

# Underground Cable Packing Web Tool

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SDMAY22-19 (Team 19)

<http://sdmay22-19.sd.ece.iastate.edu/>

## Team Member - Leadership Role

- Alexander Young - DevOps and System Engineer
- Brevin Wapp - Scrum Master
- Haadi Majeed - Quality Assurance Engineer
- Matthew Hoskins - Team Lead
- Nate Tucker - Tech. Lead
- Tom Sun - User Experience and Requirements
- Quinten Sorice - Client Point of Contact

# Clients and Advisor

## Client:

- Mathew Wymore
- ISU's Electrical Power Research Center (EPRC)
- Alliant Energy (Perspective User)

Advisor: Mathew Wymore

Teaching Assistant (TA) Advisor: Jacob Conn

# Project Overview

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# Generalized Problem Statement

- Companies with the need to distribute cabling, looking to better withstand environmental disasters and other potentially damaging occurrences, are shifting to underground cabling
- An expanded web tool version of an existing executable program with the addition of new features and improved primary functionality such as: enhanced algorithm, mobile support, and ease of use.
- This web tool will also allow for more readily available functionality being an application available on EPRC's website for immediate use.

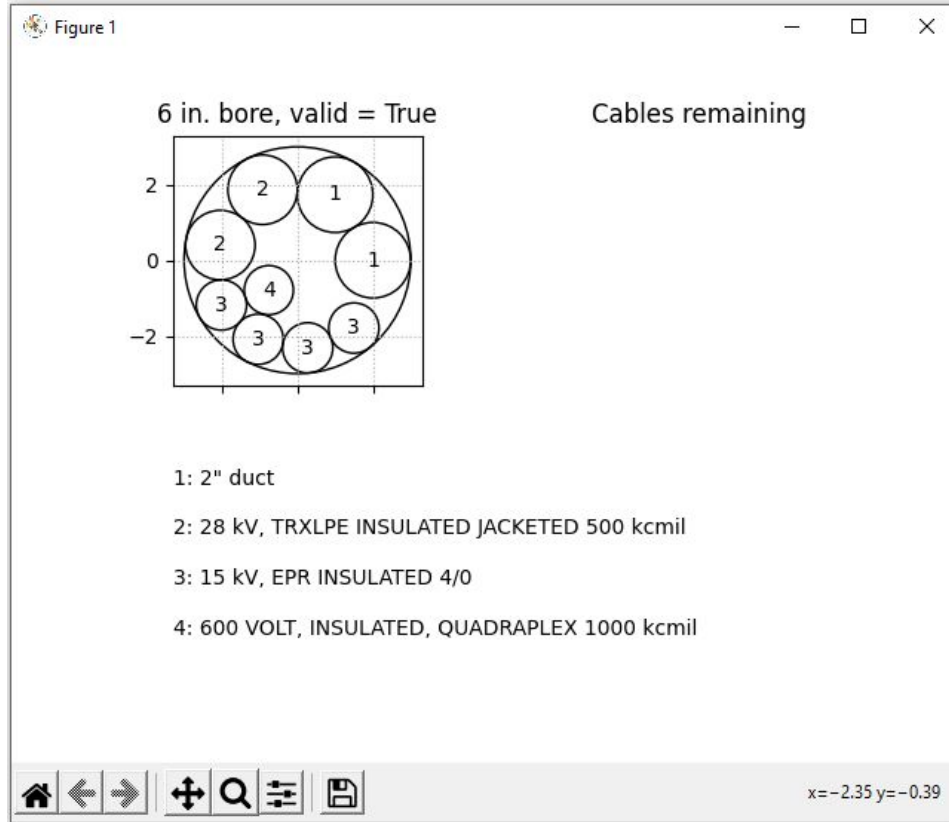
# Use Cases

- Contractor bill calculation for underground cabling
- Minimum bore size calculation and visualization
- Underground cabling project material calculation
- Easier specific utility creation for cabling project
- Circle with-in a circle area calculation

