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REMOTE AUTOMOTIVE HEATING SYSTEM

Post Mortem

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Submitted to:

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Introduction

At RAHS Tech the goal is to create a simple solution to a very common problem. RAHS is designed to defrost and heat the interior of vehicle before the user enters it. This device is a car accessory that is easily implemented into any car and heats the vehicle without starting the engine. The user can activate the system with either the timing system or the remote control device. This report will show the progress of the RAHS with respect to the initial schedule and budget. This document presents the post mortem of the RAHS TECH project, providing an overview of the product, outlining the current state, individual learning, group dynamics, and the challenges encountered. Alternative solutions and existing forms of the RAHS system are discussed and critiqued in the market and competition section.

Current System State

The main component of RAHS consists of a state of the art 12V DC heater unit designed specifically for heating vehicle cabin interiors. Other components included in the overall system are the Arduino Microcontroller, and alarm clock for easy user functioning, a feedback remote and a 12V car battery. The diagram below shows the system overview of RAHS

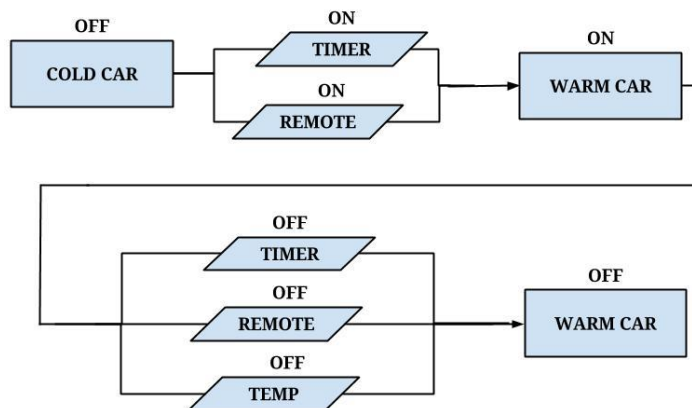


Figure 1: System flow diagram

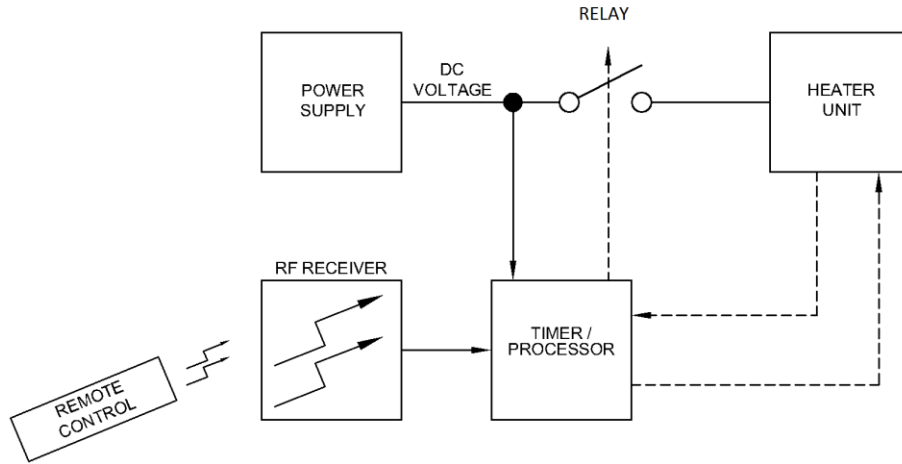


Figure 2: RAHS signal/power travelling diagram

Schedule/ Progress

The original schedule was to have all the systems integrated by March 27th. We have also allocated time for prototype modification until April 6th. The following shows the milestones and the progress of our project.

