VCU College of Engineering

MULT 22-605 (22-043) BuildEACS

Project Proposal

Prepared for:

Build, RVA

Build Forward Foundation

By:

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1 Executive Summary

The Build Forward Foundation, a non-profit organization responsible for the Build, RVA makerspace in Scott's Addition, has expressed the challenge of their members using equipment when they are not qualified to use them as well as some members not paying to use certain equipment. In some cases they have found members using equipment in an unsafe manner as they have not attended the proper classes to know all the safety precautions that come from the equipment. Considering that Build, RVA contains both a metal shop and woodworking shop, the equipment can get quite dangerous if used without the proper foundation in use. Our goal is to help Build, RVA overcome this problem by building them a system that allows them to regulate which members can use which equipment that they are trained on. The manager of the shops already has current knowledge of which users have been trained on the various systems but as Build, RVA is primarily volunteer run the managers can not be in the shops at all times to verify that members are using only equipment that they are allowed to use.

To address this problem we propose to build a system that is easy to maintain, low-cost, scalable and simple to use. We are designing an open-source system centered around a low cost central control system that takes advantage of Build, RVA's current infrastructure. We want to take advantage of the many off the shelf products that can be integrated into the project that will allow for scalability as the building grows and more equipment is added to the various workshops available for the members to use. The ability for the managers of the different shops to be able to update which members have completed the training and grant them access to the machines in an easy way is paramount to the design of the systems. With the system integrated into every part of the machine infrastructure we are focusing on reliability with a projected uptime of 99% or more. Any less than the system being running fully all the time would impact the members ability to access the machines they need to finish their project.

2 Introduction

Build, RVA contains many power tools that require proper safety training before members are able to use these tools, such as CNC machines and table saws. Currently, there is not a way to make sure that the member has completed their proper safety training course in order to operate these machines. We would like to create an open-sourced, on-site Equipment Access Control System (EACS) to only allow members to use the tools that they have been properly safety trained for. This project would require the field of electrical and computer engineers, along with computer sciencentists, to be able to construct an EACS. Creating this system could contribute to Access Control Systems (ACS) and secure equipment that would require special training in order to safely operate.

There have been many different forms of Access Control in history, from Securecomm Technologies, "Early forms of security access for business security systems was introduced in the 1960s as business owners and managers looked for alternatives to providing keys and the need to frequently replace them when there was a change in key personnel." [1]. Access control has evolved from Keypads,

Card readers, Non-intelligent, Semi-intelligent, and intelligent readers, along with IP Door readers. Our current project relates because these ACSs were created to allow users to access systems only if they are authorized. The previously mentioned ACSs were used to allow authenticated users to access control panels and unlock doors, we will build upon this by allowing authenticated users to access different equipment based on the safety training that has been completed. Some other ACSs use databases to store permissions, for example Kisi talks about Access Control Servers, “Every access control system needs a server where the permissions are stored in an access database...It is really the server that makes the decision whether the door should unlock or not by matching the credentials presented to the credentials authorized for that door.” [2]. This coincides with how we will utilize a database to keep track of authorized users and grant them access to equipment based off of their completed safety training.

In order to allow and restrict access to the different equipment in the Build, RVA building, an EACS needs to be implemented in order to authorize access to members who have completed the proper safety training needed for the machine they would like to use. The previous inventions of different ACSs, such as Card readers to IP Door readers have led to the advancement of ACSs that allow us to create the solution to our given project. Below is a diagram of an ACS [3], used to allow users control of a door if they are authorized. This contributes to how we will be allowing users access to a machine if they are authorized to use the machine.