# Project Visualization

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# Project Concept Sketch



EPRC Cable Packer

Type (leave blank to enter an arbitrary diameter)	Diam. (in.)	#	
2" duct	2	2	X
15 kV, EPR INSULATED 4/0	1.33	4	X
28 kV, TRXLPE INSULATED JACKETED 500 kcmil	1.84	2	X
600 VOLT, INSULATED, QUADRAPLEX 1000 kcmil	1.3	1	X

Add Row GO

v1.0, Copyright ISU EPRC 2021

(Images from previous executable program as a source of project concept)



# Project Requirements

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# Major Functional Requirements

- Must be a web application
- Processing time targets  
(assuming a test case of one dozen cables/ducts or less)
  - < 20 seconds wait for results on page (**constraint**)
  - < 10 minutes for user emailed results asynchronously (**constraint**)
- Frontend must run on common browsers
- Backend must run on target infrastructure (ETG server)
- Capable of sharing recent results via URL
- Accurate results with the following guidelines
  - All cables must fit within outer diameter
  - Which will not fit in a size smaller

# Other Requirements

## Qualitative Aesthetics Requirements

- User Interface (UI) needs Electrical Power Research Center (EPRC) branding
- Output: Cables packed to the Center of the Duct

## UI Requirements

- Clean and Intuitive UI
- UI is Functional and Usable on Mobile Browsers

## Software Requirements

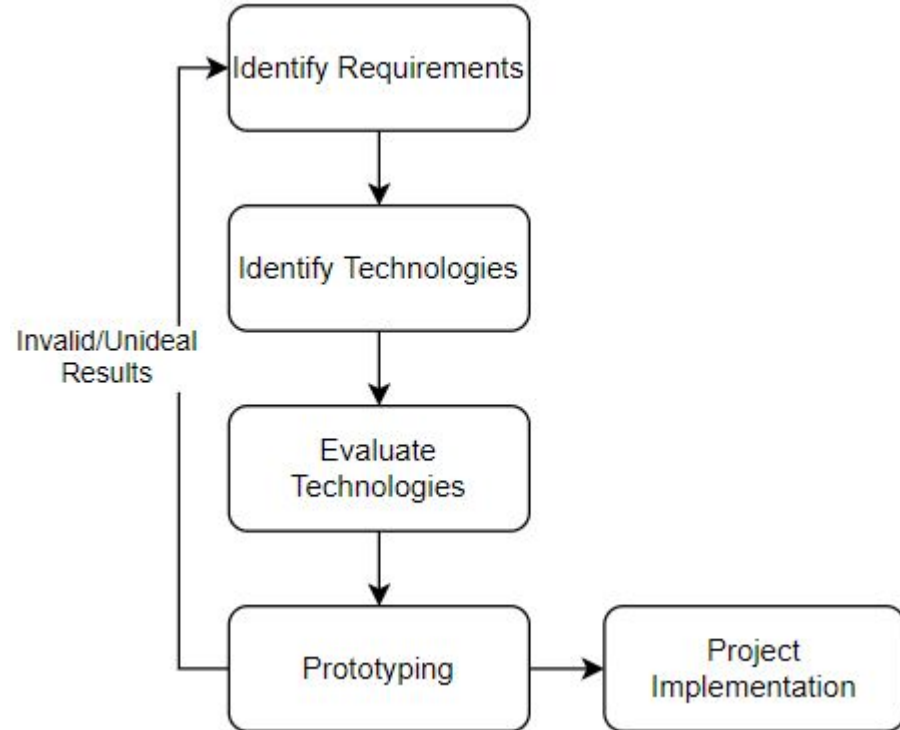
- Using a Standard Web-Stack with Documentation (**constraint**)

# Conceptual Design Diagram

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# Design Iteration and Approach

- Analysis of requirements
- Major task identification
- Minor and sub task identification
- Identify/decide on technology to perform tasks
- Prototyping stage of design ideas
- Project implementation
- Task testing upon completion
- Acceptance testing upon project completion



# Project System Design

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# Technology, Frameworks, and Libraries