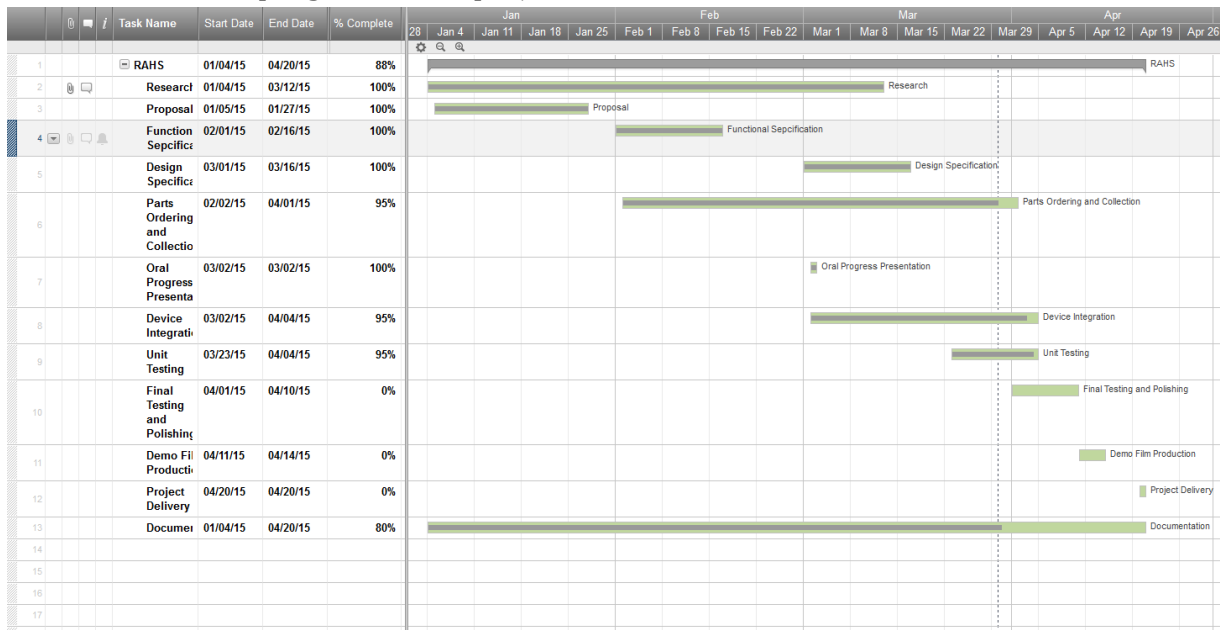


Figure 3: Project timeline for RAHS

Given our somewhat drastic changes to the system design (seen below in remediation) we have not been able to implement our design fully as per our original schedule. This is mainly due to the fact that the chosen heater for our design is currently being manufactured in California. All other hardware components have been fully assembled and integrated together. The Battery, relay switch, and microcontroller, and sensors have been tested and are functioning as per our design. We have tested the system with a resistor to mimic the function of the heater unit. Once we have received the heater unit, we will implement the heater with our control mechanism to test the overall efficiency and functionality of the device. We are hoping to polish the device by packaging all the components into a black box and leaving the interface for user to prevent any damages towards the device. Our controller unit software is currently in the debugging stage where we are sorting out the remaining bugs for smooth user controllability. All software bugs should be eliminated and the controller fully operational by the prototype demo date April 20th.

Finances

All necessary components for implementation have been acquired and the project is currently within the proposed budget. ESSEF has been RAHS Tech’s main source of funding and have provided \$400 for this project. So far we have spent \$390 on components such as the microcontroller, RF transmitter, relay switch, temperature sensor, and the heater. We also have access to the engineering lab which provides us with wire, solder, and tools saving us costs of having to purchase these tools. We have managed to reduce our product costs by changing our overall system design which is described below under remediation.

Item	Actual Price	Estimated Price
Heater	\$190	\$100
Microcontroller/Arduino	\$80	\$110 (Battery substituted)
RF Transmitter	\$10	\$30
Relay Switch	\$60	\$95 (Inverter substituted)
Phi-2 Shield	\$50	\$30
Total Cost	\$390	\$400

Table 1: Project budget for RAHS

Problems and Challenges

Our original plan and design concept included utilizing a DC to AC power inverter as well as a standard 120V AC heater unit. Furthermore this was to be connected to the vehicle battery. After careful consideration, as well as extensive research and testing our team concluded that the power losses of this design were too great and would cause battery life failure. Instead of using a 1200W AC heater we used an energy efficient 600W 12V DC heater unit manufactured explicitly to be used with standard 12V car batteries. This allowed us to bypass the unnecessary conversions of DC to AC power via the inverter which contributed overall system power loss. This subsequent design has cut power losses by half. The new system design also has reduced the cost of project by \$150 allowing us to implement a secondary battery which will be responsible only for heating while leaving the vehicles existing battery alone. Both batteries would be connected to the alternator in the future allowing both batteries to be charged simultaneously, and each battery safe from draining to unsafe levels. Furthermore our timing system design is being run with an Arduino microcontroller which allowed us to implement additional functionality such as temperature and tilt sensors. The microcontroller operated a solid state relay which allowed us to have complete control over the circuit from the battery to the heater.

