REXOS

Post Mortem for a

Rehabilitation Exoskeleton Hand Device

Project Team: Anton Khomutskiy
Joshua Law
Tony Lee
Seungjun Lee
Doug Tao

Contact Person: Tony Lee
leetonyl@sfu.ca

Submitted to: Dr. Andrew Rawicz – ENSC 440W
Steve Whitmore – ENSC 305W
School of Engineering Science
Simon Fraser University

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REXOS

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1 Introduction

The hand is the most agile part of the human body, allowing the human species to perform tasks that other creatures cannot replicate. The team at Rexos aims to help who have lost some of their hand motor functions due to health issues or trauma.

The RexoGrip is the product of our desire to better assist people who have experienced a stroke. We hope to enrich the lives of those affected by stroke by allowing them to perform more everyday tasks.

This post-mortem document will describe the current state of the RexoGrip at the end of this development cycle. Additionally, information pertaining to challenges encountered, possible future work, financials, and scheduling will be included.

2 Current State of the Device

The RexoGrip is currently completed up to its conceptual stage as shown in Figure 1. Because the computer generated design of the prototype model fell behind schedule, a conceptual model was created using materials found at the local hardware store.

The conceptual model, shown in Figure 1, has rings which fits on the intermediate phalanges of the index, middle, ring, and pinky finger. These rings each contain two tactile push switches at the top and the bottom of the ring. Actuation of the up switch will move the finger mechanism upwards, while actuation of the down switch will move the finger mechanism downwards. The movement of each individual finger mechanism is controlled by a single servo motor.

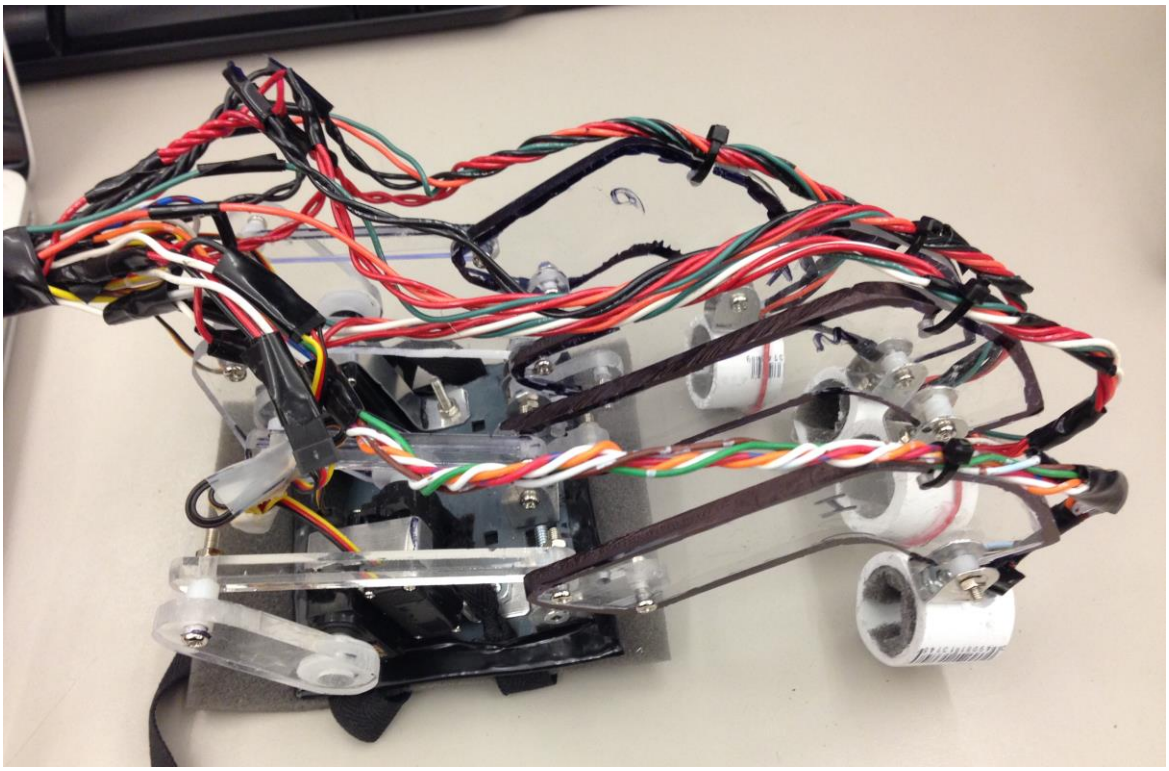

Figure 1 - Conceptual Design

The enclosure box for our device houses the microcontroller and batteries. Two single pull single throw rocker switches are also installed on the side of the box, with corresponding LEDs to indicate whether a battery is switched on. The Arduino Uno R3 microcontroller is powered by a single 9V battery and is controlled by the left switch seen in Figure 2. The four AA batteries that make up the 6V power source for the motors and push switches is controlled by the right switch. Additionally, the AA battery case is glued onto the lid of the enclosure box.

