending a typical squirrel above the ground and moving the typical squirrel in a substantially oscillating motion.
4. The animal feeding apparatus of claim 1 , wherein the food attachment device includes a screw.
5. An animal feeding apparatus having a first end and a second end, comprising:
  - a metal mounting device;*
  - a metal spring coupled to the mounting device, the metal spring having a spring force within a range that is capable of suspending an animal above the ground and moving the animal in a substantially oscillating motion;*
  - a flexible shield substantially covering the metal spring;*
  - a length of metal cable coupled to the resilient biasing device; and*
  - a metal food attachment device coupled to the length of metal cable, and located at the second end.*
6. An animal feeding apparatus having a first end and a second end, comprising:
  - a mounting region located at the first end;*
  - a plurality of length adjusting members attached to the mounting region;*
  - a resilient biasing device coupled to the plurality of length adjusting members, the resilient biasing device having a biasing force within a range that is capable of suspending an animal above the ground and moving the animal in a substantially oscillating motion; and*
  - an article of food located at the second end and coupled to the resilient biasing device using a food attachment device.*
7. The animal feeding apparatus of claim 6 , wherein the plurality of length adjusting members includes a length of chain.
8. The animal feeding apparatus of claim 6 , further including a length of flexible material coupled between the resilient biasing device and the food attachment device.

9. The animal feeding apparatus of claim 8 , wherein the length of flexible material includes a length of metal cable.
10. The animal feeding apparatus of claim 6 , wherein the resilient biasing device includes a coil spring.
11. The animal feeding apparatus of claim 6 , wherein the article of food includes a cob of corn.

#### Claims of Squirrel Bungee:

1. A squirrel bungee apparatus, comprising:

*a vertically disposed first plate member having first and second ends;*

*a vertically disposed second plate member having first and second ends;*

*said first end of said second plate member being pivotally secured to said second end of said first plate member by a pivot pin;*

*a hanger, having upper and lower ends, for supporting the apparatus;*

*said upper end of said hanger being configured to be secured to an overhead support;*

*said lower end of said hanger being pivotally secured to said first plate member at said first end thereof;*

*said first and second plate members being pivotally movable between first and second positions;*

*a torsion spring having a central coil portion and first and second spring legs extending therefrom;*

*said central coil portion of said torsion spring being mounted on said pivot pin between said first and second plate members;*

*said first spring leg being attached to said first plate member;*

*said second spring leg being attached to said second plate member;*

*the spring action of said torsion spring and the connection of said first and second spring legs to said first and second plate members respectively yieldably maintaining said first and second plate members in said first position;*

*an elongated flexible support member having upper and lower ends;*

*said upper end of said flexible support member being secured to said second plate member at said second end thereof; and*

*a squirrel attraction device secured to said lower end of said flexible support member whereby the weight of a squirrel jumping onto the squirrel attraction device will cause said first and second plate members to be moved back and forth from their said first position to their said second position and from their said second position to their said first position thereby causing the squirrel to rise and fall.*

2. The squirrel bungee apparatus of claim 1 wherein said first plate member has the shape of a squirrel's tail and wherein said second plate member has the shape of a squirrel's body.
3. The squirrel bungee apparatus of claim 1 wherein said squirrel attraction device is a food item.
4. The squirrel bungee apparatus of claim 3 wherein said food item is an ear of corn.
5. The squirrel bungee apparatus of claim 3 wherein said food item is a feed block.
6. The squirrel bungee apparatus of claim 3 wherein said food item is a log of feed.
7. A squirrel bungee apparatus, comprising:
  - a vertically disposed first plate member having first and second ends;*
  - a vertically disposed second plate member having first and second ends;*

*said second plate member being pivotally secured at its said first end to said first plate member at said second end of said first plate member;*

*a hanger, having upper and lower ends, for supporting the apparatus;*

*said upper end of said hanger being configured to be secured to an overhead support;*

*said lower end of said hanger being pivotally secured to said first plate member at said first end of said first plate member;*

*said first and second plate members being pivotally movable between first and second positions;*

*a spring positioned between said first and second plate members which interconnects said first and second plate members;*

*said spring yieldably maintaining said first and second plate members in said first position;*

*said spring yieldably resisting the pivotal movement of said first and second plate members from their said first position to their said second position;*

*an elongated flexible support having upper and lower ends;*

*said upper end of said flexible support being secured to said second plate member at said second end of said second plate member; and*

*said lower end of said flexible support being configured to have a food item secured thereto whereby the weight of a squirrel jumping onto the food item will cause said first and second plate members to be moved back and forth from their said first position to their said second position and from their said second position to their said first position causing the squirrel to rise and fall.*

8. The squirrel bungee apparatus of claim 7 wherein said first plate member has the shape of a squirrel's tail and wherein said second plate member has the shape of a squirrel's body.
9. The squirrel bungee of claim 7 wherein the food item is an ear of corn.
10. The squirrel bungee of claim 7 wherein the food item is a block of feed.
11. The squirrel bungee of claim 7 wherein the food item is a log of feed.
12. The squirrel bungee of claim 7 wherein said spring is a torsion spring.
13. The squirrel bungee of claim 7 wherein a pivot pin pivotally secures said first and second plate members together and wherein said spring is a torsion spring mounted on said pivot pin between said first and second plate members.

-Contrasting them the newer one used different verbiage of basically saying the same thing

-Not many notable differences but Squegee never really says Squirrels

-Newer design had more physical components/decor rather than the first one was more plain (there's a squirrel on it)

-Being very specific in the newer one

-A slightly differ in the spring systems

-You would be able to market something even if you can't patent it so you could have some more competition

Group time!

-Things to remember/try:

Group by Simple Family

CPC using classifications

CPC using individual records

Search by Citation (Cited by and Cites)

-Use search strategies for our own project

Glowcose patent:

- US 2024/0032876 A1

**Conclusions/action items: I will keep these search and other research tips when we get further into the market side of our project. We will pass these on to Kiera. These tips will be especially relavent if we want to win Tong!**



## 03/06/2026 - Tong Lecture

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Lauren Klein - Mar 06, 2026, 7:00 PM CST

**Title:** Tong Lecture

**Date:** 03/06/2026

**Content by:** Lauren

**Present:** All of BME

**Goals:** To learn from Prof Justin Williams on his experience in the industry and career accomplishments

**Content:**

-Professor Justin Williams

-Reflection on how seminar impacts my life

**Conclusions/action items:** Professor Williams' seminar on his career and accomplishments was incredibly inspirational and enlightening to listen to. Learning about how he was able to start so many companies and foster so many ideas that have changed the lives of millions was really amazing! I think its really important like he said to not worry about making things bigger and better but sometimes realize that smaller is more impactful.