The heater took a long time to be manufactured in California and so we did not have very much time to mount the heater. Most of the testing had to be done with just the relay which was not as useful as having the whole system. The only solution we had for the heater arriving late was to finish everything else in the project and then implement the heater integration system after it arrived.

Group Dynamics

This project required all members in all phases of the development of RAHS. The duties for each member of the group were divided as evenly as possible with each member working to their personal specialty. The company needed structure which was why we divided the team into three different roles. The CEO of RAHS Tech was Patrick Krzesinski and his main roles were the hardware design and implementation of the heating system. The CTO was Joe Kuo whose responsibilities were the software design and implementing the alarm clock system. The CFO was Andrew Piechnik and his responsibilities were integration of the systems and documentation.

Personal Reflections

Patrick Krzesinski – Chief Executive Officer

The last 4 months have been a major learning experience for me. I was surprised how much one can learn from simply trying to make an idea into a working design and create that design into a physical product. This project has brought to light skills I never knew I possessed and taught many skills that I will be able to apply later on in life. I also has to opportunity to work with two of my classmates whom I've going to school with for the last 3 years. Our small 3 person group was a challenge and a blessing. The amount of work that was required from each of us took its toll during the semester; however the added responsibility of each member forced us to work together as a single unit. As we all had our own responsibilities and designated tasks, no team member was unaware or uninvolved with the tasks and duties of other members. This actually allowed us all too really understand how the entire project needs to work and how all the different systems come together.

As CEO of the group I had to make some tough decisions on short notice, while we all would agree on the best course of action at certain times I needed to simply take charge. An example of this was near the end of the semester when our original interactive clock/button design was causing us problems. We had been spending too much time trying to fix the problems and make the current design work simply because we had already paid for the components. I realized we were not using our time wisely and drove to Walmart to buy and alarm clock. I then disassembled the clock and we integrated the required components and it worked very smoothly. While we would have liked our original design to work I needed the team to focus on more important matters at hand and so we carried on with the new clock solution.

Working in our trio really brought us close together, and no one person was stuck with an unmanageable task. Everyone stuck it out to the end and did their parts.

I learned more about electronics this semester than I did in most previous semesters because we were actually forced to take components apart and put them together. Many times things did not work and we had no idea why finally after pouring over things we would find what was causing problems and add that to our knowledge databank. I learned a lot about programming embedded systems and about microcontrollers and all many uses they have that I can now use in the future. Having very little to no experience with these things before I greatly expanded my personal skill set and knowledge. It is quite true what Dr. Rawicz said at the beginning of the year; "this course is the only course you can make mistakes in Engineering at SFU or even before you step into your career." The most

valuable lessons I learned were from all the mistakes we made in design or in the actually building. I really learned to take a step back before doing anything think things through, say to myself is this going to work?

In conclusion I would say this semester has been a success. My team and I had many projects alongside this one and we really managed to complete them all even if that required staying at SFU all night. In the end, our final project worked and was packaged nicely. We were very proud of ourselves because of the many unforeseen problems we had encountered. The night before our demo our LCD screen stopped work at around 9pm on a Sunday night. We toiled over it all night and made it work for the demo. Having spoken to other groups this semester who's projects did not fully work, we were worried we might also not be able to have a working prototype to show. However everything worked smoothly as planned and even though our design drastically changed, we changed it for the better. I would recommend both of my team members for any future project or jobs they may have.