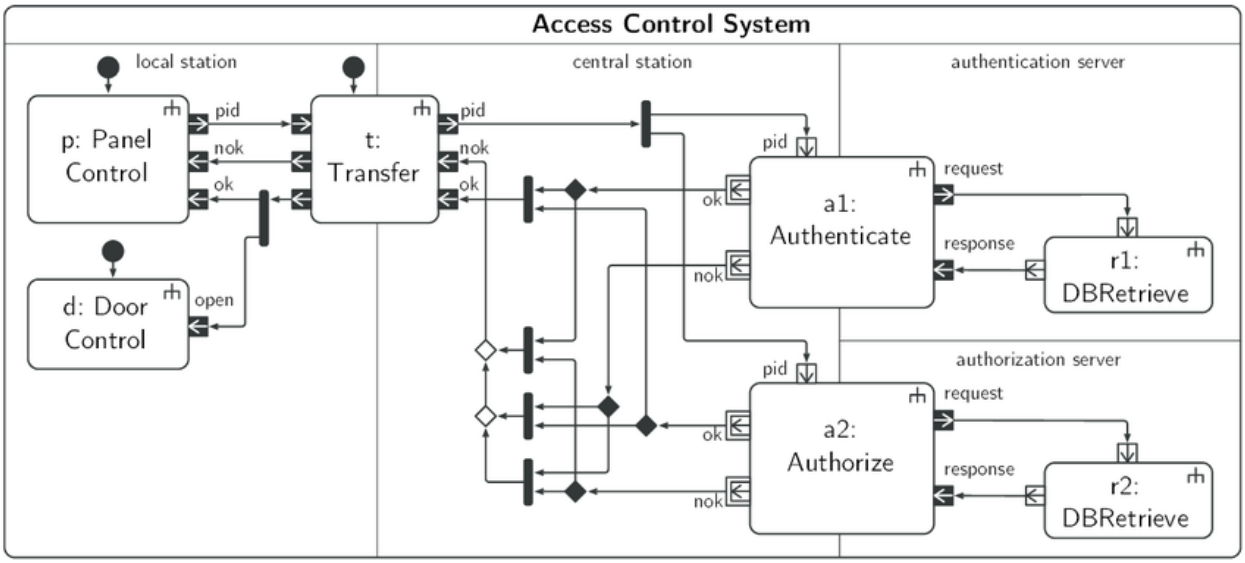

Diagram of an ACS [3]

3 Project Definition

Goals (i.e., Problem Statement and Customer Needs)

The Build Forward Foundation needs an EACS to mitigate the risk of members using power tools including table saws and CNC machines without completing the proper safety training course through Build, RVA volunteers first. There is also a need to track logistical information to ensure that all power tools are used properly and that all power tools have been serviced and are operating properly.

The Customer Needs are as follows:

- To restrict equipment access to trained users
- To identify what equipment a user has been trained on
- To reserve equipment usage by date and time.
- To monitor electrical current spikes
- To monitor equipment downtime and equipment failure
    - To record breakage of equipment
    - To record wear on equipment (e.g. frayed electrical cord)
- To monitor equipment maintenance and repair.

3.1 Objectives (i.e., Interpreted Needs)

To meet the Build Forward Foundation's needs, the EACS will be able to read user RFID tags present in member key FOBs used to access Build, RVA, and to verify the member's training certifications using information from the Build, RVA's existing database. The EACS will restrict power flow to the power tool by default, and will have the ability to direct current back to the power tool in question if the member is approved to operate it. Additionally, the EACS network should store logistical information that users can access and edit within the server. Finally, the EACS will be easy to maintain through consistent documentation across software and hardware. This documentation will simplify the maintenance process for anyone that does not specialize in electronics or programming.

- The EACS will be easy to maintain
    - The software will include documentation in code files as well as README files to explain the code and areas of the code that could be customized/modified
    - The hardware will be supported by documentation detailing parts used and how the hardware is assembled for the same of replication and repair
- The device will allow/restrict current flow to a piece of equipment
- The design will be open-source
- The design will monitor:
    - Amperage spikes
    - Times of usage
    - A log of how many instances of rejected and allowed access
- The design will utilize an app or website for monitoring.
- The design will maintain profiles for users
    - User information
    - Training status
    - Certification of what machines the user has been trained on
    - User usage time on specific machines

    - User's current scheduled reserve times on equipment
- The design will maintain profiles for equipment
    - Type of training needed to use a machine
    - Length of time a user can reserve time on the machine in one session
    - Make, model, date of service, serial number
    - Description and functional of the machine