## 03/11/2026 - Lec #8

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Lauren Klein - Mar 11, 2026, 1:48 PM CDT

### **Title: Protocol Development**

**Date:** 03/11/2026

**Content by:** Lauren

**Present:** BME 301s

**Goals:** To learn about making protocols and testing plans

### **Content:**

-Fail Fast and Forward

-FAIL EARLY

-Perfection is not important (low fidelity like cardboard, start early, test individual pieces)

-Still document

-1080 ECB Closet has leftover materials

Preliminary Testing/Analysis:

-Low fidelity again

-Circuit diagrams and testing

-Fittings aka connection points

-Simple calculations

-Free Body Designs & Mechanics of Materials

Planning for fab and testing:

-Materials = detailed list and match the table

-Should have name, concentration, amount, dimensions, manufacturer and part number, purpose, list of equipment needed, references

-Methods step by step plan or list (mix or cut)

-Rule #1 = repeatable by unfamiliar reader

-Given Sample fabrication/testing procedure and had to find what was wrong

-Need sig figs and raw data at first

-Example didn't list where they got materials from, no units, no tablet description

-NEEDS to be repeatable

3D printing:

-Same rules apply plus more

-Materials

-Methods, etc

Manufacturing:

-Consider throughout the process

-Cannot manufacture everything you can 3D print

-Common methods: molding (blow, injection, thermoforming, extrusion, rotational), machining (mill, lathe, waterjet), Joining (welding, soldering, screwing, riveting, adhesives)

-Seek professional advice

#### Fabrication Plans

-See template on slides

-See testing plan additional considerations

**Conclusions/action items: After lecture, split off into teams to create a protocol for the assignment in Canvas. We will have to make a few protocols since we have many moving aspects. Tentatively, Isabel will do Solidworks, I'll do Circuitry, and Claudia will do Software.**



## 03/18/2026 - Lec #9

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Lauren Klein - Mar 18, 2026, 1:41 PM CDT

### **Title: Brevity in Communication**

**Date:** 03/18/2026

**Content by:** Lauren

**Present:** BME 301s

**Goals:** To create a call to action for Show & Tell

### **Content:**

-Expo volunteers needed on April 17th and 18th

-Oral elevator pitches (show & tell = 1 minute, presentation to judges = 5 minutes)

-Written = executive summary, abstracts, reports

Elevator pitches:

-Succinctly and efficiently communicate ideas and seize opportunities

-Use an elevator ride to pitch = short

-Goal is to get attention and network

-Know your audience (tailor pitch to interests and needs of audience)

-Practice, practice, practice (rehearse so it flows naturally and confidently)

-Be authentic (let passion show!)

-Keep it simple (avoid jargon and technical language that may confuse audience)

-Adapt and Iterate (be open to feedback and refine your pitch based on responses and outcomes)

Structure:

-Attention grabber (start with a hook to engage)

-Introduction (intro yourself and project)

-Value Proposition (clearly articulate what you offer and problem you're solving)

-Benefits

-Call to Action

-Example on slides

-The majority of the focus should be on what you're trying to solve and what you're struggling with (What do you need help with?)

-Tong award example as well (Marketable project with big impact)

-Design Excellence = meets user needs very well

-Can flip intro and attention grabber

-On website there are guidelines for the executive summary for prep for tong and design excellence

-Really wanna win Tong!

-We will be doing Tong since big impact!

-Do's and don't on elevator pitching

Do: eye contact, exude confidence, concise and focused, tailor pitch to audiences

Don't: overwhelm with unnecessary details, forget to listen and engage with audience, sound rehearsed or robotic

Executive Summary:

-Purpose is to turn the elevator pitch into a one page document to provide a concise overview of a longer document and capture attention/convey key information

-Also want to enable quick understanding and engage audience

-See general structure of Exec Summary (very similar to elevator pitch)

-See doc with key points for Tong criteria

Abstracts:

-Write it last

-Typically 150-300 words (250 most common)

-Provide a clear, concise, and specific summary of your work

-Helps readers decide if they wanna read full paper

-Journals may require longer exec summary style abstracts (1 page w subtitles)

-Structure = similar to report (background/context, objective, methods, results & analysis, discussion/conclusion, and maybe future work)

-Technical Reports need to be written concisely

-Eliminate extra text that explain obvious or unnecessary details or redundant pairs

-Avoid conversational text

-Introduce acronyms

-Don't include raw data

-Proofread thoroughly

-See show & tell instructions and complete all necessary comments

**Conclusions/action items: We have registered to compete for the Tong award! We need to write out call to action. We need to also write and practice our elevator pitch.**



## 03/25/2026 - Lec #10

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Lauren Klein - Apr 05, 2026, 7:57 AM CDT

**Title: Ethics in Engineering**

**Date:** 03/25/2026

**Content by:** Lauren

**Present:** BME 301s

**Goals:** To learn about Ethics in Engineering

**Content:**

What even defines ethics? → not always clear-cut

Comes from:

- personal values
- cultural/societal norms
- professional standards

Important distinction:

- Personal ethics = what YOU believe is right
- Professional ethics = what you are expected to do as an engineer
- Instructors think ethics are extremely important
- Students tend to value ethics less (or more situationally)

Applies across:

- communication
- teamwork
- leadership
- ethics itself

→ Probably because students don't always see real-world consequences yet

**BME Code of Ethics**

-Exists to guide decision making in real scenarios

Important for:

- patient safety
- honesty in reporting data
- responsibility to society
- Ethics = Design Process

Ethical problem solving is basically the same as engineering design

Steps (same mindset as design):

- Identify the problem (is there an ethical dilemma?)
- Understand the situation fully
- Brainstorm possible actions
- Evaluate solutions
- Choose + implement
- Not a one-step decision → iterative + requires thinking through consequences

#### -Ethical Decision-Making Framework

- First step = awareness
- recognize when something has ethical implications

Then consider:

Stakeholders: patients, doctors, engineers, companies, public

Options: multiple possible actions (not just yes/no)

#### How to Evaluate Options (Tests)

##### Core Tests

- Harm test: minimizes negative consequences?
- Publicity test: would I be okay if this decision was public?
- Reversibility test: would I be okay if I was the one affected?
- Universality test: what if EVERYONE did this?