Joe Kuo - Chief Technology Officer

Over this course of this semester, I am proud that I had the chance to be a part of RAHS and I had a great time working with team. We have been through the whole parts of industrial procedure, which includes brainstorming for project ideas, designing & implementing features, debugging & redesigning, and testing. It was a great challenge for us to build a project by our own and it was the first time for me to design and build a whole project rather than finishing assigned tasks. This project requires intense team works and brilliant individual works, I have to say it is my honor to work with these talented engineers and our success is closely related to all of our team members. I was focusing on the software part of this project including programming the alarm system and RF transmitter/receiver system.. I was primarily responsible for software programming, debugging, modification and testing with other members' assistances. Throughout the process of development, I have learned that I have to practice my skills and adapt the new working environment/equipment before I start to work. In addition, I have learn that during the design/testing process, fatal mistake can occupy and completely ruin the whole project. For our project, since our original design is not good for practical business plan, we have to change our design and start to work from beginning stage. Our original idea for the heating component and power system is completely different from our final prototype. To accomplish this major shift of design, all three of us had to put in extra time into research stage and rush plan B into its completion. For further projects, I will predict the risk of design solutions and prepare back-up plan. Beside the technical skills and project management skills, the biggest benefit I have gained from our project is teamwork and communication skills within group. We worked together for the most of time and we kept informing all team members about the

changes/updates, which saved a lot of time and there is almost no misunderstand between all team members. Overall, all of us did a great job on this project. Thanks all the team members: Patrick and Andrew. I will remember my experience at RAHS tech.

Andrew Piechnik – Chief Financial Officer

As the CFO of RAHS Tech, I was able to work closely with our team to create a useful product. My job as CFO was to work with the team and make sure that all purchases were reasonable with respect to the design. This project was very challenging and had ups and downs throughout the whole project. In this project, I learned how to deal with finances from the simple project proposals to allocating funds for each component of the project.

At the start, the plan was simply to come up with an idea that would be useful, new, and creative. In January we were thinking of ideas and started looking around at real world problems in our everyday lives. When we came up with the idea for RAHS, we recognized the potential and started creating a solution and getting funding. I learned how to work with my team to come up with an idea for a project and through good communication, we were able to properly set up RAHS Tech.

The next stage of this project was designing the system based on our desired functionality. This was a very important part as we had to decide what was feasible and what components we needed for functionality. After completing the initial design with just regular industrial components, we discovered that the integration would be nearly impossible. We had to redesign our project multiple times and eventually came up with a good solution. I learned that design is a very important part of creating a good system and that asking experts for help is the best method to get on the right track when designing a system.

The financial component of this project was difficult because we needed a balance of buying what we need for the project while not overspending. This was a challenge that was overcome by testing many different components before deciding on a final product. For example, we tested more than five different heaters which really gave us a sense of what we needed for our design. We learned that it is important to research and test whenever possible because excessive amounts of money can be wasted if not properly researched. Our biggest financial mistake as buying our arduino for double the regular price because we did not talk to anyone who had previously bought an arduino. The project taught me to research components and get advice about components before purchasing them.

The final stage was implementation and debugging. Anyone who has done capstone has

probably figured out that this is by far the most frustrating part of the project. Debugging the project took many hours and in a couple cases, we had to change our design. As a group we learned to support each other with every aspect the implementation and with enough thought, we were able to overcome all of the obstacles we encountered. This project takes great deal of time and can be tedious. I learned how important it is to have a good team to work with. Everyone knew their parts and together we successfully created RAHS.

Future Work

In the future, The RAHS Tech Team would implement various different improvements to make the overall product more marketable and reliable. First of all, removing the clock setting mechanism from the car to the users' smart phone by developing an app for smartphones we could connect directly to the microcontroller via Bluetooth. The user would not even need to be in the car to set the alarm, simply can be set from anywhere via their phone. This also removes the additional remote on/off switch as this would be integrated into the new app. A proper mounting would be implemented that would direct heat to the windshield that could be easily removed the by user once they enter the vehicle. Furthermore the additional battery would receive some serious upgrades, such as proper fastening and being hidden from view so as to not obstruct driver or passenger space.

Conclusion

RAHS Tech has put a lot of time into designing and implementing the systems included in RAHS. The modification on the timing system changes the classic alarm clock into an Arduino microcontroller which can be more easily integrated into our system. In addition, these changes will not influence the net cost of project. Although remediation is needed for our project, the project is still on schedule and will be completed by April 20th.

