

**Jaime Stephen**  
ME '18



**Derek Feehrer**  
CS '18



**Carter Reynolds**  
ECE '18



**Taylor Stephen**  
RBE '18

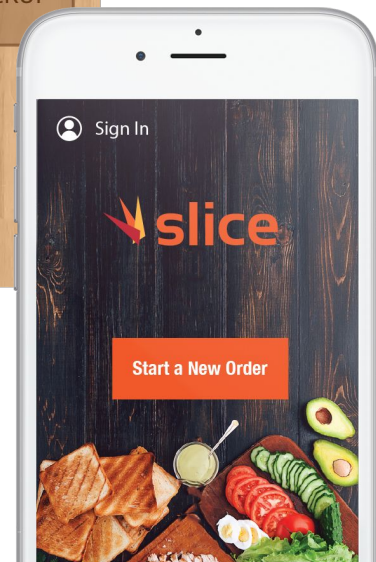


**WPI**

# AUTOMATED SANDWICH ASSEMBLY



*Designing a fully-automated robotic kiosk  
for serving fresh, made-to-order  
sandwiches.*





chowbotics  
robots for food service

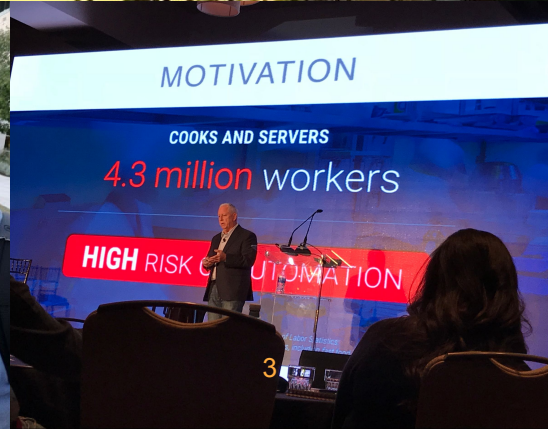
Roostersbot  
Autonomous Chicken Sandwich Restaurants

spyce

CAFEX

# CUSTOMER DISCOVERY

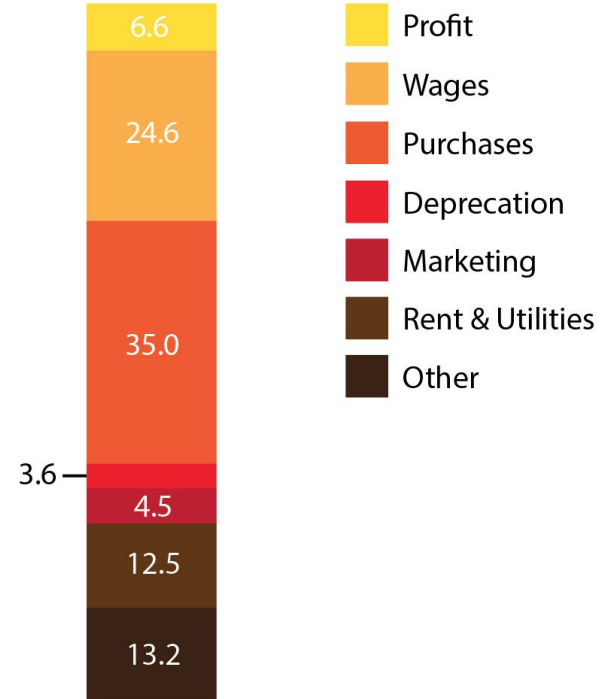
- **Accelerate Program**
  - Mentorship and budget to discover our customer
  - Conducted 43 interviews
- **Restaurant Innovation Summit**



# INDUSTRY BACKGROUND

- Restaurants employ the most near-minimum wage workers of any industry
- Push for \$15 dollar minimum wage
- Low operating margins → risk averse
- The fast casual: customers demand higher quality food
- Restaurant automation growing

*Restaurant Industry Costs*



# VALUE PROPOSITION

Slice is a fully automated restaurant kiosk that can assemble and serve hot sandwiches using fresh ingredients. Unlike traditional sandwich restaurants, Slice doesn't have to pay food prep employees or cashiers, so we operate with higher margins, and can sell gourmet sandwiches for much cheaper than traditional restaurants.