##### Additional Tests

- Respect for persons: does this respect rights/dignity?
- Utilitarian: greatest good for greatest number?
- Social justice: does this unfairly impact vulnerable groups?

#### Case Study: Guidant (Medical Device Ethics)

Scenario: whether to report complications to FDA

-Stakeholder perspectives

Company (VPs):

- might justify NOT reporting:
- financial risk
- reputation
- uncertainty in data

Patients + doctors want:

- transparency
- safety
- informed decisions

Design engineers stuck between:

- company pressure
- ethical responsibility

#### Real Outcome

- Employees anonymously reported to FDA

#### Result:

- federal investigation
- felony convictions (2003)
- \$92.4 million penalty
- company collapse → acquisition
- HUGE example of why ethics matters in engineering

#### Application to Design Project

- Every design has ethical dimensions
- safety vs cost
- performance vs accessibility
- risk vs innovation

#### What we need to do

- Identify: where ethical issues could arise in our design
- Develop: plan for addressing them

**Conclusions/action items: The team and I need to use this information to complete the Ethics in Engineering Assignment. We also have our Executive Summary due on Thursday. Our Shark Tank presentation is also Thursday.**



## 04/08/2026 - Lec #11

Lauren Klein - Apr 08, 2026, 1:39 PM CDT

### Title: Engineering Judgment

Date: 04/08/2026

Content by: Lauren

Present: BME 301s

Goals: To learn about Engineering Judgment

### Content:

-The process of making informed decisions, often in situations where there isn't a clear-cut answer or a specific code or standard to follow, by weighing available information, experience, and principles to arrive at a reasonable solution

-Example: How many times larger is the sun than the earth? How many earths would fit into the sun?

1)109.29 2) 1.3 million earths

-Expectation of being an engineer: ABET outcome 6 --> an ability to develop and conduct appropriate experimentation, analyze, and interpret data and use engineering judgment to draw conclusions

-Real world problems

-Open ended problems

-Teamwork and collaboration with others

-Critical thinking (evaluate solutions, testing/analysis)

-Communication (all forms)

-Handling uncertainty (including incomplete info and changing conditions)

-Intuition (uses experiences/reflect on past projects)

-Ask questions

-Embrace life-long learning

-Deesha Chadha (Imperial College London)

-Interviewed 20+ professional organizations

-3 Domains of the model

1) Attitudes (what you feel/believe)

2) Behaviors (how you demonstrate and act upon knowledge and attitudes)

3) Cognitive (what you know about/are able to do)

-In class activity relating to these "ABCs" ^^

-Also seeking feedback about utility of content, clarity of wording/layout, etc

**Conclusions/action items: We need to complete the in class activity on the ABCs. We also need to complete our Executive Summary. We have our pharmacy presentation tomorrow!**



## 04/15/2026 - Lec #12

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Lauren Klein - Apr 15, 2026, 1:46 PM CDT

### **Title: Poster Presentations**

**Date:** 04/15/2026

**Content by:** Lauren

**Present:** BME 301s

**Goals:** To learn about how to give the best Poster Presentation possible!

### **Content:**

What Makes a Good Poster?

- Uniform fonts & sizes
- Understandable Graphs
- Important Images
- Figures
- Good Flow/Organized
- Color
- Limited Blank Space
- Concise but detailed information
- Not too overwhelming
- Graphs with same scales/fonts
- No single hanging bullets

What Makes a Bad Poster?

- Blurry graphs
- Inconsistent fonts/sizes
- No Figures
- Too much or not enough text
- Excessive wording
- No raw data/CAD drawings
- Not including statistics
- Redundancy

-Went through bad examples

-Final Design area needs to be self explanatory, dimensions, labels, etc

-Fabrication shouldn't be too much text

Getting Started:

- Read requirements and evaluation form

- Include relevant and correct contact info
- Descriptive but concise titles and subtitles
- Have a storyline (what are you doing and why do we care?)
- Show your best results, not ALL
- Minimize text (bulleted text with descriptive subtitles)
- LOTS of colorful but high res pics/graphics to explain but make sure they're relevant/understandable
- Captions on all figures/graphics (Figure number, title, description, citation if needed)
- Fonts (style must be easy to read)
- Colors (use for ease of reading to separate sections and highlight important points)
- Avoid harsh, too many, or clashing colors
- Must be able to read from 3 feet away (usually 24-28)
- References in relatively small font
- Also reference all pics/graphs not your own
- Include enough white space to define and separate different topics

#### Context of Use and Workflow:

- Start with user and setting (who, where)
- Show workflow and user-device interaction
- Place in a larger system (app, clinic, etc)
- Use color/grouping to organize/show what belongs together
- Use labels with minimal text
- Keep it high-level and understandable at a glance
- See BAD flow chart example

#### Final Details:

- Handouts (business cards, copies of poster, surveys, etc)
- Have several other people proofread
- Is it understandable by an unfamiliar audience?

**Conclusions/action items: Bring a printed copy of our poster next week for peer review feedback. The rest of class is worktime on our poster which we will be able to reuse some stuff from last semester on.**



## 04/22/2026 - Lec #13

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Lauren Klein - Apr 23, 2026, 10:42 AM CDT

**Title:** Final 301 Lecture - Peer Poster Review

**Date:** 04/22/2026

**Content by:** Lauren

**Present:** BME 301s

**Goals:** To get feedback on our poster and prep for Friday

**Content:**

-Exchanged with Ella Barsness

-Got some good feedback

-Still need to fix Dr. P's bracelet

**Conclusions/action items:** I am going to the Makerspace after lecture to fix the spare bracelet. We will be practicing our presentation and submitting for printing tonight.



