Contextualization/Design Check In

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Client/Advisor: Dr. Duwe

Project Overview

- Design a microcontroller with radio communication capabilities
- Open-source
- Can be fabricated
- Will be used by ISU ChipForge group, possibly faculty and hobbyists
- Designed using the Caravel platform from Efabless

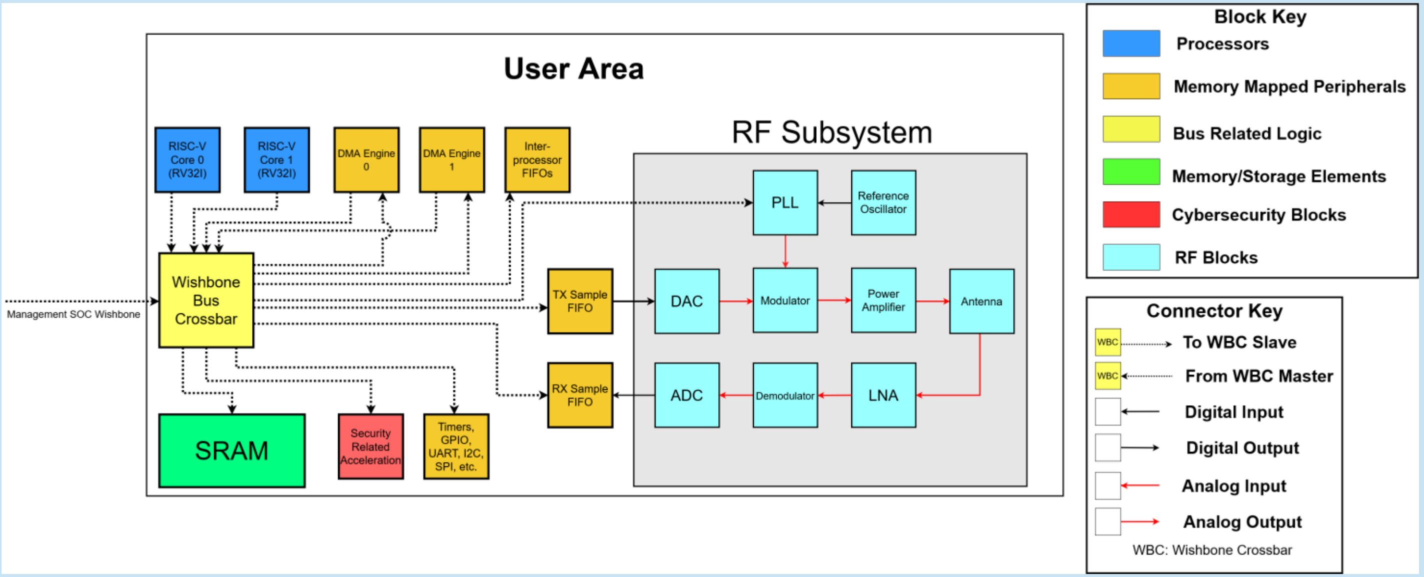
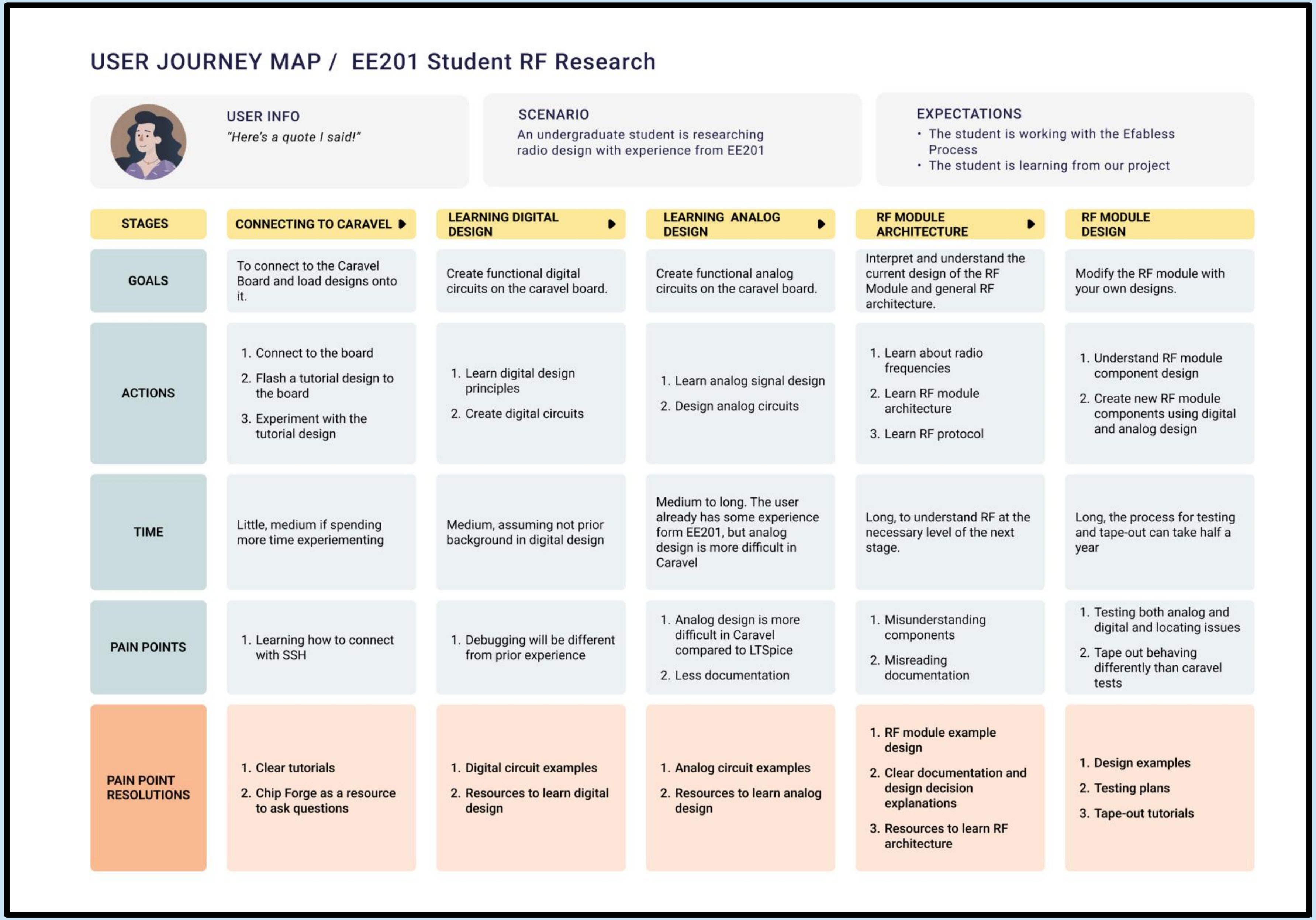