# ROADMAP



# ROADMAP



**Slicing**



**Sanitation**

Focus: Develop a modular, expandable system, and the novel modules needed to form a working prototype.

# KIOSK MODULE BREAKDOWN



*Full System Components and Design*



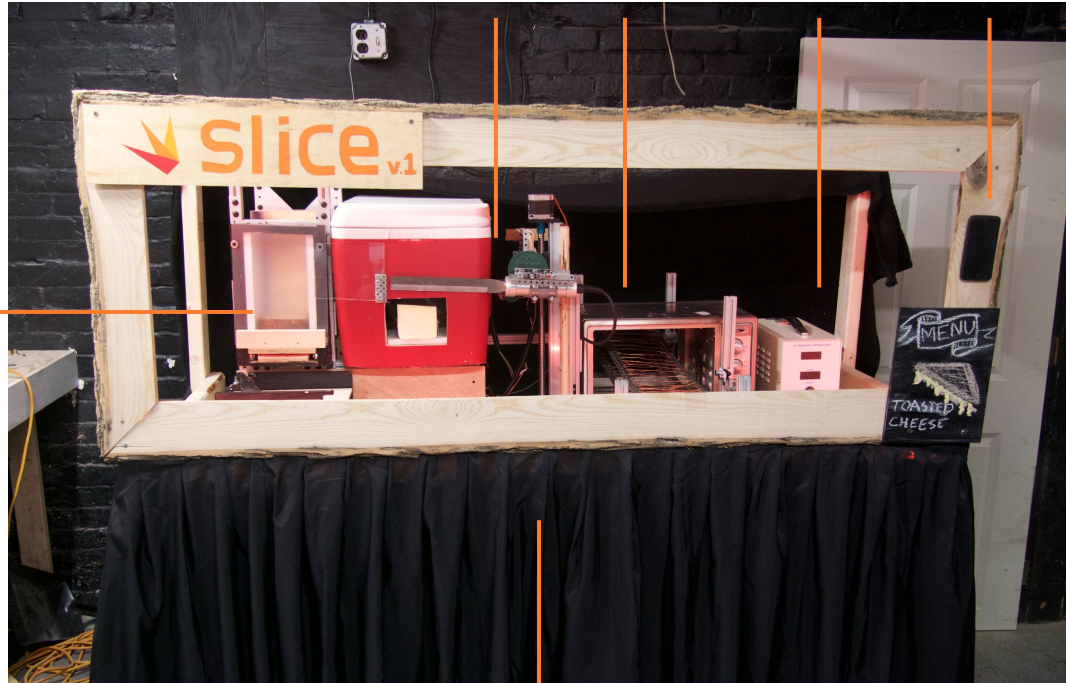
# KIOSK LAYOUT

Cheese  
Slicer

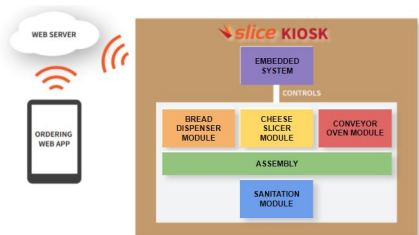