## 01/30/26 - BSAC #1

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Lauren Klein - Jan 30, 2026, 11:29 AM CST

**Title:** BSAC #1

**Date:** 01/30/26

**Content by:** Lauren

**Present:** Individual

**Goals:** To talk about current pressing matters in BME

**Content:**

-Jose is still chair --> Senior, Bioinstrumentation, 201 SA

-BSAC Executive Committee

-Reach out to BME Mentees

-BSAC approving training throughout the curriculum requests now

-Went into small group

-Intros

-Takeaway from Fall --> Pay attention to client, payment situation with client early,

-Status

-201 lab

-301/201 lecture

-402 advice

**Conclusions/action items:** Will be at Exec next week!



## 02/13/2026 - BSAC w Faculty

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Lauren Klein - Feb 13, 2026, 11:28 AM CST

**Title:** BSAC w Faculty

**Date:** 02/13/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To speak with faculty about current problems in BME

**Content:**

-Went through Faculty Intros

-Can't swap BME 200/201 cause of mentorship emphasis, difficulties for students admitted in January, harder to get 70+ projects

-201 rubric for notebooks and getting into the habit of documenting the design process rather than checking off a rubric

-Still looking for feedback on this

-Thoughts on BME 200 lecture --> improvement of technical writing

-201 lecture experience --> a little chaotic, aren't finishing prelab stuff, stressful

-201s PDS, notebook checks --> confused about what needs to be in the notebooks, PDS feedback on canvas was helpful, no rubric is for real world simulation

-402 prelim pres --> was helpful to make sure you're on top of it and get goals aligned to give you purpose, would maybe be helpful to be meeting with other teams/a cohort,

-301 prelim pres --> feeling fine, some setbacks due to materials, some client issues, fabrication

-201/301 enrollment/track questions --> no

-Anything else? --> hard to know what the advisor wants, maybe not getting enough feedback fast enough, better communication/expectations, maybe a soldering/PCB making training,

-Prof Williams

**Conclusions/action items:** BSAC Exec next week. Hopefully 200 lecture will be implemented as I think it would be very helpful. Preliminary Presentations are next week already!

**02/27/2026 - BSAC #3**

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Lauren Klein - Mar 04, 2026, 12:50 PM CST

**Title:** BSAC w/o faculty**Date:** 02/27/26**Content by:** Lauren**Present:** Individual**Goals:** To improve the BME Department and get updates on current issues.**Content:**

-Talked about thoughts on 201 lecture being chaotic and moving the pre-lec content/quizzes

BME 200 Lecture topics (an in-progress list)

-Move career fair/resume to 200 and move post-grad to 301

201 Lecture structure change to a power lecture or TA/SA office hours

-Office Hours after

201's electronics report feedback

-Troubles getting group together to write or polish it

201's electronics unit feedback

-Fine overall, atleast interesting

301 preliminary presentations and report

-Went really well

-Was nice to get feedback and learn about other groups projects

402 journal article

-Not enough instructions

-Didn't know how to write journal style

-Had to write about results they didn't have yet

Feedback Fruits

-Went well overall!

**Conclusions/action items:** We will meet next week for BSAC Exec. Hopefully 200 lecture is implemented!



## 03/11/2026 - Learning LabVIEW Training

Lauren Klein - Mar 11, 2026, 3:50 PM CDT

**Title:** Learning LabVIEW - Training Throughout the Curriculum

**Date:** 03/11/2026

**Content by:** Lauren

**Present:** Individual

**Goals:** To complete my Training Throughout the Curriculum --> Learning LabVIEW

**Content:**

See attached certificate below

**Conclusions/action items:** I've completed my design training and successfully learned how to use LabVIEW. I've attached the certificate/verification of completion. I'll use my knowledge of LabVIEW in my future industry experiences.

Lauren Klein - Mar 11, 2026, 3:50 PM CDT



[Download](#)

CertificateOfCompletion\_Learning\_LabVIEW.pdf (62.7 kB)



## 03/13/2026 - BSAC w Faculty

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Lauren Klein - Mar 13, 2026, 11:34 AM CDT

**Title:** BSAC w Faculty

**Date:** 03/13/26

**Content by:** Lauren


**Present:** Individual

**Goals:** To talk about current issues in BME with staff

**Content:**

- Reach out to Mentees!
- BSAC Chair Elections coming up
- Issue with Feedback Fruits showing up on assignment calendar
- Next Friday is Show & Tell
- 301s at tables with call to action and 402s will come around and offer design/project advice
- Went through intros
- BME 201 power lecture
- Training throughout the curriculum wasn't advertised as much this semester
- Everyone is feeling good about Show & Tell
- 402s have been working on completing their outreach
- More lffy on the journal articles
- AI isn't always right and can be misleading
- 201 issues with sample holder materials (not knowing plastics are allowed)
- All course options are out
- Enrollment dates released on March 23
- Prof Ohnsorg
- Talked about career fair and struggles
- Internships leading into full time

**Conclusions/action items:** We have BSAC Exec next week and then none the week after.



# 2/5/2026 - Diabetes Spending

KIERA KLEMM - Feb 26, 2026, 1:08 PM CST

**Title:** Diabetes Spending Research

**Date:** 2/5/2026

**Content by:** Kiera Klemm

**Citation:** Parker ED, Lin JD, Mahoney TJ, et al. Economic Costs of Diabetes in the U.S. in 2022. *Diabetes Care*. 2023;47(1).

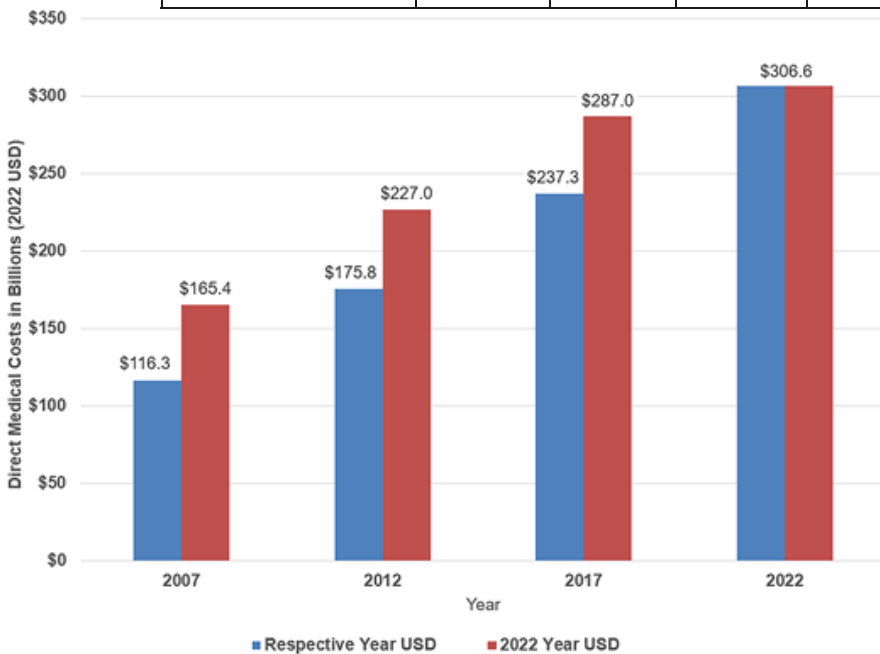
doi:<https://doi.org/10.2337/dci23-0085>