Image Source: Created by our team

Journey Map

- Journey map shows how a user's experience with the product progresses
- Considers how the user feels through different milestones



USER JOURNEY MAP / EE201 Student RF Research

USER INFO
"Here's a quote I said!"

SCENARIO
An undergraduate student is researching radio design with experience from EE201

EXPECTATIONS
- The student is working with the Efabless Process
- The student is learning from our project

STAGES	CONNECTING TO CARAVEL	LEARNING DIGITAL DESIGN	LEARNING ANALOG DESIGN	RF MODULE ARCHITECTURE	RF MODULE DESIGN
GOALS	To connect to the Caravel Board and load designs onto it.	Create functional digital circuits on the caravel board.	Create functional analog circuits on the caravel board.	Interpret and understand the current design of the RF Module and general RF architecture.	Modify the RF module with your own designs.
ACTIONS	1. Connect to the board 2. Flash a tutorial design to the board 3. Experiment with the tutorial design	1. Learn digital design principles 2. Create digital circuits	1. Learn analog signal design 2. Design analog circuits	1. Learn about radio frequencies 2. Learn RF module architecture 3. Learn RF protocol	1. Understand RF module component design 2. Create new RF module components using digital and analog design
TIME	Little, medium if spending more time experiementing	Medium, assuming not prior background in digital design	Medium to long. The user already has some experience form EE201, but analog design is more difficult in Caravel	Long, to understand RF at the necessary level of the next stage.	Long, the process for testing and tape-out can take half a year
PAIN POINTS	1. Learning how to connect with SSH	1. Debugging will be different from prior experience	1. Analog design is more difficult in Caravel compared to LTSpice 2. Less documentation	1. Misunderstanding components 2. Misreading documentation	1. Testing both analog and digital and locating issues 2. Tape out behaving differently than caravel tests
PAIN POINT RESOLUTIONS	1. Clear tutorials 2. Chip Forge as a resource to ask questions	1. Digital circuit examples 2. Resources to learn digital design	1. Analog circuit examples 2. Resources to learn analog design	1. RF module example design 2. Clear documentation and design decision explanations 3. Resources to learn RF architecture	1. Design examples 2. Testing plans 3. Tape-out tutorials

Image Source: Created by our team from a free Figma template (http://www.figma.com)

Pros/Cons

- Comparing our radio microcontroller to others on the market:

Our Design	
Pros	Cons
• Open Source ○ Easy to modify and extend • Two CPU Cores • Good documentation •	• Lower performance CPU • Less RAM • Higher cost per unit • No Wi-Fi or Bluetooth support

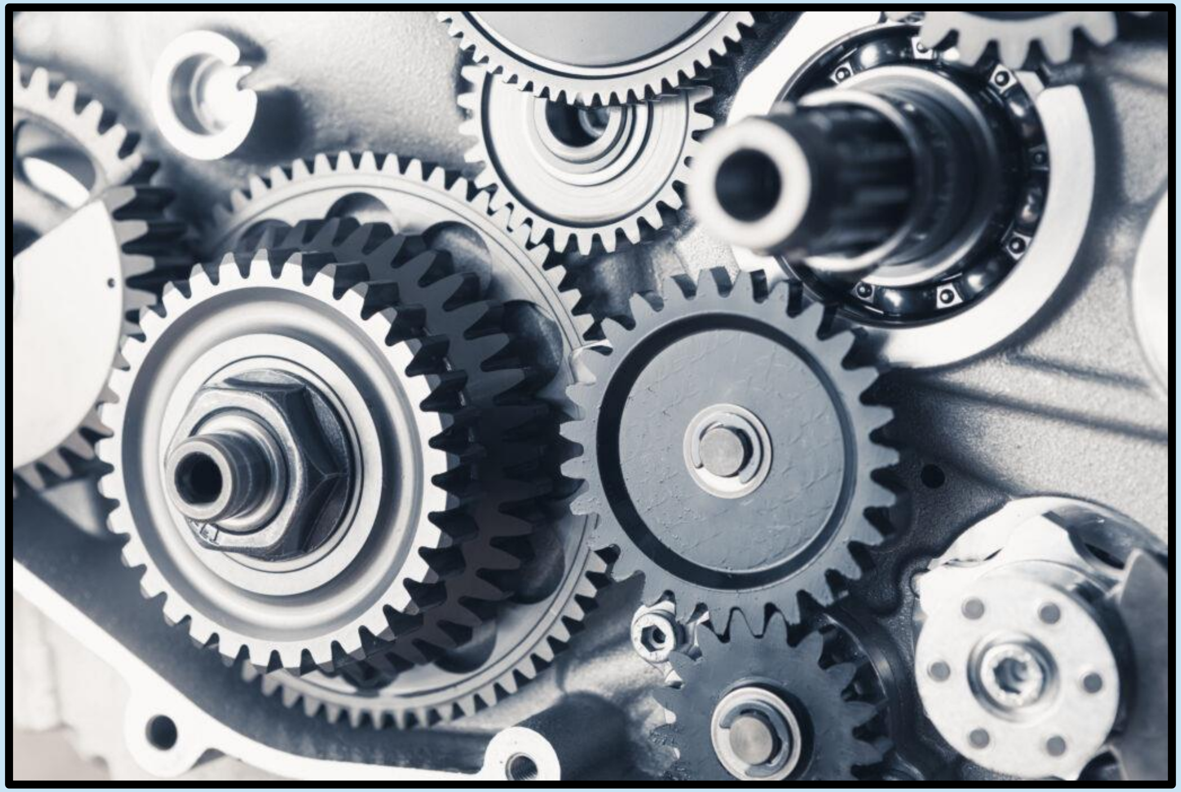
Raspberry Pi Pico W	
Pros	Cons
• Two CPU Cores ○ Higher performance than our design • More RAM • PIO state machines • Wi-Fi support • No need for flashing application	• C/C++ SDK setup can be confusing • No Bluetooth or Zigbee support