3.2 Constraints

- Maintainability Constraint
    - Design must operate for at least 6 hours without requiring maintenance
    - Design must be able to be maintained by a nontechnical employee after project completion
- Cost Constraint
    - Design must be cheaper to produce than currently available designs (ideally less than $100 per unit)
- Functional Constraints
    - Design must integrate with existing infrastructure
        - Design must connect to 110V and 220V circuits
        - Design must interact with members through RFID tags already uniquely assigned to each member
        - Design must interact with existing database of member who have or don't have access to certain areas/tools based on their certification

4 Scope

The purpose of the project is to provide an application to ensure users in the Maker Space have been trained properly on how to use the equipment. This will ensure that the equipment is used safely and properly. Reducing accidents and unnecessary repairs on the equipment. The scope of this project is to provide an EACS that will secure usage of the equipment only to trained and authorized users.

- Objectives
    - Design a raspberry pi driven EACS that can lock doors and can interrupt the power supply to various systems as a means of locking those systems by controlling the flow of power to equipment
        - Primary
            - Need to restrict access to equipment by only trained users.
            - Need to identify what equipment a user has been trained on
            - Need to monitor electrical current spikes
        - Secondary
            - Need to reserve equipment usage - by date and time.
            - Need to monitor equipment downtime (equipment failure)
                - Record breakage of equipment
                - Record wear on equipment (e.g. frayed electrical cord)

    - Need to monitor equipment maintenance and repair.
- Timeline
    - October 8 - Project Proposal.
    - October 22 - High Level Design/Architecture
    - November 11 - If primary goals are achieved, secondary objectives will be implemented
    - November 18 - Initial Prototype
    - November 19 - Detail Level Design
    - December 3 - Working Prototype/Proof of Concept
    - March 4 - Final Report
    - April 1 - Completed Project
- Deliverables
    - Working Prototype of code that interacts with raspberry pi system and potentially over-arching “membership system”, testing and documentation will need to be delivered to allow for further distribution and enhancements in the future
- Responsibilities of team members
    - Michael Blatt and Cheyenna Kent - Handling website and coding
    - Kimberly Pham, Frederick Roddy, Joseph Mustachio - Handling integration of Raspberry Pi and electrical work

5 Deliverables

- Project Proposal
- Hardware Specifications
- Software Specifications
- High Level Design/Architecture
- Cost Breakdown
- Detail Level Design
- Working Prototype/Proof of Concept

6 Organization

This section lists all individuals and organizations involved in the projects and defines their roles and responsibilities.

6.1 Project Sponsor

This project is being sponsored by The Build Forward Foundation, a non-profit organization that runs and maintains Build, RVA, a makerspace in Scott’s Addition. Being a makerspace, Build, RVA provides access to various pieces of equipment from sewing machines and 3D printers to table saws and lathes. For these heavier pieces of equipment, Build, RVA offers training classes on a weekly basis.

- Seth Estep - Program Director
- Alex Casas - Project Manager
- Joshua Stolberg - Project Manager

6.2 Design Team

- Kimberly Pham, Project Manager - Computer Engineer
- Joseph Mustachio, Logistics Manager - Electrical Engineer
- Frederick Roddy, Systems Engineer and Manufacturing Engineer - Computer Engineer
- Cheyenne Kent, Financial Manager - Computer Science
- Michael Blatt, Test Engineer - Computer Science

6.3 Faculty Advisor(s)

- Dr. Bob Dahlberg - Computer Science Advisor
- Dr. Yanxiao Zhao - Electrical and Computer Engineering Advisor

7 Timeline

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References

[1] A. (2018, April 27). *The Evolution of Access Control Systems*. Securecom Technologies. https://securecomminc.com/blog/2014/06/19/the-evolution-of-access-control-systems/

[2] *Access Control Systems: Different Types and PDF Guide | Kisi*. (2012). Https://Www.Getkisi.Com/Access-Control. https://www.getkisi.com/access-control

[3] Slåtten, Vidar. (2021). *Model Checking Collaborative Service Specifications in TLA with TLC*. (2007). https://www.researchgate.net/publication/268054189_Model_Checking_Collaborative_Service_Specifications_in_TLA_with_TLC