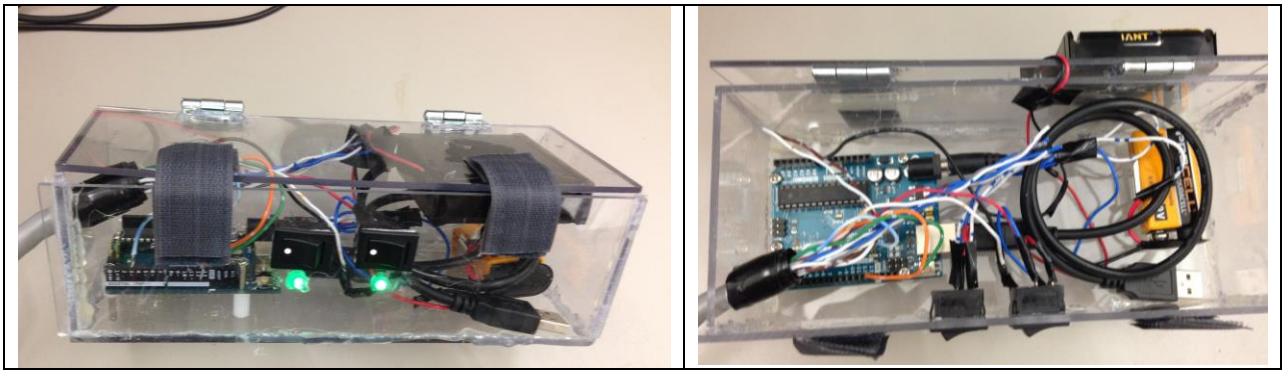

Figure 2 - Enclosure for Microcontroller and Batteries

3 Deviation of the System and Challenges

3.1 Finger Sensor

There were no changes to the plans to use a push button switch to act as the sensor to detect movement of the fingertip. This movement which would act as the catalyst to actuate the motors. However, we encountered a challenge in finding a push switch which was lightweight, small, and easy to press. For our conceptual model, we compromised the ease of use of the push button in order to use a small and lightweight switch. In future revisions of our device, we would need to find a switch which is easier to press.

3.2 Motor Selection

Our original plans were to use linear actuators to control the movement of the finger mechanisms. Linear stepper motors were chosen at the start of the development because they actuated linearly and allowed fine control over its movement. After purchasing them and testing linear stepper motors, it was found to have several issues; speed, heat output, weight, and size. This issue resulted in the change to using rotary servo motors which was found at a local hobby shop.

3.3 Alignment of Finger Mechanisms

One major challenge fabricating the components for the conceptual design was the length and alignment of the pieces. Because each individual's hand is different, there is no dimension for our design that fits perfectly for everyone's hand. Additionally, there are slightly alignment issues because of the parts used to machine the conceptual device. One cause is the use of the PVC pipes to create the ring which fits over the finger. Due to the outer width of the pipe, it causes slight space issues, which can be corrected through 3D printing of a more customizable dimension.

4 Future Plans

For future development of our product, we would look into using 3D printing for our prototype design. We were able to create a design and have it 3D printed. However, due to time constraints, we were not able to realize the project using 3D printing and completed our project with the conceptual design. The 3D printed design would result in a lower profile and a more custom fit for each user. The 3D printed model can be viewed in Figure 3. Other design changes would be the inclusion of a pressure sensitive sensor on the inner linings of the finger mechanisms to detect how much force is being exerted on a grip. This sensor would help alleviate any unneeded stress on the motors. Finally, we would also look into reducing the current size of the enclosure box housing the microcontroller and batteries.

Figure 3 - 3D Printed Prototype Model

5 Budget and Schedule

The total expenses associated with this project is shown below in Table 1. Compared to our total proposed budget of $1060 the actual costs came to $771.62, leaving us $288.38 under budget. At the beginning of term we received $750 from the Engineering Students Society Endowment Fund for this project, and this amount has covered nearly all of the expenditures. The remaining $21.62 has been paid by Doug.

Table 1 - Final Budget

Category	Budgeted Cost	Actual Cost	Change
Microcontroller	$ 85.00	$ 79.98	$ 5.02
Motor	$ 425.00	$ 446.22	-$ 21.22
Material	$ 100.00	$ 144.01	-$ 44.01
Power	$ 140.00	$ 47.26	$ 92.74
Sensors	$ 10.00	$ 4.14	$ 5.86
3D Printing	$ 300.00	$ 50.00	$ 250.00
Total	$ 1,060.00	$ 771.62	$ 288.38

A detailed breakdown of individual costs by chronological purchase order can be found in Table 3 of Appendix B: Expenditure Breakdown.