**Content:**

- ”The total estimated cost of diagnosed diabetes in the U.S. in 2022 is \$412.9 billion, including \$306.6 billion in direct medical costs and \$106.3 billion in indirect costs attributable to diabetes.”
- Diabetes accounts for 1 in 4 health care dollars in the US
- People with diabetes have \$12,022 in medical expenditures, 2.6 times higher than those without diabetes
- ”Major contributors to indirect costs are reduced employment due to disability (\$28.3 billion), presenteeism (\$35.8 billion), and lost productivity due to 338,526 premature deaths (\$32.4 billion).”
- Includes absenteeism and disability wages that don’t apply to product population of children, thought he difference isn’t as stark cause of parents missing work

Cost component	Population with diabetes				Population without diabetes	Total\$
	Attributable to diabetes		Total incurred by people with diabetes			
	USD	% of U.S. total	USD	% of U.S. total		
Institutional care						
Hospital inpatient days	96,182	19	144,538	29	354,857	499,395
Nursing/residential facility days	9,581	8	30,286	25	88,676	118,961
Hospice care days	57	0.3	2,852	13	19,672	22,525
Subtotal	105,820	17	177,676	28	463,205	640,881
Outpatient care						
Office visits	33,646	12	58,875	20	233,577	292,452
ER visits	11,821	7	23,451	13	154,856	178,308
Ambulance services	208	2	1,250	12	9,318	10,568

Hospital outpatient visits	12,114	8	22,033	15	121,260	143,296
Home health	5,591	5	22,680	19	96,153	118,834
Podiatry	363	10	767	22	2,800	3,567
Subtotal	63,742	9	129,057	17	617,967	747,023
Outpatient medications and supplies						
Insulin	22,389	100	22,389	100	0	22,389
Diabetes supplies*	4,232	100	4,232	100	0	4,232
Noninsulin glucose-lowering medications†	24,709	100	24,709	100	0	24,709
Other prescription medications	84,483	16	138,024	27	381,428	519,452
Other equipment and supplies‡	1,192	2	7,187	12	53,285	60,472
Subtotal	137,005	22	196,542	31	434,713	631,254
Total	306,568	15	503,274	25	1,515,885	2,019,159



**Conclusions:** The economic burden of diabetes falls on insurers and people with diabetes. It accounts for a large portion of health care spending while also reducing employee productivity and presence resulting in lost wages. The

amount of people with diabetes is generally increasing though reaching stability starting in 2022.



## 2-5-2026 Cost Effectiveness of CGMs

**Citation:** 2. Jiao Y, Lin R, Hua X, et al. A systematic review: Cost-effectiveness of continuous glucose monitoring compared to self-monitoring of blood glucose in type 1 diabetes. *Endocrinology, Diabetes & Metabolism*. 2022;5(6). doi:<https://doi.org/10.1002/edm2.369>

- ”Its use has been shown to improve glycaemic management and reduce the risk of hypoglycaemic events.”
- Cost of CGMs are a large barrier
- Use of CGMs can prevent hypoglycemic shock and other emergency events which can lower medical costs
- ”These improvements in physiological parameters have also translated into psychological benefits. With CGM use, individuals have reported reductions in diabetes-related distress, improved hypoglycaemic confidence, and improvements in fear of hypoglycaemia “
- ”Hypoglycaemia alone is estimated to be responsible for 100,000 emergency department visits in the United States of America (USA)<sup>6</sup>; with a total annual estimated cost between USD 1.8 to 5.9 billion.”
- ”Seventeen studies concluded that CGM is cost effective based on willingness-to-pay thresholds that ranged from \$42,000 to \$175,000. “
- Continued development of CGMs is lowering usage costs
- ”youth is a risk factor for hypoglycaemic events”
- This systematic review provides evidence that CGM appears to be a cost-effective intervention for individuals with type 1 diabetes. Key drivers of CGM cost-effectiveness include reduction of chronic complications through improvement in glycaemic management, and reduction in frequency and duration of hypoglycaemic episodes. These studies also highlight the rapidly evolving nature of CGM which has driven down usage costs and may continue to do so with further advances.”



## 3/5/2026 - T1D Market Size

---

KIERA KLEMM - Mar 05, 2026, 9:10 PM CST

**Title:** T1D Market Size

**Date:** 3/5/2026

**Content by:** Kiera Klemm

**Present:** n/a

**Goals:** To understand the potential of our total addressable market and serviceable addressable market

**Citation:** CMI, "Type 1 Diabetes Market Size to Worth USD 24.36 Bn By 2031," *Yahoo.com*, May 16, 2024. <https://finance.yahoo.com/news/type-1-diabetes-market-size-093000719.html>

**Content:**

*-Growing number of t1d cases is increasing market size, predicted growth rate us 6.2%*

*-Advancing treatment options and solutions are driving market growth*

*-"The global type 1 diabetes market size is calculated at USD 15.95 billion in 2024 and is expected to be worth around USD 24.36 billion by 2031, growing at a CAGR of 6.2% from 2024 to 2031."*

**Conclusions/action items:**

The article is very short focusing on establishing numbers and statistics on this topic. The article predicts type 1 diabetes to be a growing strong industry. sentiment about the market growing due to new innovations indicates competition within the market. The source provides accurate information but is not scholarly.



## 3/5/2026 - Market Size Determination

---

KIERA KLEMM - Mar 05, 2026, 10:59 PM CST

### Brainstorming

- Parents of newly diagnosed children with T1D
- Children with T1D
- School nurses
- Caretakers:
  - Teachers
  - Babysitters
  - Extended Family

### Beachhead Market

Parents of Children with T1D participating in online support groups

- Easy to access and communicate with
- Pains: fear, lack of sleep, caring for child while at school, keeping their child alive, cost of treatment

### End User

Education Platform: Parents of Children with T1D

Watch: Children with T1D

- Economic buyer: parents
- Champion: online support groups
- Influencer: endocrinologists, nurses
- Veto power: FDA

### Market Size Calculation

- About 364,000 Americans under age 20 are estimated to have diagnosed diabetes
- Assume low initial penetration from technology S-Curve, 5%
- **Market Volume = 18200 Customers**
- **Market Value = NEEDS PRICE**
- Penetration rate could be lower due to target younger side of initial demographic, could also be higher due to unforeseen use in older population and higher penetration