Appendix Meeting Minutes

Date	Jan 12
Members Present	Andrew, Patrick, Joe
Location	At C9001
Start Time	4:00 pm
Agenda	Come up with idea
Minutes	Ideas for projects: Electrical engineering Food expiry date scanner Alarm clock heater We agreed on the alarm clock heater All three attendees to present project idea by next meeting
End Time	Finished at 4:20

Date	Jan 20
Members Present	Andrew, Patrick, Joe
Location	At lab 4
Start Time	6:00 pm
Agenda	Project presentation Come up with name
Minutes	Presentation... who does what Name: RAHS (Remote Automotive Heating System) Andrew: Overview & budget Joe: Explain diagram Patrick: Auxiliary, conclusion
End Time	Finished at 6:15

Date	Feb 2
Members Present	Andrew, Patrick, Joe
Location	At Lab4
Start Time	2:30 pm
Agenda	Functional Specs
Minutes	Essef has given us \$400 for our project. The money will be in my account, so I can reimburse for any purchases... or make the purchase myself. Functional specs is the next document due. Feb 16. And we have spring break to work on the project. All of us are this week, so we will work on the functional specs next week.
End Time	Finished at 2:45

Date	Fri Feb 13
Members Present	Andrew, Patrick, Joe
Location	At BCIT
Start Time	2 pm

Agenda	Completing Functional Specs
Minutes	Functional specs are partially complete. 7 pages complete. We need to fill in the outline. It's due Monday The plan is for everyone to just fill in what they can. We will do the editing and formatting on Monday.
End Time	Finished at 2:15

Date	Mar 9
Members Present	Andrew, Joe, Patrick
Location	At Lab 4
Start Time	3 pm
Agenda	Design specs are due next week
Minutes	Need to order the heater. Andrew, needs address from joe for shipping Joe has already ordered the RF Transmitter Looking for timing system, the circuit will depend on what type of RF transmitter we get The timing switch should be attached to a relay Andrew also wants to add a Temperature sensor with a relay switch
End Time	Finished At 4

Date	Mar 16
Members Present	Andrew, Joe, Patrick
Location	At Lab 4
Start Time	7 pm
Agenda	
Minutes	Design Specification document is not completed, we need to ask for an extension. Andrew needs to track down the heater

	We needed to order a relay switch which we did Arduino comes by Wednesday
End Time	Finished at 7:30

Date	Mar 23
Members Present	Andrew, Joe, Patrick
Location	At ASB
Start Time	3:30 pm
Agenda	We need to get the shield and the relay and the transmitter
Minutes	Joe will pick-up the relay and the shield from the US PO box tomorrow We may go to rp electronics to buy an rf transmitter tomorrow because ours is going to arrive late Tomorrow we will meet up to connect the shield to the Arduino and to try program our system
End Time	Finished at 3:45

Date	Mar 30
Members Present	Andrew, Joe, Patrick
Location	At ASB
Start Time	3:30 pm
Agenda	Progress Report
Minutes	We need to finish up the written progress report by midnight Need to ask if we need to do peer review Joe has the Arduino and is looking into the code tonight Need to find the heater as soon as possible
End Time	Finished at 4:15

Date	Apr 8
Members Present	Andrew, Joe, Patrick
Location	At Lab 4
Start Time	2:30 pm
Agenda	How do we get the controller working
Minutes	<p>We are waiting for an email back from the manufacturer about potential problems about the clock</p> <p>We are considering switching to a RP if that would be easier</p> <p>Need to email Fabio about clock & troubleshooting</p> <p>Meeting tomorrow afternoon to figure out any more problem</p> <p>Heater should be at the PO box by Friday</p>
End Time	Finished at 3:00

Date	Apr 13
Members Present	Andrew, Joe, Patrick
Location	At Lab 1
Start Time	3:30 pm
Agenda	When will everything be done
Minutes	<p>We got the heater</p> <p>Alarm clock is working with the Arduino</p> <p>Need to go buy an RF transmitter as the other one has not arrived yet</p> <p>Need to get wire for 50 amps</p> <p>Tuesday we will work on the project</p>
End Time	Finished at 4:00