## Web Tool Project

- React, version 17.0.2: Frontend development
- Golang, version 1.17: Backend/algorithm development
- PostgreSQL, version 14.1: Database management
- Prettier, version 9.0.0: Software standardization
- GitLab, version 14.4.2: Software development and sharing tool
- JSON, version 2020-12: Data-interchange formatting
- Google Drive, online version: Project document creation and editing

## Existing Program

- Python, version 3.9.5: Primary programming language
- Matplotlib, version 3.4.2: Visualization library
- NumPy, version 1.20: Mathematics library

# Software Engineering Standards

- IEEE 1016
  - Create and maintain software design document
- IEEE 830
  - Create Software Requirements Specification (SRS)
- ISO/IEC/IEEE 29119
  - Software tests defined, operated, and documented properly

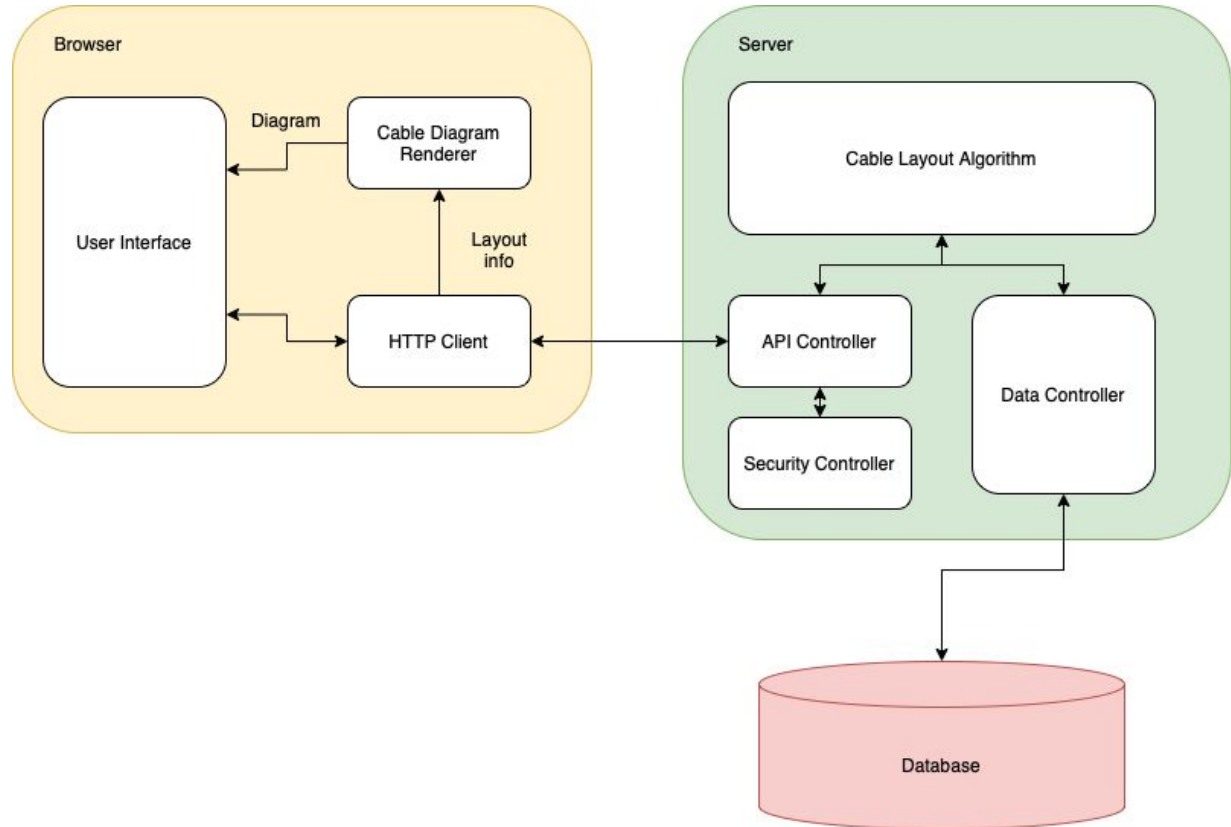
Used Abbreviations:

Institute of Electrical and Electronics Engineers (IEEE), International Organization for Standardization (ISO), International Electrotechnical Commission (IEC)

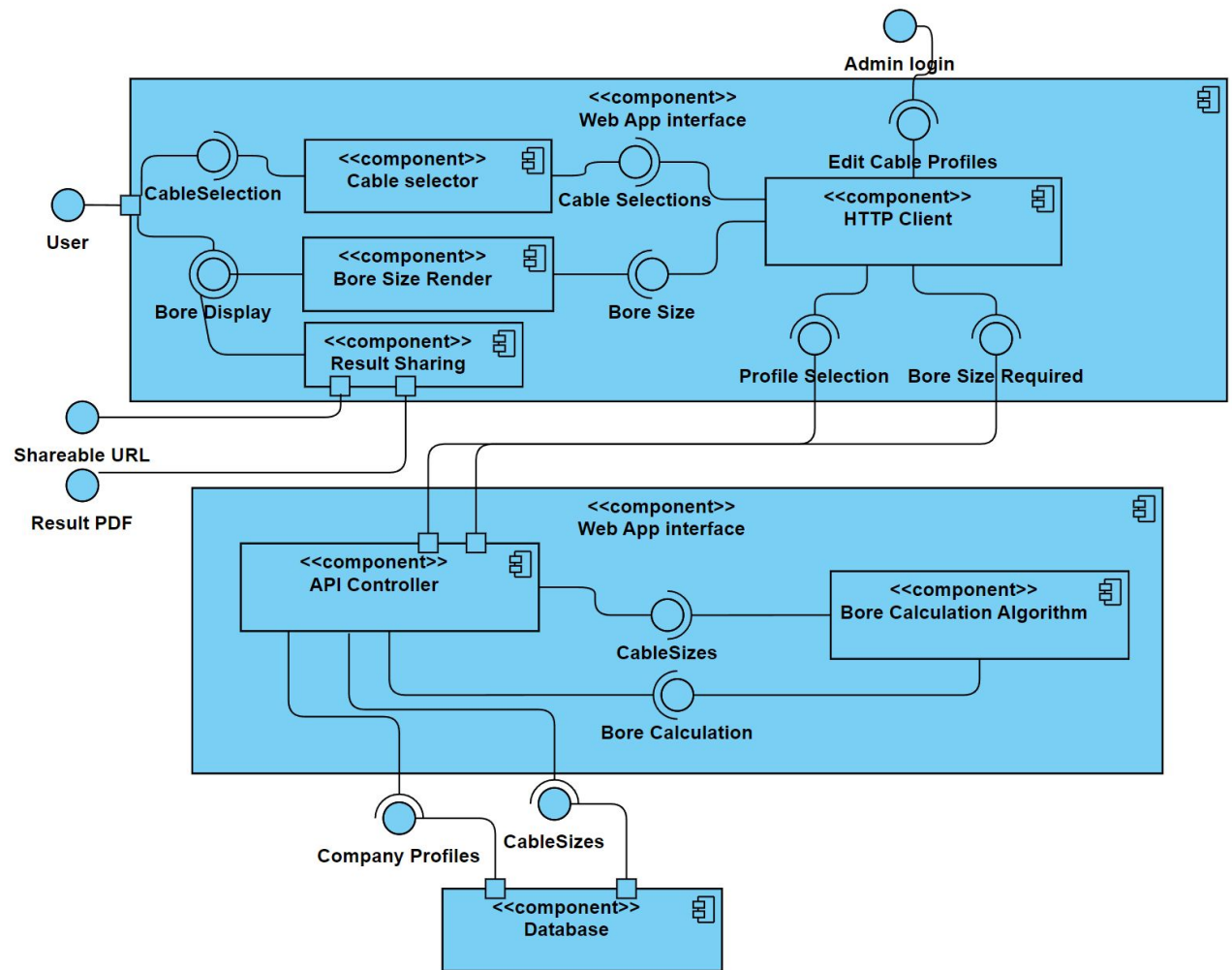


# Software Architecture

- Browser
- Server
- Database



# Component Diagram



# Design Focuses

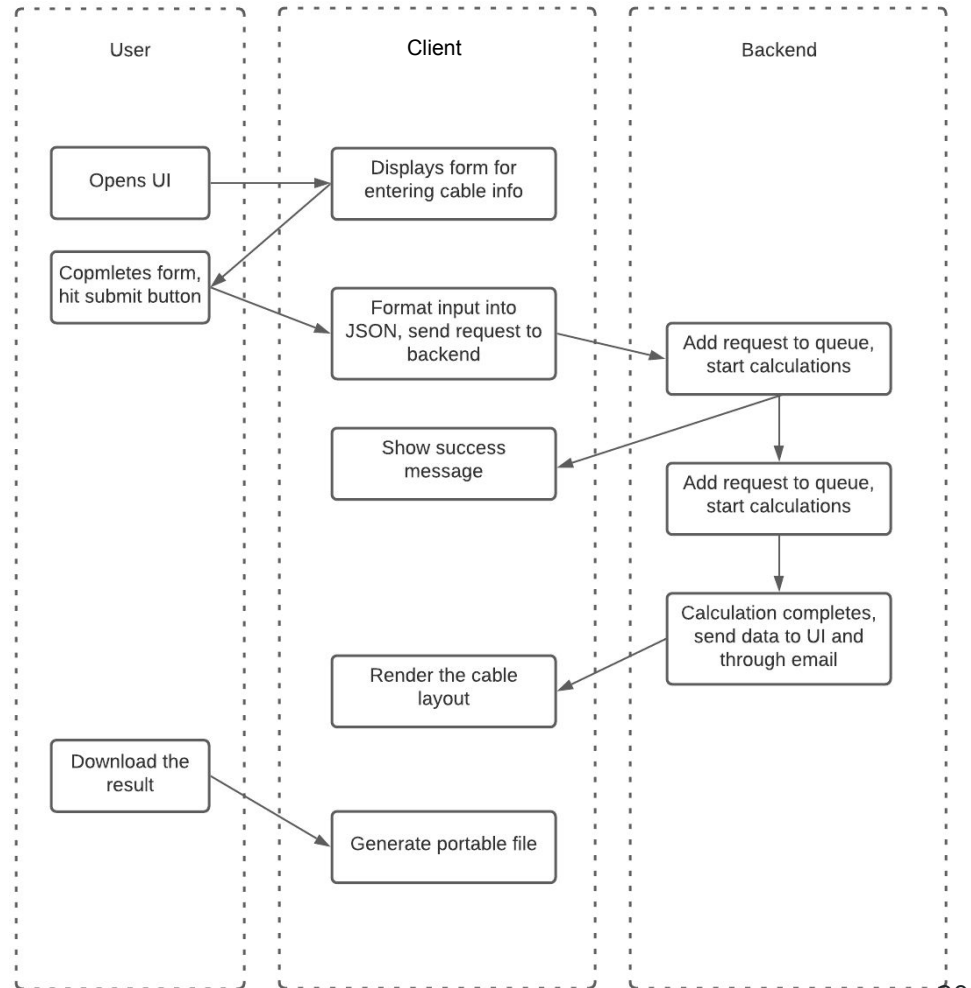
In order to fulfill the project requirements:

- Frontend UI takes in user input
- Backend algorithm receives input and generates result
- Result send via JSON back to frontend
- Frontend renders received JSON into final result
- Special URL created for final results viewing
- Backend sends results to specified email (if applicable)