Due to multiple revisions during the design phase throughout the term, the final schedule can be seen in Figure 4

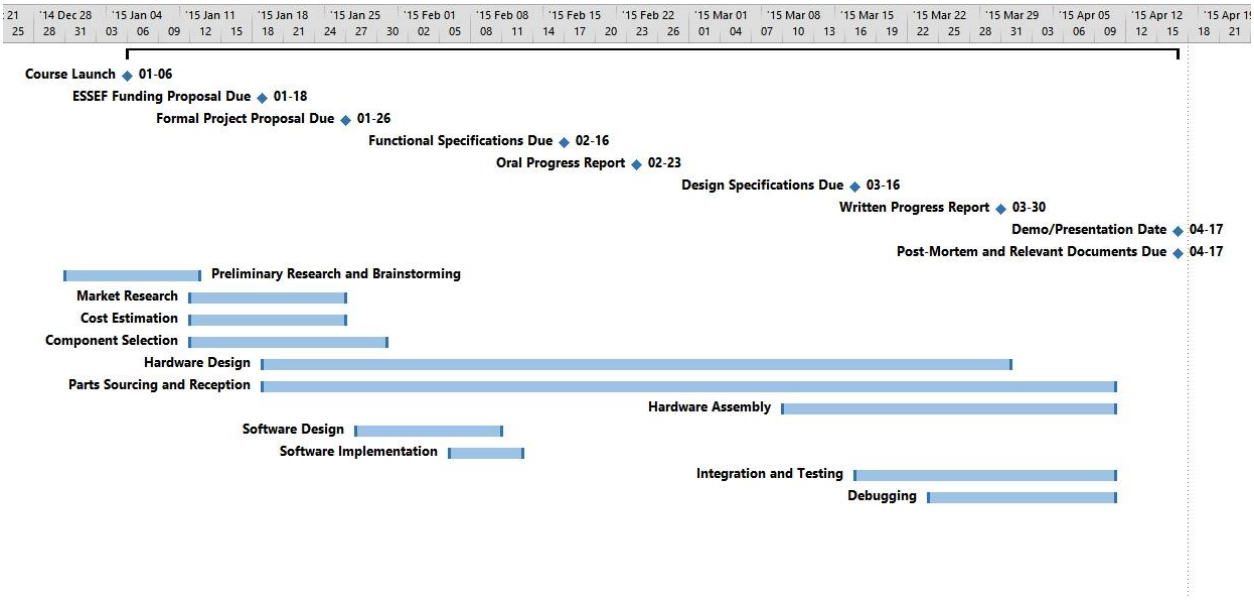

Figure 4 - Actual Schedule

6 Inter-personal and Technical Experiences

The workload distribution for the team at Rexos is described by the following chart below.

Table 2 - Workload Distribution

High-Level Task	Anton	Joshua	Tony	SeungJun	Doug
Documentation	x	xx	xx	x	x
Electronics Enclosure		xx	x		
Conceptual Design	xx				
Prototype Design					xx
Conceptual Design Fabrication	xx	x	x	x	
3D Printing					xx
Microcontroller Testing			xx		
Finger Sensor Programming			xx		
Motor Programming			xx		
Electrical Wiring		x	xx		
Parts Sourcing	x		xx		x
System Calibration and Testing			xx		

Where xx = primary responsibility; x = some responsibility

6.1 Personal Reflections

In this section, the team at Rexos will describe their reflections in the development of the RexoGrip.

6.1.1 Anton Khomutskiy

Taking this course I was expecting a fairly different experience compared to the other project courses I have taken so far. The first thing that comes to realisation is the importance of planning and time management, especially when you and your group members all take other, different, project courses that result in many different deadlines. Importance of constant communication follows that and I believe we could have done better in the beginning of the semester in regards to setting plans and deadlines. Our project required a fair bit of mechanical design that we were never really taught in any of the courses before and it was a process of trial and error to come up with the design that will work with the resources available to us. I believe, I have acquired a valuable experience that you can only get by doing projects like this. The project produced some challenges in regards to flaws in our design that we could not think about before attempting to build it. However, it was an interesting experience to come up with ways to solve them and proceed further. Some tasks could not be shared between people that extended the development process and some tasks should have been performed at a much earlier time than it happened, but overall we manage to complete the conceptual design of our project, which brought some joy to be able to see something you created working, although not perfectly.

Overall, it was a satisfactory experience that will definitely help in my future projects, some things you only learn or understand by doing them in practice.

6.1.2 Joshua Law

Of the project courses I have ever participated in, Capstone is by far the one that required the most work, gave the most headaches, and was the most emotionally rewarding at the end of the RexoGrip's development cycle. Taking three project courses in this term alone, I cannot over-emphasize the importance of good time management when it comes to meeting deadlines and milestones. It was also extremely difficult to work out a schedule so that everyone in the team of five could meet up and work, since we were all taking courses with heavy workloads.

With a larger group size, it was hard to share the labour equally in an efficient manner. It became tedious for members to do the same work repeatedly, and we could have avoided burnout by rotating the responsibilities (hardware/software) every so often with a trade-off of less comprehension. When working as a group having healthy lines of communication is key, and sometimes our internal deadlines were missed due to miscommunication and lack of consequences. Communication is also an issue when not everyone is at the same level of proficiency with a common language.

