A New Platform for Knee Surgery Patient Rehabilitation, Motivating Mirror: Providing an Interactive Experience to Knee Surgery Patients to Assist Them With a More Effective Rehabilitation.

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A New Platform for Knee Surgery Patient Rehabilitation, Motivating Mirror

Providing an interactive experience to knee surgery patients to assist them with a more effective rehabilitation.

By: Yu He

A Thesis submitted in partial fulfillment of the requirements for the degree of:
Master of Fine Arts in Visual Communication Design
School of Design
College of Imaging Arts & Science
Rochester Institute of Technology

Apr, 2018
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>04</td>
</tr>
<tr>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>Situation Analysis</td>
<td>07</td>
</tr>
<tr>
<td>Thesis Statement</td>
<td>11</td>
</tr>
<tr>
<td>Survey of Literature</td>
<td></td>
</tr>
<tr>
<td>Books</td>
<td>12</td>
</tr>
<tr>
<td>Articles &amp; Websites</td>
<td>14</td>
</tr>
<tr>
<td>Videos</td>
<td>18</td>
</tr>
<tr>
<td>Design Ideation</td>
<td></td>
</tr>
<tr>
<td>Design Implementation</td>
<td>19</td>
</tr>
<tr>
<td>Design Methodology</td>
<td>19</td>
</tr>
<tr>
<td>Design Overview</td>
<td>20</td>
</tr>
<tr>
<td>Visual Development</td>
<td></td>
</tr>
<tr>
<td>Visual Style</td>
<td>21</td>
</tr>
<tr>
<td>Logo Development</td>
<td>23</td>
</tr>
<tr>
<td>Interface Design</td>
<td>26</td>
</tr>
<tr>
<td>Video Shooting</td>
<td>29</td>
</tr>
<tr>
<td>Final Design</td>
<td></td>
</tr>
<tr>
<td>Logo Design</td>
<td>31</td>
</tr>
<tr>
<td>Interface Design</td>
<td>32</td>
</tr>
<tr>
<td>Video Design</td>
<td>44</td>
</tr>
<tr>
<td>MFA Thesis show</td>
<td>48</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation and Conclusion</td>
<td>50</td>
</tr>
<tr>
<td>Appendix</td>
<td></td>
</tr>
<tr>
<td>A: Imagine RIT Surveys</td>
<td>52</td>
</tr>
<tr>
<td>B: Thesis Proposal</td>
<td>69</td>
</tr>
<tr>
<td>Bibliography</td>
<td>107</td>
</tr>
</tbody>
</table>
ABSTRACT

There are many tools for knee injury patients to use for rehabilitation. Both Physical Therapists and Occupational Therapists work with patients on rehabilitation to help them recover, bring them back from illness or injury. For knee surgery patients, they will go through rehabilitation including CPM (Continuous passive movement) and exercises assigned by PT (Physical Therapists) to improve recovery.

CPM is a passive motion that a machine forces patients to do, and along with and after that, patients need to be active to do other exercises themselves. Lots of patients run into trouble when rehabbing. Some of them refuse to do the exercises because they have a negative attitude about this rehabilitation. Some of them think it’s troublesome to go to the gym do the rehab exercises; they just stay at home and wait until their leg recovers. Others are afraid of the rehabilitation. Whatever the reason, it turns out they won’t recover very well.

As part of this preliminary study, a survey was presented to patients who had knee injury and doctors who are expert in knee surgery. The patients were asked if they would find it beneficial and appealing to have a more effective experience while they taking rehab exercises. The general consensus was they would find useful as they could be more interested in rehab instead of forcing themselves go to a hospital. On the other side, doctors weren’t so sure about it because we don’t have anything similar on the market. Besides, this project wasn’t so fascinating since the rehab exercises are limited and repeat.

This project is trying to help patients help the patient to recover consciously, help them maintain their health level or to have the passion to explore ways to improve it, and help recover patients’ both physiological and psychological health.
The purpose of this design would be that users could increase flexibility while they have walking limitations, and encourage them with more effective rehabilitation.

**Keywords:**
Rehabilitation, Medical health, Exercises, Way finding, User Interface Design, Video prototype, Interactive

**Project Website:**
http://yuheheyu.com/thesis.html

**Video Prototype:**
https://vimeo.com/218472552
**Situation Analysis**

Knee surgery patients typically have exercises for rehab. There are many tools for people with a knee injury to use for rehabilitation. Physical Therapists and Occupational Therapists work with patients on rehabilitation to help them recover, bring them back from illness or injury. For knee surgery patients, they will go through rehabilitation including CPM (Continuous passive movement) and exercises assigned by PT (Physical Therapists) to improve recovery.