Program modules broken down into specific functionality

# API and Interface Diagram

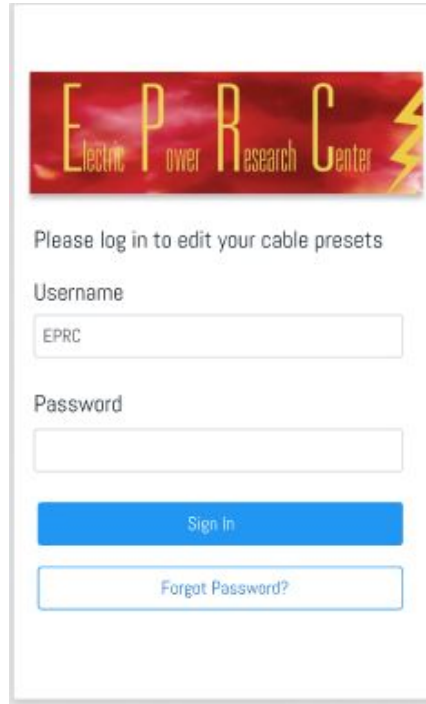
- User
  - Utilize UI for input
  - Obtain results
- API
  - Data transference and rendering
- Backend
  - Take request input
  - Run algorithm
  - Return



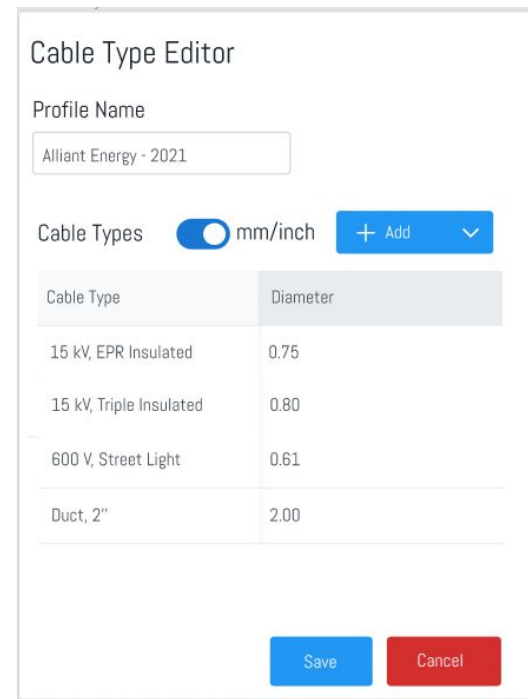
# User Interface (UI) Design

## Mock-up (1):

- Login panel to access type editor
- Overlay panel to edit predefined cable list sets
- Each company/user can set up a profile (authenticated)



The login panel features a header with the EPRC logo (Electric Power Research Center) on a red background. Below the logo, the text "Please log in to edit your cable presets" is displayed. The form includes a "Username" field with the value "EPRC", a "Password" field, a blue "Sign In" button, and a "Forgot Password?" link.



The Cable Type Editor overlay shows a "Profile Name" field with the value "Alliant Energy - 2021". Below this, there is a "Cable Types" section with a toggle switch set to "mm/inch" and a blue "+ Add" button. A table lists predefined cable types and their diameters:

Cable Type	Diameter
15 kV, EPR Insulated	0.75
15 kV, Triple Insulated	0.80
600 V, Street Light	0.61
Duct, 2"	2.00

At the bottom right, there are "Save" and "Cancel" buttons.

# User Interface (UI) Design

## Mock-up (2):

- Add cables to be packed
- Set parameters

The screenshot shows a web browser window titled "Underground Cable Packer" with the URL "sdmay-22-19.iastate.edu". The page is titled "Main Page - Add Cable" and features a logo for "EPRC" (Energy Power Research Center). A progress bar indicates four steps: 1. Add Cable Types, 2. Add Cables (highlighted), 3. Submit, and 4. Export.

The main content area includes a "Cable List" section with a "Preset" dropdown set to "EPRC - 2021" and a unit selector for "mm/inch". Below this is a table with columns for "Cable Type", "Diameter", and "Amount".

Cable Type	Diameter	Amount
15 kV, EPR Insulated	0.75	3

Below the table is a "Select Cable Type" dropdown menu with options: "15 kV, Triple Insulated", "Duct, 1.5\"", and "Duct, 2\"".

To the right of the table are input fields for "Bore Size Increment:" (value: 2) and "Min. Bore Size:" (value: 4). There is also a checked checkbox for "Email me when the results are available:" and an "Email:" input field.