On the technical side, the Arduino was a new piece of equipment for me and learning the new environment was made easier by the fact that Arduino scripts share many commonalities with C++. Pin assignments were complex, necessitating proper documentation and attention to detail so that other team members would be able to follow the circuits. The project required extensive fabrication for each part, giving me more experience with hand tools such as the hand drill, files, and more.

We had the seed of an idea at the beginning of the term which took nearly three months to germinate into the state it is today. There were multiple setbacks during the mechanical design phase, but if we were to repeat this project we would do well to remember that there are people more knowledgeable which were available to help us. Another thing that would have been useful would be to have agreed-upon punishments for members who miss a deadline and cause the group to be delayed, which would enforce the importance of following timelines. However, at the end of the project, I am deeply satisfied with the teamwork we developed over the term and emotionally rewarded by the completion of a device which we poured our blood and tears into making.

6.1.3 Tony Lee

As a student in my final semester at Simon Fraser University, I was able to work within a team on a project based course, which is similar to engineers in the real world, where everyone must work together.

I spent a considerate amount of time writing documentation for this project, allowing me to exercise my literacy skills. Although it may not seem to be the most important or exciting aspect of a project, it is extremely vital that one can write documentation. During my previous co-op terms, documentation occurred with every project and this project allowed me to practice my writing skills more.

From a technical standpoint, I had my first official exposure to the Arduino platform, which is popular in the hobbyist world. I learned many things on programming the Arduino microcontroller which behaved very similarly to the VHDL language. Besides programming, I've also learned many things about the Arduino platform and how to connect various sensors and motors to an Arduino microcontroller. Luckily, with my many years of experience from other course project on microcontrollers, the logic behind using the Arduino Uno microcontroller was easy to grasp, thus allowing me to complete the software and electronics aspect of our project fairly quickly. The Arduino platform being open source was a major help to me learning how to write the program by looking at the many Arduino programs uploaded by fellow hobbyist on the internet.

I was also in charge of the electrical connections for our device, planning the circuit layout and interconnections. For these tasks I spent a considerate amount of time soldering connections together and performing tests to validate sensors and motors are operating correctly.

Another part of the project I was a part of was working with Anton for creating the conceptual design. Together we tackled the problems encountered as we went through several iterations of our finger mechanisms. Once the basic working design was developed, I was able to give Anton the task of designing for all the fingers, while I worked on other parts of the project.

One of the most frustrating aspects of this project was when team members continuously missed deadlines for the project with no consideration for the others, leading to the project being delayed and ultimately, more work on my part to try to catch up on missed time. Although there were many bumps along the road, this project allowed me to further strengthen my ability to work in a team, while developing my experiences in project management. As the leader of this team, I have gained valuable experiences from an administrative standpoint, learning many lessons with time management of the team. In summary I was able to touch upon the many aspects of engineering: documentation, software, electrical, and mechanical.

6.1.4 SeungJun Lee

I am currently studying electronics engineering at SFU. My position at REXOS is CRO (Chief Risk Officer). My responsibilities as CRO includes risk management for our product and helping my teammates wherever needed in our project. In reality, I have done more work helping make the conceptual model and testing it. I would like to take this opportunity to thank my entire team member, especially Tony for his hard work. This semester was the hardest semester of my undergraduate study. Even though I had a heavy workload this semester, it was enjoyable with my team members. We created the group on the first day of class and started the project. Two of my main responsibilities were risk and safety management and help to any parts such as conceptual hardware design. Besides that, business and market competition research and data collection was done by me. In terms of technical skills, I also gained a huge amount of knowledge and improved my technical skills. Mainly, I assisted our team member Anton in building the finger conceptual model and with mounting the servo motor in our conceptual model. Unfortunately, I was not involved in the software part of this project since our team member did an amazing job on it. For this ENSC305W and 440W project course, I was able to use all of my engineering knowledge and technical skills. In my opinion, the two most important aspect for a successful project is teamwork, which includes frequent communication with our team members and documentation, especially functional and design specification. I would like to take this opportunity to thanks my all team members, Steve Whitmore and Andrew Rawicz and all other helpful people who assisted in achieve our project goals. Thus, I learned a lot of technical skills such as mechanical designing, prototype model testing, soldering, and troubleshooting with many interpersonal skills such as making decision, scheduling, and communications. My documentation skills also were improved. This capstone project gave me really good experiences to deal with technical project, and I had a great time working with our teammates.

6.1.5 Doug Tao

My time at Rexos Ltd has been a roller coaster of experiences from inception to end. We knew from the beginning that our project idea would be extremely difficult, and a large task to take on, but success would mean we accomplished something amazing. I believe for the most part, we accomplished what we set out to do, but not as gracefully as we would've liked.