Espressif ESP-32	
Pros	Cons
• Two CPU cores ○ Higher performance than our designs • More RAM • Wi-Fi and Bluetooth support • Compatible with Arduino IDE ○ Accessible to newcomers	• Documentation lacking • High power consumption • No Zigbee support

Image Sources: Created by our team

Technical Complexity Analysis

- Utilizes many existing components
  - RISCV Cores, SRAM, PLL
- However, designing these without closed source IP is difficult
- Connecting components is difficult
- Fabrication limitations



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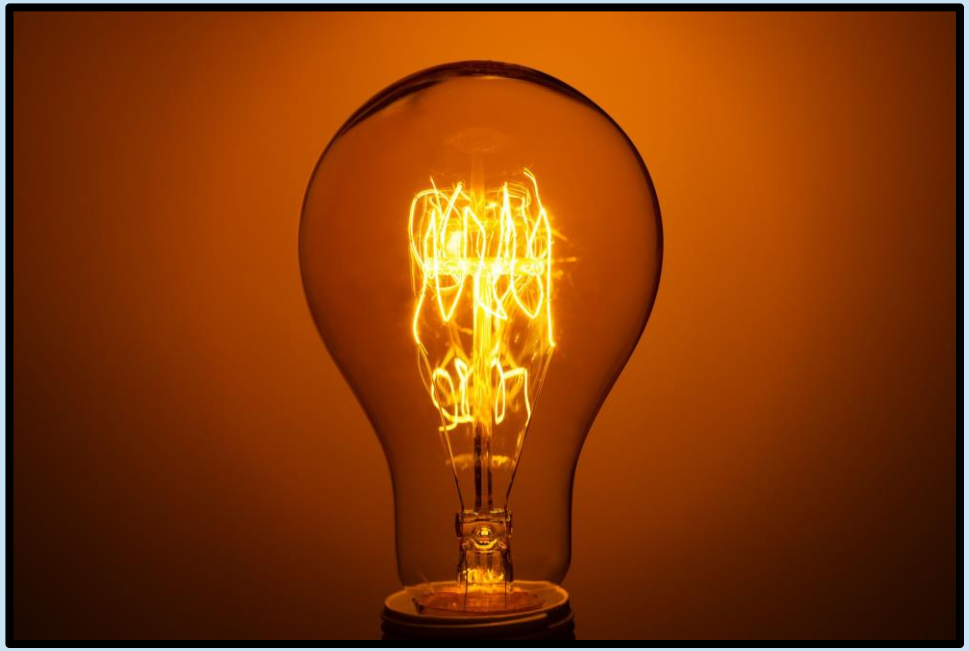
Conclusion

- Project reflection is important!
- Human, economic, and technical aspects of the design need to be addressed
- Design continually adjusted to meet all requirements and provide users a great experience



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