Conveyor  
Oven  
Module

Smartphone  
Ordering  
Device

Bread  
Dispenser

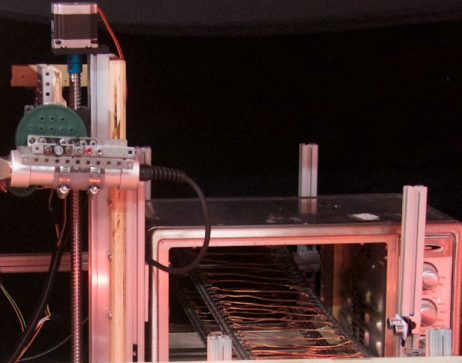


Sanitation  
Module



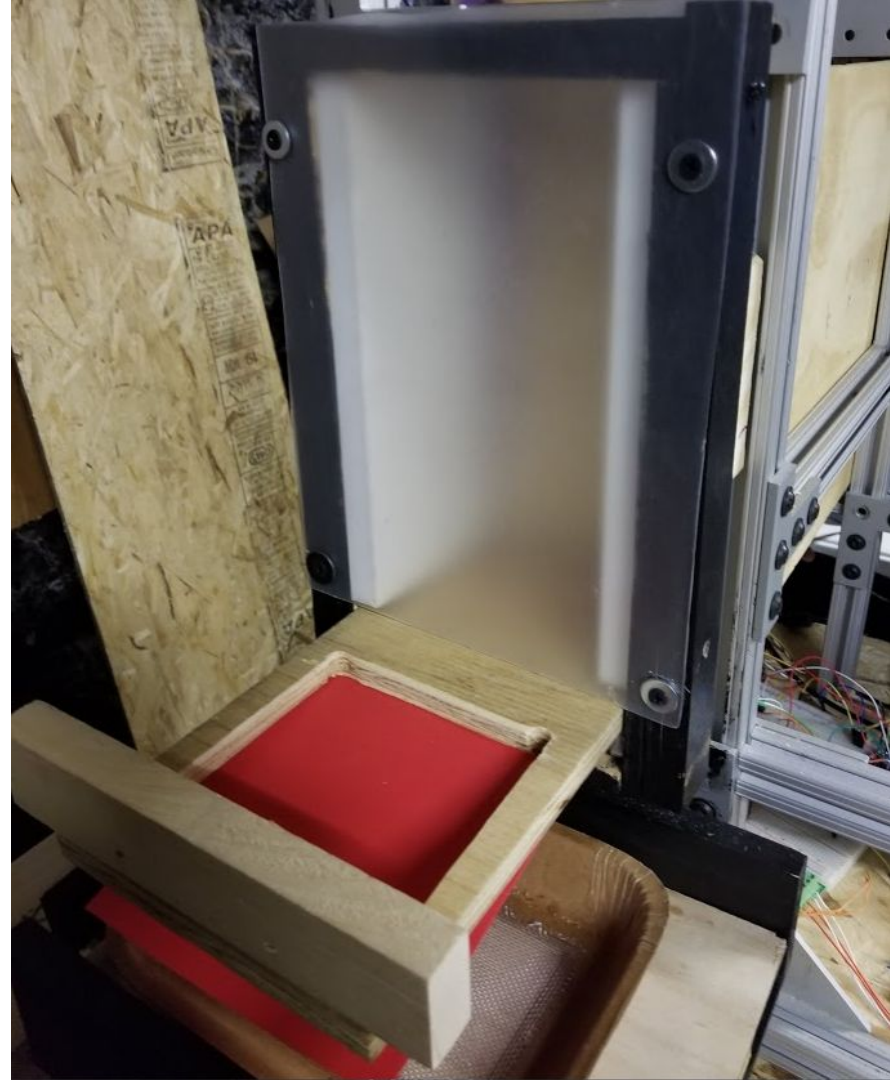
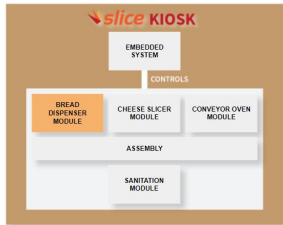


slice v.1



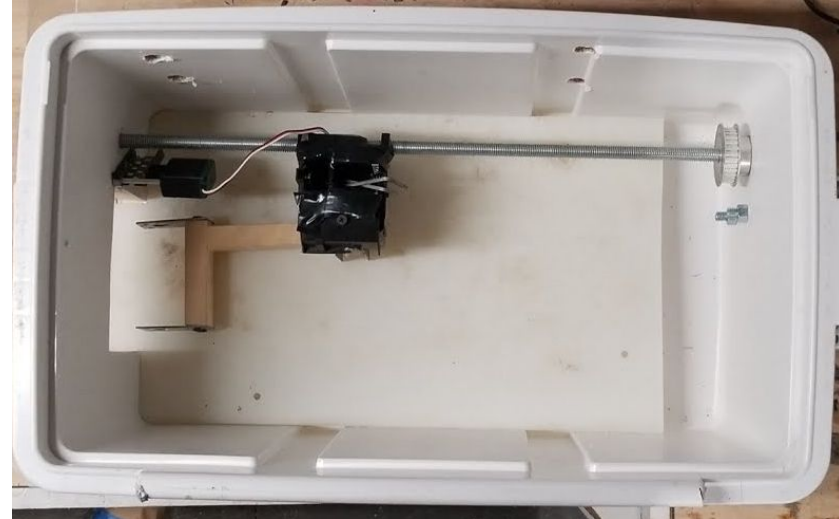
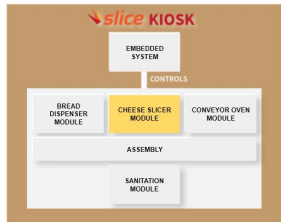
# BREAD DISPENSER MODULE