Through this project and working with the mechanical side of the design, I've had to learn to use CAD tools, stress analysis tools, and material design tools. I've always had good mechanical skills, being proficient with power tools, and having had formal experience with mechanical design during my co-op made me the best choice to take on the mechanical design aspects. But there is a very large discrepancy between developing a concept from scratch, and designing around templates already set in place

Working in a team dynamic on a design project, you learn a lot about yourself and your team, but you learn even more about the skills you lack. You learn as a group to work to your strengths, and compensate for where people lack. Our group was formed in advanced as a group of friends, and being friends would make it easy to work together, at least that was the assumption. Sometimes being friends makes it harder to work together, you tend to give them more slack when things go wrong, and stay silent about things one normally wouldn't. And of course when there's friction, and there always is, everything is magnitudes worse. But the key

thing to remember is that we're friends first, partners second, and that a lot of times, disagreements come from the stress and fear of not finishing on time.

Working at Rexos Ltd. was definitely an eye opening experience. With group design projects, you live and die by your group. All the ups and downs are shared as one, and when things go wrong, all that matters is the job at hand. The important thing, is you finish the way you started, as a group. But they always say hindsight is 20/20.

7 Conclusion

The team at Rexos, through their hard work, was able to develop a conceptual model to showcase the idea behind our product. With more time and a tighter schedule, we believe we would be able to present a more refined revision of our product.

REXOS

Appendix A: Meeting Minutes

***Un-named* Inc.**

AGENDA

January 9, 2015

12:00 – 13:00

Mackenzie Café, SFU

Purpose of Meeting: To discuss possible project ideas and research requirements

Items for Discussion:

- Brainstorm project ideas
- Lay out plans of action to research aforementioned ideas to determine viability
- Come up with possible company names
- Develop a logo

REXOS

Un-named **Inc.**

MINUTES

January 9, 2015

12:00 – 13:00

Mackenzie Café, SFU

Present: Joshua Law, Jun Lee, Tony Lee, Doug Tao

Absent: Anton Khomutskiy (with regrets)

Purpose of Meeting: To discuss possible project ideas and research requirements

Minutes:

Joshua called the meeting to order at 12:00.

A. Approval of the agenda and minutes of the previous meeting

No previous minutes to approve, as this is the first meeting held.

B. Business Arising

None.

C. Project Ideas

Discussion:

Doug brought up the concept of an assisting device for hand rehabilitation of patients, with multiple control schemes (dip switches/neuro/paired devices). Video viewed "Wearable ExoSkeleton Hand".

Tony mentioned a mobile facial recognition device which contains a camera that would connect to a database and compare objects in the visual range to the database.

Another idea would be to use the exoskeleton idea in conjunction with the Oculus Rift to turn the two into a game. This will be used for training muscle sensation and muscle strength.

Action: Come up with at least one more project idea, and determine each's suitability.

D. Research

Discussion: For the rehabilitation device, need to research hardware specifics such as motor availability and suitability (weight, motor torque), prototyping boards (Arduino, imbedded), as well as medical specifics (average hand strength). For the facial recognition device, research commercially available facial recognition software and how the device would interface with databases.

Action: Check to see if anyone has already done what we want to do, as well as preliminary research of the project ideas.

E. Possible Company Names

Action: Tabulated until we decide on projects.

F. Logos

Action: Doug will contact an artist for logos after a company name is decided.

G. Next Meeting Date

The next meeting was tentatively arranged for January 16, 2015, 1200, in a quieter location.

H. Other Business

None.

Meeting was adjourned at 12:45.

REXOS

Un-named Inc.

AGENDA

January 16, 2015

12:00 – 13:00

Laboratory 1, SFU

Purpose of Meeting: To create a company, including things such as name, logo, and positions

Items for Discussion:

- Come up with a company name
- Develop a logo idea to bring to the artist
- Assign positions to team members

REXOS

Un-named Inc.

MINUTES

January 16, 2015

12:00 – 13:00

Laboratory 1, SFU

Present: Joshua Law, Jun Lee, Tony Lee, Doug Tao, Anton Khomutskiy

Absent: none

Purpose of Meeting: To create a company, including things such as name, logo, and positions

Minutes:

Joshua called the meeting to order at 12:00.

A. Approval of the agenda and minutes of the previous meeting

No previous minutes to approve, as this is the first meeting held.

B. Business Arising

None.

C. Company Name

Discussion: "Rexos", "Rexomanus", some other names that were already taken

D. Logo Design

Discussion: Has to be legible and artistic. Specifics: block letters, simple colour difference, no serifs.

Action: Doug will take "Rexos" to his artist contact with the above specifications.

E. Team Member Positions

Discussion: Tony will assume team leader responsibilities and primary spokesperson. Anton, as designated recipient of the ESSEF funding, will assume financial responsibilities.

Action: CEO – Tony, CFO – Anton, CMO – Seungjun, COO – Joshua, CDO – Doug

F. Next Meeting Date

The next meeting was arranged for January 27, 2015, 12:30, in the same location.

G. Other Business

Project approval by Prof. Rawicz required, will talk to him after this meeting.

Meeting was adjourned at 12:40.

REXOS

Rexos Ltd.

AGENDA

January 23, 2015

12:30 – 13:30

Laboratory 1, SFU

Purpose of Meeting: To discuss proposal details, finalize design and discuss parts sourcing.