# 3/5/2026 - How to Estimate Market Size

KIERA KLEMM - Mar 05, 2026, 11:00 PM CST

**Entre Opportunities**

**- Dynamic competition topology**

Intensity	resources constrained	abundant
	growth	low
Market	diversified	specialized
	high growth	low growth
Structure	diversified	specialized
	high growth	low growth
Scale	low	high
	low	high

**- Social entrepreneurship:** first profit, goal is measure to change metric is 10% less waste

**- Intercapability/compatibility:** better support a few more, limited amount

**- Family business:** family issues can be good and bad

**Motivations:**

**Passion:** I like doing it I want make it a business  
- not enough on its own

**Technology:** I have an idea / high volume  
- great solution, how to make sure it solves an actual problem

**Problem:** Established customer need / for: venture  
- Possible, there is a problem or not profitable

**Hybrid:** applies both to new problem

**Identifying opportunity:**

- Deductive: try to predict what will turn to favorable outcomes
- Learning: Experimentation

**Customer demand:**

**Problems:** market research + keyword research

**Users:** what should be social sample version of idea and get customer feedback

**Market:** how many competitors will use my tool

**Long term profits:**

**Definition:** determine 5 forces (what industries are involved)

1. Buyer power: A buyer can easily go elsewhere and
2. Supplier power: how much can suppliers be replaced
3. Pricing: how many competitors
4. Substitutes: how easy can demand be replaced

**Technology Adoption:**

- Few that a tech starts getting used
- S curve

- Many that of choice from not listening to feedback

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MHR\_Module\_2.pdf (2.33 MB)



## 3/19/2026 - RACE Marketing Plan Health Professionals

---

KIERA KLEMM - Apr 09, 2026, 7:10 PM CDT

**Title:** RACE Marketing Plan

**Date:** 3/19/2026

**Content by:** Kiera Klemm

**Present:** N/A

**Goals:** To establish a plan for how our product will be market when launched

**Content:**

# RACE Analysis 1: Healthcare Professionals and Medical Conferences

## Reach

We will reach healthcare professionals by attending conferences and technology fairs at hospitals. These events occur frequently across the country, including major diabetes-focused events such as the Diabetes Technology Conference. These settings allow healthcare providers to be introduced to and educated on our device.

## Act

After initial exposure, we will provide informational materials such as pamphlets that healthcare professionals can review and distribute to patients. These materials will explain the purpose of the product and how it improves diabetes management, helping to build interest and understanding.

## Convert

Endorsement by healthcare professionals is critical, as there is an established sense of fear and hesitation within the community when adopting new technology. A recommendation from an endocrinologist or nurse can both introduce the product and establish trust. To support this, we will offer referral codes through providers that give patients access to a free trial of our educational service for a limited time. This allows users to interact with the product at a lower risk and introduces them to the Glow Band.

## Engage

Continued engagement will be maintained through ongoing communication with both healthcare providers and users. Emails, updates, and support through the educational platform will help reinforce trust and encourage long-term subscription and use of the product.

**Conclusions/action items:**

**This plan is a good strategy for connecting through multiple routes and continuing to interact after the initial introduction. This plan follows the RACE model for creating a marketing plan. Both of these strategies require relatively low financial investment which will be crucial in initial phases.**



## 3/19/2026 - RACE Analysis Parents and Social Media

KIERA KLEMM - Apr 09, 2026, 6:40 PM CDT

KIERA KLEMM - Apr 09, 2026, 7:15 PM CDT

**Title:** Race analysis parents and social media

**Date:** 3/19/2026

**Content by:** Kiera Klemm

**Present:** N/A

**Goals:** To understand how we can reach parents as customers

**Content:**

# RACE Analysis 2: Parents and Social Media Communities

## Reach

We will reach parents through email lists and social media platforms. We have already collected a list of potential customers through Facebook and other platforms, and we can expand into online forums and movements such as #WeAreNotWaiting. These communities actively push for technological advancements in diabetes treatment and align with our product.

## Act

After establishing connections, we can contact these individuals directly and send information about the product. Emails containing parent testimonials, educational content, and promotions will help draw individuals in and encourage them to learn more about the product.

## Convert

Conversion will be driven through targeted emails and promotions, as well as offering free trials of the educational platform. This allows parents to engage with the product at a lower risk and understand its value before committing. During this process, we can also introduce the Glow Band and demonstrate how it improves diabetes management.

## Engage

After users sign up, continued contact and support will help maintain engagement. Ongoing emails, reminders, and interaction through the platform will encourage long-term use and build customer loyalty

### Conclusions/action items:

This marketing plan address how to pull parents in by informing them on the existence of our device and further involve them through various strategies that eventually lead to purchase.



# 4/6/2026 - Presentation handout

KIERA KLEMM - Apr 09, 2026, 8:32 PM CDT

**Title:** Presentation handout

**Date:** 4/6/2026

**Content by:** Kiera Klemm

**Present:** N/A

**Goals:** To create something we can give our judges during the presentation to help them understand the subscription options of our service.

**Content:**

See attached

**Conclusions/action items:** This handout will help the judges understand their options. It highlight the 4 tiers of subscription and what features each of them come with. It also is amde in the same style and theme as the presentation slides creating a cohesive brand image.

KIERA KLEMM - Apr 09, 2026, 8:25 PM CDT

**SUGAR SAFE**  
CONTROL IN COLOR

**IMPROVED EDUCATION AND CARE FOR CHILDHOOD TYPE 1 DIABETES**

**SUGAR SAFE BAND**

- Wearable LED Display Band
- Connects Directly to a Continuous Glucose Monitor (CGM)
- Real-time Blood Sugar Status Displayed on Band

LOW ——— HIGH

**TIER 1**  
Just the Basics

**\$15/MONTH**

- SugarSafe Band
- Pairing and Set Up Information
- Introductory Education Content
- App Access

A simple, affordable option for families who want essential tracking without extra features.