- Holds up to one loaf of bread
- Uses a plastic flap to place gently onto trap
- A drawer slides back and forth taking one slice of bread at a time



# CHEESE SLICER MODULE

- Refrigeration module
  - Cheese slides on cutting board in cooled container
- Ultrasonic knife
  - Titanium blade vibrates at 28kHz, reducing the coefficient of friction
- Vertical and rotational motion



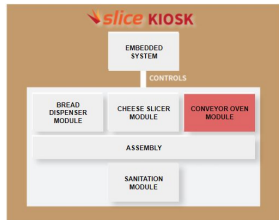
*Cheese Cooling Module*



*Ultrasonic Knife Fixture*

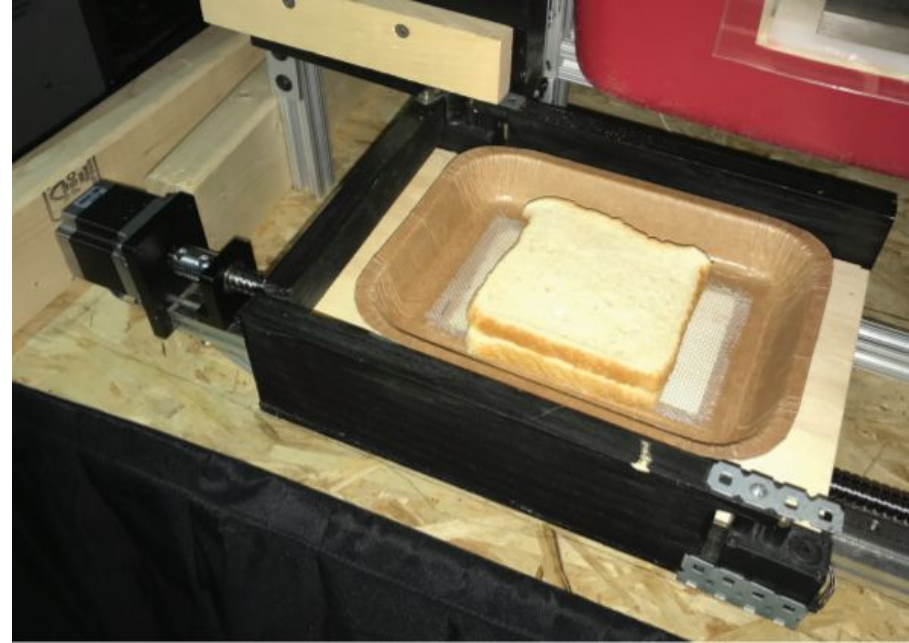
# CONVEYOR OVEN MODULE

- Heats to 250° F, temperatures above 160° F kill foodborne pathogens
- High-temperature thermometer and ultrasonic sensor
  - Heatproof cardboard & aluminum tray
- Varies toasting time according to customer preference

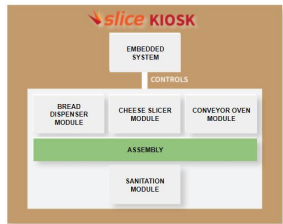


# ASSEMBLY LINE

- Linear slide to move the sandwich between the modules.
- Carriage
  - Features a load cell to verify the quantity of ingredients added to the sandwich using weight
  - Motorized doors