Items for Discussion:

- Outline details for each section of the proposal document
- Choose which mechanism to design for the frame
- Decide which parts need to be ordered first in order to ensure efficient delivery

REXOS

Rexos Ltd.

MINUTES

January 23, 2015

12:30 – 13:30

Laboratory 1, SFU

Present: Joshua Law, Jun Lee, Tony Lee, Doug Tao

Absent: Anton Khomutskiy (with regrets)

Purpose of Meeting: To create a company, including things such as name, logo, and positions

Minutes:

Joshua called the meeting to order at 12:30.

A. Approval of the agenda and minutes of the previous meeting

Previous minutes were approved.

B. Business Arising

None.

C. Proposal Details

Discussion: Jun would like to handle the market research section. For market share, check Health Canada's statistics for people with hand injuries that could use the device.

Action: After the meeting is adjourned, we will collectively decide on what points have to be covered. Joshua will be doing the final editing.

D. Final Mechanism

Discussion: #1: spring loaded on top, motors attached to wire underside which draws the fingers closed. #2: wire on both sides, #3 rigid frame, #4 single motor with hard plate that push/pulls finger.

#1 and #2 might not allow full grip on the bottom, and reduced sensation if a frame is required.

Action: Still go with original idea #3, with #4 being alternative.

E. Parts Sourcing

Discussion: Of the parts we might need, the only online order parts are motors. To reduce the expense if we order the wrong parts, we'll break up the 5x order into 2x/3x. Other parts are locally available and can be picked up at a later date (including motor shield and board) after design is finalized.

Action: Anton will order the two linear motors on Monday.

F. Next Meeting Date

The next meeting was arranged for January 27, 2015, 12:30, in the same location.

Meeting was adjourned at 1:15.

REXOS

Rexos Ltd.

AGENDA

January 30, 2015

15:30 – 16:30

Skype

Purpose of Meeting: To discuss the prototyping method, assign roles, develop a specific timeline, and brainstorm a product name/designation.

Items for Discussion:

- Discuss what materials and procedure we want to use for the rough and refined prototypes
- Assign roles for the (rough) prototype development
- Develop a timeline for the tasks associated with the (rough) prototype
- Brainstorm a simple product name to use in the documentation

REXOS

Rexos Ltd.

MINUTES

January 30, 2015

15:30 – 16:30

Skype

Present: Joshua Law, Jun Lee, Tony Lee, Anton Khomutskiy

Absent: Doug Tao (with regrets)

Purpose of Meeting: To discuss the prototyping method, assign roles, develop a specific timeline, and brainstorm a product name/designation.

Minutes:

Tony called the meeting to order at 15:30.

A. Approval of the agenda and minutes of the previous meeting

Previous minutes were approved, disregarding the change in meeting time from 12:30 to 15:30 and location to Skype.

B. Business Arising

None.

C. Prototyping method

Discussion: Continue discussion of what design we will use. Originally we were going for the rigid body method. However, Anton suggested an alternate design using springs from this source: http://i.ytimg.com/vi/2eauUq2tl6I/hqdefault.jpg

http://ral.web.nitech.ac.jp/images/handexo.jpg

Discussion on viability of rigid frame method, how to design second joint. Problems with second joint design for finger.

Main gain is movement of first two joints of finger, stretch goal is the third joint.

Anton's design requires a flexible material, further discussion needed for material.

Additional concerns on motor stress and back drive.

Action: Test rigid frame using cardboard. Anton will look for scrap parts for his design.

D. Deadlines

Discussion: Decide on deadlines for project progress

Action: Rough prototype by feb 12
Design by Feb 16

E. Roles

Discussion: Decide on individual roles for the upcoming weeks

Action: **Tony/Josh –** find scrap to work on rigid frame (need pivots)

Anton – Technical artwork/design

Doug - functional specs

Jun – Research power requirements/batteries for arduino board and motor shield (motors are rated for 12v, 0.3A)

F. Product Name

Discussion: Discuss potential product names:

-Rexohand

-Rexopaw

-Rexofive

-Fiveflex

-Rexogrip

-Gripxo

-Grixo

-Grexo

Action: TBD at a later date

G. Next Meeting Date

The next meeting was arranged for February 2, 2015, 12:30, in lab 1.

Meeting was adjourned at 16:44.

REXOS

Rexos Ltd.

AGENDA

February 9, 2015

21:00 – 22:00

Skype

Purpose of Meeting: To touch base on project progress

Items for Discussion:

- Components found and their uses
- Mechanism design approach
- Product name

REXOS

Rexos Ltd.

MINUTES

February 9, 2015

21:00 – 22:00

Skype

Present: Joshua Law, Jun Lee, Tony Lee, Anton Khomutskiy, Doug Tao

Absent: none

Purpose of Meeting: To touch base on project progress

Minutes:

Tony called the meeting to order at 21:00.

A. Approval of the agenda and minutes of the previous meeting

Previous minutes were approved.

B. Business Arising

None.

C. Project Progress

Discussion: Doug has yet to submit a CAD model for peer review.
Action: Tony will be switching from mechanism design to work on the software.