At the bottom of the form are three buttons: "+ Add", "Submit", and "Cancel".

# User Interface (UI) Design

## Mock-up (3):

- Completed form

The screenshot displays the 'Underground Cable Packer' web application. The browser address bar shows 'sdmay-22-19.iastate.edu'. The page title is 'Main Page - Submit'. The application header includes the title 'Underground Cable Packer' and a logo for 'EPRC Energy Power Research Center'. A progress bar shows four steps: 1. Add Cable Types, 2. Add Cables (highlighted), 3. Submit, and 4. Export. Below the progress bar, the 'Cable List' section features a 'Preset' dropdown set to 'EPRC - 2021' and a unit toggle set to 'mm/inch'. A table lists cable types with their diameters and amounts. To the right, there are input fields for 'Bore Size Increment' (value: 2) and 'Min. Bore Size' (value: 4). A checkbox for 'Email me when the results are available:' is checked, and the 'Email' field contains 'sdmay-22-19@iastate.edu'. At the bottom right, there are 'Submit' and 'Cancel' buttons.

Cable Type	Diameter	Amount
15 kV, EPR Insulated	0.75	3
15 kV, Triple Insulated	0.88	7
10 kV, EPR Insulated	0.67	2
Duct, 2"	2	2
600 Volt, Streetlight	0.61	3

# User Interface (UI) Design

## Mock-up (4):

- Results

The screenshot shows a web browser window titled "Underground Cable Packer". The address bar contains the URL: `sdmay.22-19.iastata.edu/retrieve/f8237db0-1cf0-4e3e-a77c-161927abaac2`. The page content includes:

- Navigation links: "Open Previous Page", "Underground Cable Packer", "New Project", and "Open Previous".
- A search bar with "Result ID:" and a "Find" button. The input field contains the same URL as the address bar.
- A "Rendering..." progress bar showing 33% completion.
- A diagram titled "8 in. bore, valid = True" and "Cables remaining". The diagram shows a circular layout of cables with a coordinate system from -4 to 4 on both axes. The cables are numbered 1, 2, and 3.
- A list of cable specifications:
  - 1: 600 VOLT, INSULATED, QUADRAPLEX 350 kcmil
  - 2: 15 kV, TRXLPE INSULATED JACKETED 750 kcmil
  - 3: 15 kV, TRXLPE INSULATED JACKETED 4/0 full neutral
- Buttons at the bottom: "+ Export" and "Share".



# Design Complexity

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# Complexity

## Complexities

- Sharing and saving results
- Accommodating mobile users

## Iterations

- Current desktop application functions as version 1
  - Iterations required to add functionality and improve speed
  - Still ongoing
- Client conversations created

# Risks and Mitigation

- ISU Engineering Hosted Server
  - Allows close contact and no externally hosted information
- Performance Requirements - Software
  - Performance testing of individual performance
- Scheduling Conflict with External Stakeholders
  - Maintain close contact, plan early
- Security (Data Leak, DoS, etc)
  - Avoid storing sensitive data
  - Internally hosted
  - Use up-to-date dependencies

# Project Plan

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# Project Milestones

1. Protocols, Technologies, and Requirements have a team consensus.
2. Git configured with CI/CD, individual work environments are set up.
3. Mockups are verified by client, professor, and TA.
4. Algorithm must produce the correct result within 20 seconds.
5. Frontend and backend can successfully communicate.
6. Application must pass all unit tests and produce expected results.
7. Application must be deployed on the Iowa State server.