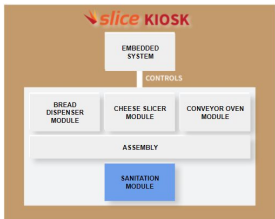
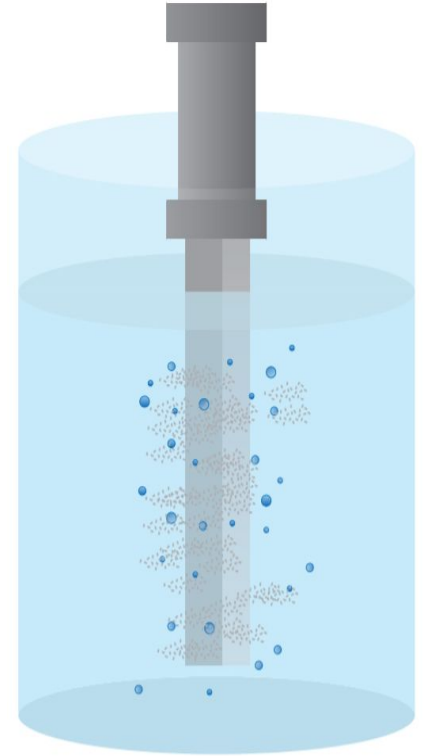


*Sandwich Carriage*

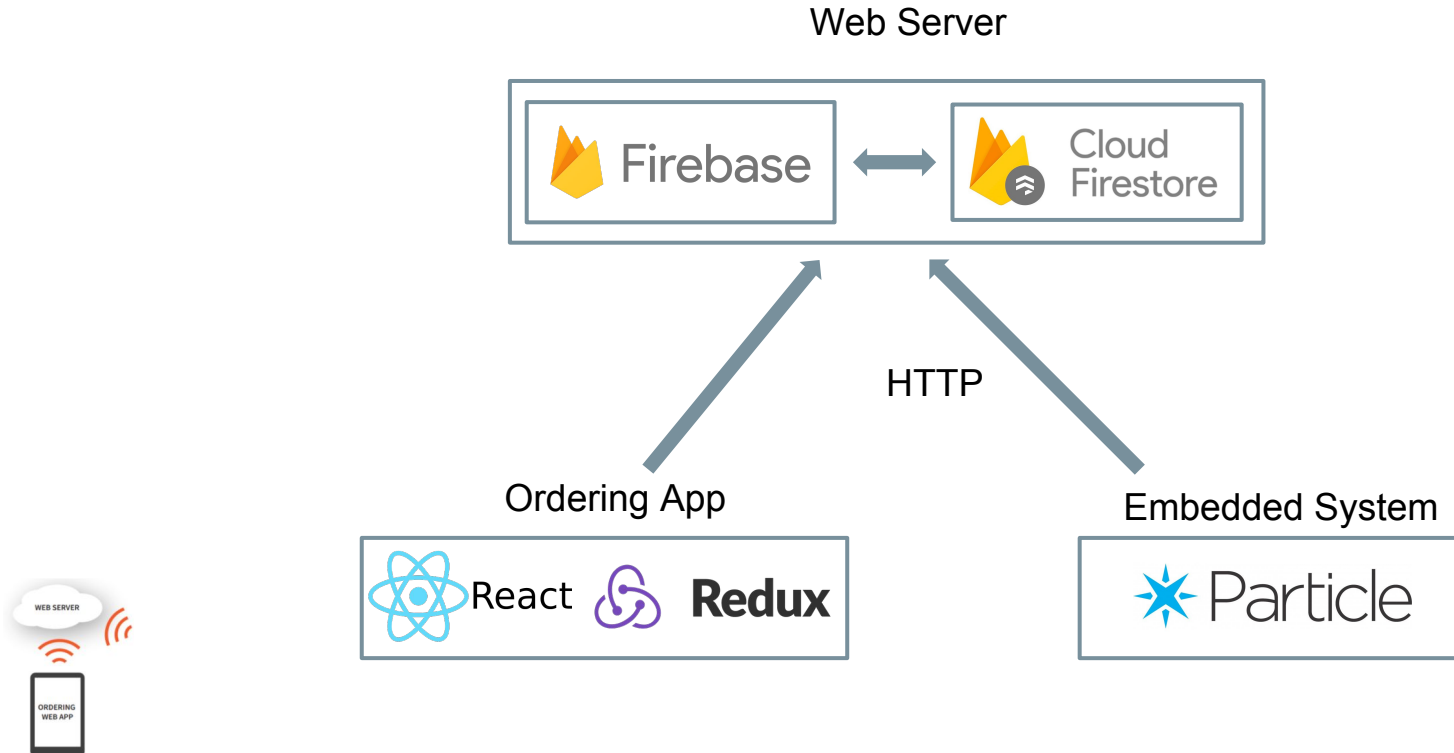


# SANITATION MODULE

- Foodborne illnesses common with deli meats
- The FDA mandates slicers be cleaned every four hours, but noncompliance is common
  - Traditional deli slicers can be difficult to clean
- Ultrasonic cleaning—wash, rinse, sanitize
  - The same transducer used for slicing vibrates the knife to deep-clean the surface of the metal
  - Cavitation bubbles remove contaminants