C. Components

Discussion: Tony found switches at RP, but they were too large for our purposes

D. Mechanism Design

Action: Anton and Doug will get together to work on a mechanism and a mockup.

E. Product name

Action: A coin was flipped and the name decided on is "RexoGrip"

F. Next Meeting Date

The next meeting was arranged for February 11, 2015, 12:30, in lab 1.

Meeting was adjourned at 22:00.

REXOS

Rexos Ltd.

AGENDA

February 21, 2015

21:00 – 22:00

Skype

Purpose of Meeting: Decision to change or add the motors Doug found into the implemented design

Items for Discussion:

- Merits to using new motors and implications on current design
- Implications of using new motor in conjunction with old motors in regards to the motor shield and power supplies.

REXOS

Rexos Ltd.

MINUTES

February 21, 2015

21:00 – 22:00

Skype

Present: Joshua Law, Jun Lee, Tony Lee, Anton Khomutskiy, Doug Tao

Absent: none

Purpose of Meeting: Decision to change or add the motors Doug found into the implemented design

Minutes:

Doug called the meeting to order at 21:00.

A. Approval of the agenda and minutes of the previous meeting

Previous minutes were approved.

B. Business Arising

None.

C. Performance difference between new and old motors

Discussion: New motors are servo motors rated at 1N, much weaker than original motors

D. Power supply requirements

Discussion: New motors require 3.2V-4.2V and 4.8V-6V, would need a power supply separate from the one supplying the original stepper motors.

E. Decision

Decision tabulated pending testing of motors for appropriate strength.

F. Next Meeting Date

The next meeting was arranged for February 25, 2015, 12:30, in lab 1.

Meeting was adjourned at 22:00.

REXOS

Rexos Ltd.

AGENDA

February 25, 2015

12:30 - 13:30

Laboratory 1, SFU

Purpose of Meeting: To go over project progress, compare to timeline, and cover things that need to be presented during the oral progress report

Items for Discussion:

- Discuss plans moving forward after motor testing
- Oral report preparations

REXOS

Rexos Ltd.

MINUTES

February 25, 2015

12:30 – 13:30

Laboratory 1, SFU

Present: Joshua Law, Jun Lee, Tony Lee, Anton Khomutskiy, Doug Tao

Absent: none

Purpose of Meeting: To go over project progress, compare to timeline, and cover things that need to be presented during the oral progress report

Minutes:

Joshua called the meeting to order at 12:30.

A. Approval of the agenda and minutes of the previous meeting

Previous minutes were approved.

B. Business Arising

None.

C. Next Step

Discussion: Need to procure material to build the device. Possible materials include Velcro to fasten the device, and a test apparatus (stuffed glove?).

D. Oral Report

Action: Rehearse points after the meeting

E. Next Meeting Date

The next meeting was arranged for February 27, 2015, 12:30, in lab 1.

Meeting was adjourned at 13:30.

REXOS

Rexos Ltd.

AGENDA

March 2, 2015

12:30 – 13:30

Laboratory 1, SFU

Purpose of Meeting: To review CAD mockup to determine if it is ready for 3D printing

Items for Discussion:

- Review CAD mockup
- Determine suitability for submission
- Breakdown of tasks for the current week

REXOS

Rexos Ltd.

MINUTES

March 2, 2015

12:30 – 13:30

Laboratory 1, SFU

Present: Joshua Law, Jun Lee, Tony Lee, Anton Khomutskiy

Absent: Doug Tao (with regrets)

Purpose of Meeting: To review CAD mockup to determine if it is ready for 3D printing

Minutes:

Tony called the meeting to order at 12:30pm.

A. Approval of the agenda and minutes of the previous meeting

Previous minutes were approved.

B. Business Arising

None.

C. CAD Mockup

Discussion: Model requires revisions which include: enlarging inner volume, creating space for knuckles, and slanting the top shell to follow natural knuckle triangular shape

D. 3D Printing

Submission tabulated until revisions

E. Week's Task

Action: Anton will cut plexiglass to shape in preparation for assembly, which will begin Friday.

F. Next Meeting Date

The next meeting was arranged for March 6, 2015, 12:00, in Lab 1.

Meeting was adjourned at 13:30.

REXOS

Rexos Ltd.

AGENDA

March 11, 2015

12:30 - 13:30

Laboratory 1, SFU

Purpose of Meeting: Finalize mechanism and discuss conflict resolution

Items for Discussion:

- Synthesis of mechanisms A (straight link) and B (curved link)
- Attempt to resolve conflict before the meeting with Steve

REXOS

Rexos Ltd.

MINUTES

March 11, 2015

12:30 - 13:30

Lab 1

Present: Joshua Law, Jun Lee, Tony Lee, Anton Khomutskiy, Doug Tao

Absent: none

Purpose of Meeting: Finalize mechanism and discuss conflict resolution

Minutes:

Tony called the meeting to order at 12:30pm.

A. Approval of the agenda and minutes of the previous meeting

Previous minutes were approved.

B. Business Arising

C. Mechanism Design

Discussion: The best course of action would be to synthesize the two mechanisms.