[Download](#)

**Sugarsafe\_brochure.pdf (1.45 MB)**



## 2/4/2026 - Meeting with Abbott Marketing Employee

KIERA KLEMM - Apr 09, 2026, 7:42 PM CDT

**Title:** Meeting with Abbott Marketing Employee

**Date:** 2/4/2026

**Content by:** Kiera Klemm

**Present:** Kiera Klemm, Callie Berg, Olive Cerniglia

**Goals:** To learn how other medical devices are marketed to analyze how we could apply similar methods to our project

**Content:**

**Vahe Aывcazian - VP Marketing Abbott**

**Call flow:**

- Introduction
- Ask about what he does
  - Started studying marketing at kelly school of business → proctor and gamble healthcare division, worked on international and global scale, how needs vary country to country
  - Worked for head of sales in hair care/cosmetics how to grow commercial business
  - Worked on marketing campaign development, wanted to go back in to healthcare
  - Worked in diagnostics marketing and eventually took on global responsibilities, working in both downstream and upstream marketing.
  - Head of corporate marketing now. In charge of “abbott brand”

**Questions:**

- Which marketing strategies have had the biggest impact on successfully bringing a medical device to market and is there a particular moment or campaign that really illustrates why they worked
- What would make Abbott work with/promote other medical devices? → if time
- What differences in marketing strategies do you see with a medically necessary device like the FreeStyle Libre CGM compared with a consumer-oriented device such as Lingo
  - Everything is regulated, more intense in prescribed products and so is the marketing. Pharmaceuticals have large amount of marketing, patients have more power in treatment plan
  - 
  - How does abbott position its marketing for a device differently for clinicians vs. patients vs. payer
    - Does very little with patients because patients are often requesting products, instead doctors are recommending/ordering
    - Labs and IT departments are usually large stakeholders, can take 1-2 till final close
- How reimbursement, insurance coverage, and policy changes influence marketing strategy
  - **Diagnostics is actually a relatively low cost portion of healthcare, more testing can actually lower long term cost**, could better monitoring of blood glucose levels reduce long term costs?

- Insurance companies are not targeting diagnostics in cost cutting
- Insurance companies are not incentivized to keep population healthy through preventative care when people switch insurance frequently
- How closely does your team work with regulatory affairs to make sure what you market is of FDA/regulatory standards
  - Very closely, they keep them updated on policies, final plans are brought to them for approval
  - Very investigated, teams are looking into the policies, FDA is quite subjective
  - Multiple years long process, works with FDA to ensure protocols are done properly before investing large amounts of money
- We've recently been exploring regulatory affairs and would appreciate guidance on who to connect with regarding regulatory considerations?
- What should we have asked you today/ what did you expect we ask you today regarding marketing?

## Our product → 10 min left w/ interview

- A wearable secondary glucose display that presents current blood glucose readings as a simple color scale, paired with a pharmacist-led education and support platform that builds confidence, expands trust circles and intervenes earlier in child education of T1D
  - How aware is Abbott of third-party companies that use their CGM data
    - They have enormous amount of data and are willing to collaborate with other companies to improve patient quality of care, they do not sell their data
    - Wellness business: **Wichings?** [https://www.withings.com/us/en/?srsltid=AfmBOoqZktsLsSuSinvXUAjOjQH37hJyMZr5jo-4XXCSYnlY7St\\_6t\\_g](https://www.withings.com/us/en/?srsltid=AfmBOoqZktsLsSuSinvXUAjOjQH37hJyMZr5jo-4XXCSYnlY7St_6t_g)
  - We have found that there is a need for our product through customer interview and market research, however we want to ask about what marketing avenues you think a secondary device would benefit most from → marketing to hospitals, providers, or customers themselves

### Conclusions/action items:

Some companies like abbott will take on secondary medical devices as supplementals for their existing devices. This means that this could be a path for our company to take eventually.



## 2/10/2026 - Call with Marketing Contact

---

KIERA KLEMM - Feb 26, 2026, 1:10 PM CST

1. What were the biggest failures/successes you have seen from smaller companies trying to start up?
  - a. The product market fit: a lot of companies have a solution before identifying a problem, continue checking in with the initial problem. 30 second quick pitch of what the problem is.
  - b. If you don't have a solution that's going to qualify for insurance it's going to be harder to get to consumers. People are already paying for insurance so you need to prove why it is valuable beyond insurance.
  
2. How do medical device accessories usually get marketed?
  - a. Market to the people who are actually paying: parents
  - b. Co-marketing allows you to use bigger organizations' brand power to get your product known and trusted.
  - c. Digital campaigns are big right now. Using parents online interactions to advertise there
  - d. Partner with non traditional brands ie. sports
  - e. Patient advocacy groups can be good spaces
  - f. Marketing to doctors themselves through associations and groups they have
  
3. How do medical device companies position its marketing for a device differently for clinicians vs. patients vs. payer
  - a. Upstream marketing: establishing market stats and strategy before launching product
  - b. Commercial market: after approval or launch and already on market
  - c. Promotional is a separate aspect, not really associated with marketing in medical device industry
  - d. Specialized: to each different group is a different role, different language used, convincing parents of different things (cost/convenience) than insurance companies.
  - e. Pitching to different audiences has different regulations from FDA, needs claims such as this device does this, maybe 5-10 to prove usefulness over other products, need to be supported by evidence, research or paper/clinical studies. Accuracy is important to the FDA.

Look at prevalence and epidemiology to establish market size,

Make a claims matrix, a table that shows what our top 5 claims are, More quantifiable with more evidence is better for claims

<https://www.cebm.net>

Patient journey, identifying where buyers are at in their journey, connect with nurses and doctors and ask about what it is like to be diagnosed. Pitching it to them to see their thoughts

**Interview target audiences: Find parents, colds calls**

Ask where they find information on possible solutions, ask them if something was a problem, reaffirm product market fit, this is very strong and convincing evidence for our pitch.



## 2/26/2026 - Cold Call Melissa Fleites

KIERA KLEMM - Feb 26, 2026, 5:51 PM CST

**Title:** Cold Call Melissa Fleites

**Date:** 2/26/2026

**Content by:** Kiera Klemm

**Present:** N/A

**Goals:** To understand parent experiences with type one diabetes, to understand the problem we are attempting to solve

**Content:**

### Diagnosis & Early Experience

- Can you tell me the story of your child's diagnosis and what that time was like for your family?
  - Just this year in June , he was 2.5 at the time. Mom grew up with a diabetic brother, also a registered nurse, noticed he was drinking a lot of water, Her mom had a glucometer, too high to read, over 500. Sugar was greater than >1500. Put in ambulance to childrens hospital, was not in DKA. In and out of hospital in under 48 hours
- What information or support do you remember receiving in the first days or weeks after diagnosis?
  - Diabetes educator was good to them, spent hours in the hospital learning, felt like had a leg up because of medical background "they have you in and out of the hospita so quick" cannot imagine how poeple without medical backgrund navigatae

### Transition from hospital to home

- How did you feel about managing your child's diabetes once you left the hospital or clinic, and what kinds of support were available to you at that time?
  - "Number 1 emotion I felt was fear" "the support I had when I left the hospital we were having daily calls "I dint sleep for weeks months Im still not fully sleeping"

### Continued education

- What parts of daily diabetes care felt hardest/least comfortable at home?
  - Putting a needle in my two year old 10-15 times a day is unnatural and stomach turning. You cant rationalize to a 2 year old
- What topics do you still feel unsure about, even now?