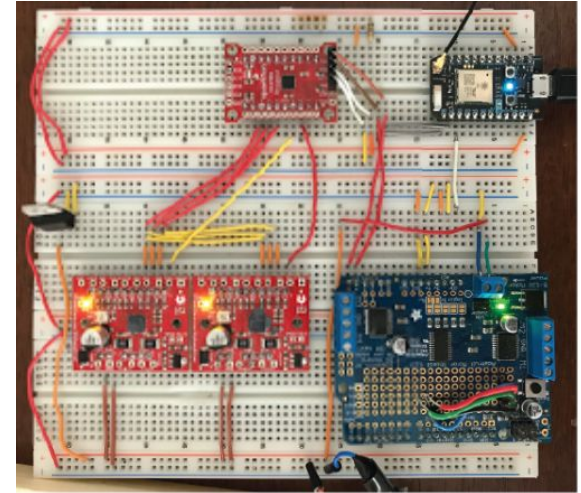
# SOFTWARE ARCHITECTURE





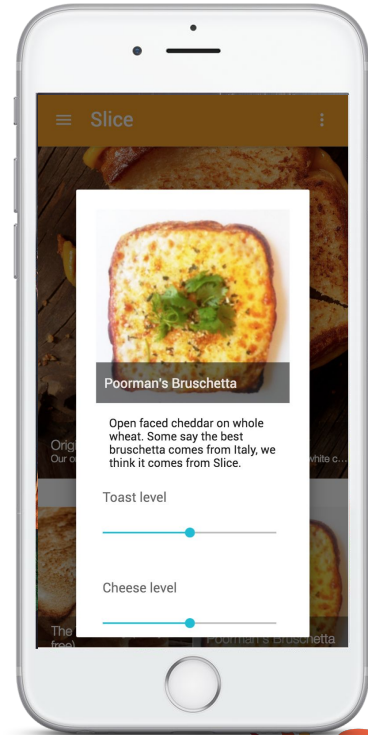
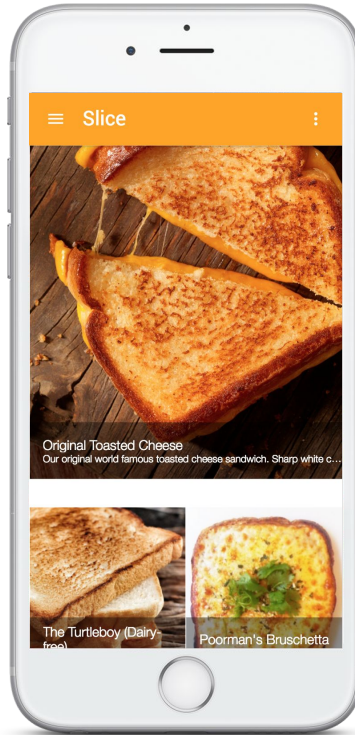
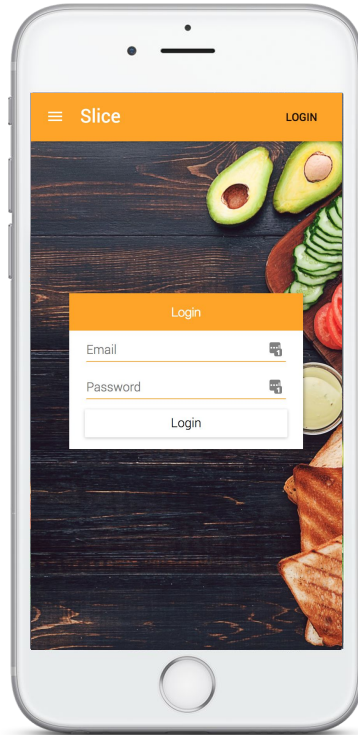
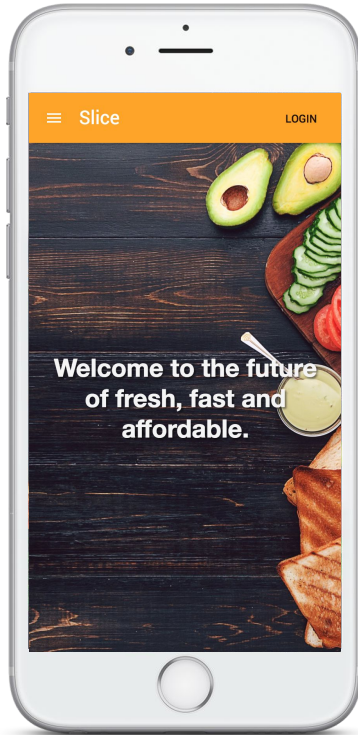
# EMBEDDED SYSTEM