Action: Go with mechanism B (curved link) when building the prototype, and re-evaluate as time allows.

D. Conflict Resolution

Discussion: Tony feels that the group is not equally contributing to documentation.

Action: Sections of the design specs were split between the group members.

E. Next Meeting Date

The next meeting was arranged for March 13, 2015, 9:00, in Lab 1.

Meeting was adjourned at 13:00.

REXOS

Rexos Ltd.

AGENDA

April 13, 2015

12:30 - 13:30

Laboratory 1, SFU

Purpose of Meeting: Demo preparation

Items for Discussion:

- Wrap up project demo model
- Segregation of parts for demo presentation
- Post-mortem part assignment

REXOS

Rexos Ltd.

MINUTES

April 13, 2015

12:30 - 13:30

Laboratory 1, SFU

Present: Joshua Law, Jun Lee, Tony Lee, Anton Khomutskiy, Doug Tao

Absent: none

Purpose of Meeting: Finalize mechanism and discuss conflict resolution

Minutes:

Tony called the meeting to order at 12:30pm.

A. Approval of the agenda and minutes of the previous meeting

Previous minutes were approved.

B. Business Arising

None.

C. Project remaining tasks

Discussion: Wrap up project demo model

Action:

D. Demo Presentation

Discussion: Segregation of parts for demo Friday

Action:

- Portfolio for each person -
  - Demo outline
  - Stroke statistics
  - Competition products/market
  - 3D drafts
  - Manufacturing materials

- Demo ordering
    - Intro (Tony)
    - Motivation (Doug)
    - Market (Jun)
    - Conceptual Design (Anton)
    - Software/Electronics (Tony)
    - Schedule/Financials (Josh)
    - Prototype Design/Future plans (Doug)
    - Questions
- Jun to do Competition/Market
- Anton to do Conceptual Design slides
- Doug to do prototype design slides
- Josh to do Scheduling/Financials
- Submit to Tony by Wednesday night

E. Post Mortem

Discussion: Assign parts for Post Mortem

Action:

- Tony will write post-mortem
- Everyone submit reflections to Tony
- Submit to Tony by Wednesday night

F. Next Meeting Date

The next meeting was arranged for Thursday, April 16, 12:30pm.

Meeting was adjourned at 1:30pm.

Appendix B: Expenditure Breakdown

Table 3 - Chronological Project Purchases

Date	Supplier	Item	Price (After tax)	Category
01-28-2015	Digikey	Portescape Stepper Motors	$ 203.00	*Motor*
01-30-2015	Lee's	Adafruit Motor Shield	$ 26.88	*Microcontroller*
		Arduino Uno	$ 36.96	*Microcontroller*
		USB Cable	$ 2.24	*Microcontroller*
02-02-2015	RP	Arduino Headers	$ 4.04	*Microcontroller*
02-10-2015	RP	Molex Connector	$ 9.86	*Microcontroller*
02-21-2015	Norburn	Motors + Misc	$ 87.01	*Motor*
02-26-2015	Norburn	Pushrod (Refund)	-$ 8.94	*Motor*
		HS 55 Servo (Refund)	-$ 15.66	*Motor*
		HS Nano Servo (Refund)	-$ 16.23	*Motor*
		HS 5085MG (x4)	$ 197.03	*Motor*
		1500 Battery Pack	$ 30.22	*Power*
		Ball links	$ 20.72	*Material*
		Misc	$ 1.56	*Material*
03-10-2015	Home Depot	PVC Pipe	$ 0.56	*Material*
		1/8 Screws	$ 3.33	*Material*
03-17-2015	RP	9V Clip	$ 5.00	*Power*
		9V Battery	$ 3.18	*Power*
		Rocker Switch	$ 3.51	*Power*
		Button Switches	$ 4.14	*Sensor*
	Home Depot	Plexiglas, Aluminium, Washers	$ 57.00	*Material*
03-18-2015	Home Depot	Nuts	$ 0.76	*Material*
		Plexiglas	$ 16.23	*Material*
		PVC Pipe	$ 1.68	*Material*
		Zip Ties	$ 2.34	*Material*
		Electrical Tape	$ 0.74	*Material*
03-20-2015	RP	Rocker Switch	$ 3.68	*Power*
		AA Battery Holder	$ 1.68	*Power*
		Spacers	$ 7.00	*Material*
03-23-2015	Home Depot	Super Glue	$ 4.47	*Material*
		Hinges	$ 2.44	*Material*
		Hot Glue Sticks	$ 4.13	*Material*
04-02-2015	SFU	3D Printing	$ 50.00	*3D Printing*
04-07-2015	Lee's	M3 Nuts	$ 1.12	*Material*
		M3 Screws	$ 3.36	*Material*
04-10-2015	Lee's	M3 Screws	$ 3.36	*Material*
		M3 Nuts	$ 1.12	*Material*
		Heat Shrink	$ 6.72	*Material*
04-13-2015	RP	Sticky Pads	$ 5.38	*Material*