### Child-focused educational and emotional support

- What challenges have you faced helping your child understand or accept their diagnosis?
  - Family connection help him understand theirs other people like him.
- What tools or approaches have worked well with your child's age and personality?
  - Hes scared of pump changes, give him control by choosing who presses the button to activate the pump.

### School, Caregivers and real-life setting

- How supported do you feel by your child's school or caregivers?

- He is in pre-school 2 days a week, private school no nurse. "I have to physically drive to the school and handle that for him" "I have not felt supported because they are completely hands off will not partake in any of his care" No carbs pump or help.
  - What situations make you most anxious when someone else is responsible for your child?
    - tRusting anyone, once you let anyone watch your cidl your putting their life in their hands. Cannot trust anyone only husband or mom. "I just dont trust enough to leave him with someone without a full grasp on the situation"
- 

If you have time...

#### **Emergency care & crisis**

- Can you share any experiences your child has had with emergency department visits or hospitalizations since diagnosis?
- What typically led up to those visits?

#### **Paid services & willingness to invest**

- Have you ever used or paid for additional diabetes-related education or support outside of standard medical care?"
  - Doesnt think, not that shes paid for, facebook groups can get advice from, pays out of pocket for diabetes supplies not covered by insurance

**Conclusions/action items:** Becuase she had past medical experiences as a nurse the transition was easier to understand. she could not miagine navigating a child iwth type one diabetes without that experience. Prior knowledge from her brother's experience made the transition easier.



## 2/26/2026 - Cold Call Abby Rinker

KIERA KLEMM - Feb 26, 2026, 5:58 PM CST

**Title:** Cold Call Abby Rinker

**Date:** 2/26/2026

**Content by:** Kiera Klemm

**Present:** N/A

**Goals:** To better understand the perspective and experience of a parent of a child with type 1 diabetes.

**Content:**

### Diagnosis & Early Experience

- Can you tell me the story of your child's diagnosis and what that time was like for your family?
  - Years old, strang beacsue her husband had noticed he was getting skinny and thought it was a growth spurt, worried about uncommon behavior, day 3 went to family gathering, he asked for water frequently and she knew immediately what it was. Brother was type 1, was able to get support for him to identify it. Went to doctor in morning and got refrenced to a near by hospital, had to travel to get education at hospital "i remmebered sobbing in the bathroom about him not being able to eat "I had to change my whole world to keep my kid alive". 8 hours of educational classes a day "How am I going to remember all of this"
- What information or support do you remember receiving in the first days or weeks after diagnosis?
  - Would recommend going to a hospital with education program made it so much easier than her experience with her brother "First 4 months I think I cried everyday"

### Transition from hospital to home

- How did you feel about managing your child's diabetes once you left the hospital or clinic, and what kinds of support were available to you at that time?
  - Hospital had a doctor available 24 hours, very helpful answered when they didnt know what to do, felt like she had the support, very overwhelmed

### Continued education

- What parts of daily diabetes care felt hardest/least comfortable at home?
- What topics do you still feel unsure about, even now?
  - We struggle with (4 years later) the unknowns, what's causing ups and downs?, How do hormones and exercise impact blood glucose levels, "he statrted crying because he thoguht

### Independent learning & information seeking – *only ask if poor hospital support*

- What kinds of research or learning have you done on your own outside of clinic visits?
- Who did you turn to when you had questions outside of clinic hours?

### Child-focused educational and emotional support

- What challenges have you faced helping your child understand or accept their diagnosis?
  - "I tried to hide it from him, I didnt want it to be a burden for him" He dint want snacks to avoid needles. "Once you get a pump and sensors life changed dramatically in the best way".
- What tools or approaches have worked well with your child's age and personality?

### School, Caregivers and real-life setting

- How supported do you feel by your child's school or caregivers?
    - "I was terrified to send him to school" "Met with school nurse several times, gave personal phone number to stay in contact" 504 plan that allows him to use restroom and retake tests if his condition impacted him.
  - What situations make you most anxious when someone else is responsible for your child?
    - Athletics, lack of training from coaches and don't understand the extremes and severity. "If you dont live it, you dont get it, you dont see it" Cant get reading during sports/foot ball. "
- 

If you have time...

### Emergency care & crisis

- Can you share any experiences your child has had with emergency department visits or hospitalizations since diagnosis?
- What typically led up to those visits?

### Paid services & willingness to invest

- Have you ever used or paid for additional diabetes-related education or support outside of standard medical care?
    - No Riley children's hospital provided education and counselors, connected him with other diabetics to help feel like not alone.
- 

### Closing

- "Is there anything about your experience with pediatric diabetes care that we haven't talked about but feels important to you?"
  - My niece has been diagnosed as well and if you don't have someone in your family who has it already it's so hard to grasp and feel supported. Advocating for new families is very important.

**Conclusions/action items:** She struggled with the transition period and heightened anxiety, even after years of managing her son's diabetes she still has questions as he gets older. She had great support from the hospital and really benefitted from their education program. She emntioed 8 hour a day classes that were difficult to retain all the information from. School was supportive but nurse was not extremely confident.



## 2014/11/03-Entry guidelines

---

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

**Title:** Descriptive title (i.e. Client Meeting)

**Date:** 9/5/2016

**Content by:** The one person who wrote the content

**Present:** Names of those present if more than just you (not necessary for individual work)

**Goals:** Establish clear goals for all text entries (meetings, individual work, etc.).

**Content:**

Contains clear and organized notes (also includes any references used)

**Conclusions/action items:**

Recap only the most significant findings and/or action items resulting from the entry.



# 2014/11/03-Template

---

John Puccinelli - Nov 03, 2014, 3:20 PM CST

**Title:**

**Date:**

**Content by:**

**Present:**

**Goals:**

**Content:**

**Conclusions/action items:**



BME Design-Fall 2025 - ISABEL PLOESSL  
Complete Notebook

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