# Testing Plan

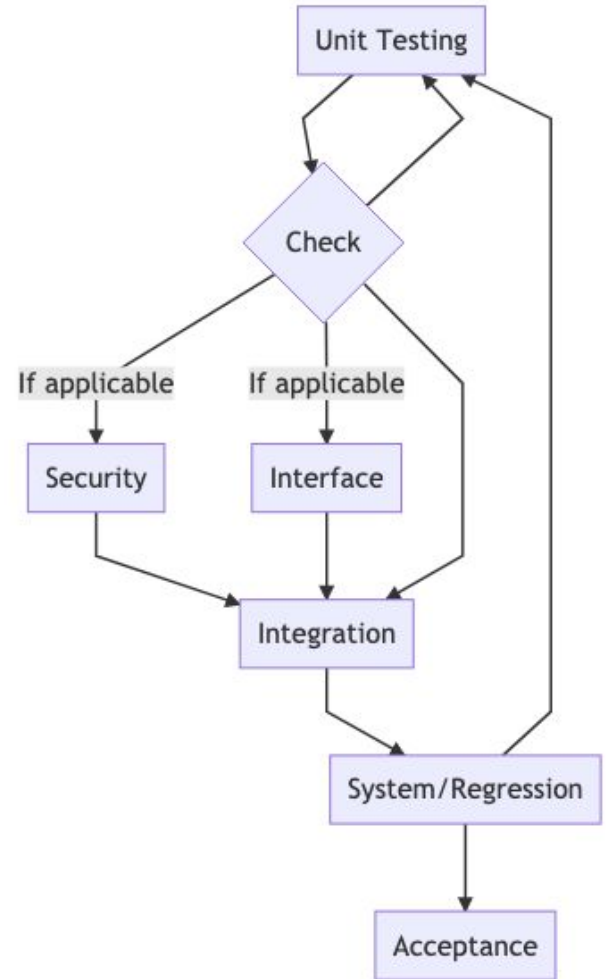
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# Testing Process

## Testing Performed

1. Unit Testing
  - a. Jest and Go testing suite
2. Security or Interface (if necessary)
3. Integration
  - a. Docker (databases), Selenium (browser env.)
4. System & Regression
5. Acceptance

(Repeating 1-4 often with each new merge)

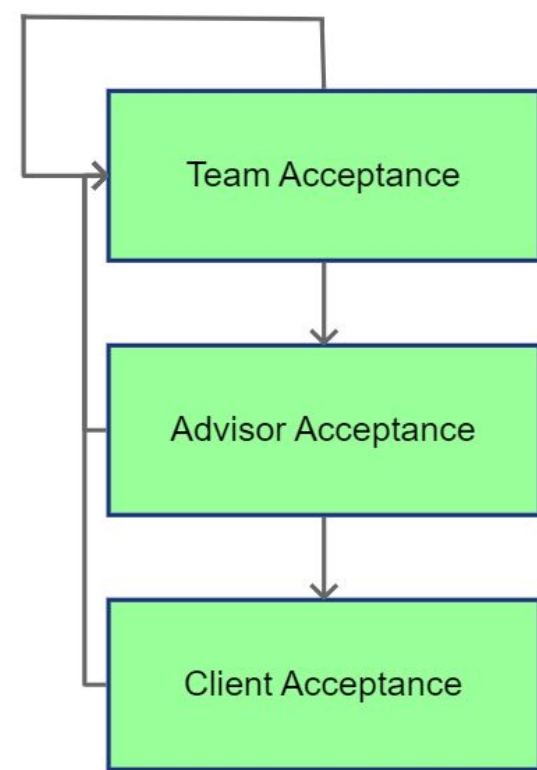


# Acceptance Testing

The last phase of testing and project development

Three phases:

- Occurs in team first
  - Test full functionality within the team
- Advisor Wymore acceptance testing
  - Have Wymore test full functionality
- Perspective client Alliant Energy
  - Have Alliant Energy Representative test full functionality





# Conclusions

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# Schedule Status

## Pre-Implementation Phase:

- Project Planning and Defining [On-Going]
- DevOps & Tech. setup [IN-PROGRESS]
- Project Design and Verification [Final Stage]

## Implementation Phase:

- Algorithm Redesign [IN-PROGRESS]

# Next Semester (Spring 2022) Schedule

## Implementation Phase:

- Create Tables [January Start - End]
- Backend Construction [January Start - March End]
- UI/Frontend Construction [January Start - March End]
- Development Testing Suite [January Start - March End]

## End Phase:

- UAT and Deployment [March Start - April End]

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