- Particle Photon wireless microcontroller (+ DC and stepper motor drivers).
  - Receives orders from the web server in JSON format over HTTP.
  - Controls the assembly of the sandwich
  - Sends status updates back to the web server
  - Also controls cleaning routines, monitors temperature, and verifies that ingredients are added to the sandwich.

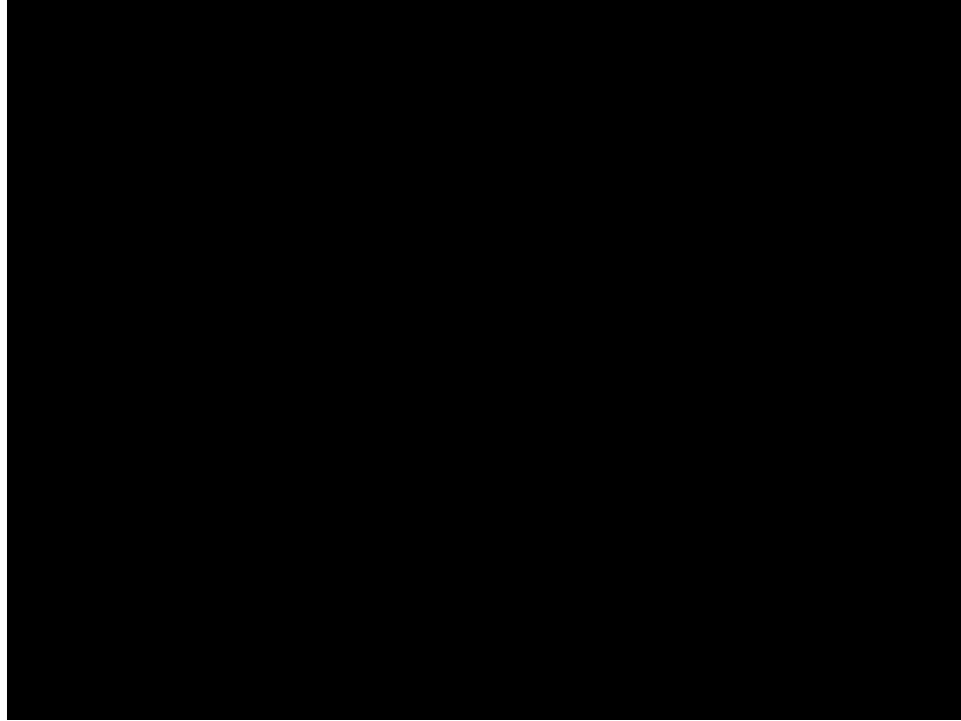


*Embedded Design*

# ORDERING WEB APP



# SLICE IN ACTION





# NEXT STEPS

- More robust assembly system
- More ingredient modules
- Security, safety and reliability support systems
- Design for FDA, NSF, UL, ServSafe, state & local regulations
- Administrator application for tracking sales, inventory, kiosk status



# THE FUTURE



## BENEFITS



Improved  
Hygiene



Reduced  
Labor Costs



Improved  
Consistency



Reduced  
Waste



Reduced  
Space  
Requirements

# QUESTIONS



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