CPM is a passive motion that a machine forces patients to do, and along with and after that, patients need to be active to do other exercises themselves. Lots of patients run into trouble when rehabbing. Some of them refuse to do the exercises because they have a negative attitude about this rehabilitation. Some of them think it’s troublesome to go to the gym do the rehab exercises; they just stay at home and wait until their leg recovers. Others are afraid of the rehabilitation. Whatever the reason, it turns out they won’t recover very well.

To make knees recover better, patients needs to have both repetitive and single action. The rehab exercises are long-term, painful, and uninteresting. Based on the questionnaire survey for this project, lots of patients did not go through their rehab perfectly. When this happens, the benefits of rehabilitation are minimal.

Though there might be family members, doctors, and other professionals to encourage and persuade patients, the patients are not well motivated by their own efforts to recover, and the results will not be as good as what they and their families would like.
Nowadays there are a series of rehabilitation exercises for people who suffer from knee injury\(^1\). It usually takes 12 weeks\(^2\) for patients to go back to normal daily life and 16 weeks to regain full muscle strength and increase overall conditioning, but only if they follow the instruction from the PT and do rehabilitation well, and after 12 weeks, it’s still important to continue with exercises. While patients go through the rehabilitation, they have to follow the instructions on the equipment in the CPM stage, and have to follow doctors’ instructions to do exercises to help with recovery. However, the process that patients go through is rather boring and without passion. In addition, there are lots of patients who are suffering from both physiological and psychological trauma. Patients are unlikely to achieve perfect recovery when they have no power and passion to take part in rehabilitation. Some of them may even be too afraid of pain they need to suffer while exercising to get rehabilitation. As a focus area, people having knee surgery will be the main component of this thesis project.

To get more information from patients, one on-line questionnaire has been published and has gotten responses from doctors and patients. The main questions include:
- What’s the gender of the person injured?
- How old is the patient?
- How badly does this injury affect him/her?
- Did patient go through the whole rehabilitation?
- If yes, what’s the process for the rehab? If not, why patient didn’t go to rehab?
- What are the commonly used rehab exercises?
- For rehab, will it be different rehab exercises between knee replacement patients and knee surgery patients? And is there any difference between different generations and different occupations?


Situation Analysis

- If there is any interactive experience for patients to motivate him/her to do the rehab exercises, what kind of experiences do you think the patients might be interested in?
- If there are some entertainment activities happening while patients are exercising, will these activities diffuse patients’ attention and energies, and have bad influences for the rehab? Or will it be helpful for patients to not pay attention to painful exercises?

Based on the responses this questionnaire got, the exercises for rehab are determined by how badly he/she hurts and how long since the surgery for a surgical knee or replaced knee. Most respondents (84.3%) said physical feedback would be a great way to show the patients overall condition, because it can tell them realistically how far along they have come for their recovery. This can give patients a realistic time period of how their progress is doing and roughly how long it will take for their complete rehab of the surgical knee or replaced knee. In addition, 72.9% of participants said digital interaction would be optimal too because at the same time, it will represent the knee of the patient and it can show them how the overall healing process works and what the body is going through to recover knee function. And 78.2% of respondents feel if there are entertainment activities, it will motivate the patients if they can be more interactive with their recovery in rehab. However, it also comes down to price and how much the patient can afford for recovery as opposed to physical feedback with PT covered by insurance or so.

Usually patients get really tired or frustrated about how long the healing process takes. Nevertheless, it is important that patients keep up with their rehab, because it will help them recover following surgeries. If a good distracting tool were provided so that patients would not be so worried about the pain, they could focus on the exercises in a fun and engaging manner. Sometimes we may perceive a lot of pain, but at the same time, we can trick our brain with imagery and distraction to not think too much about the pain.
Situation Analysis

The goal of this thesis project is to provide a solution that people who need rehab for knee surgery may use to willingly take part in rehabilitation and will improve their rehab quality. According to the questionnaire and research, there are different kinds of knee surgeries such as Arthroscopy: Trimming a Torn Meniscus, Meniscus Repair, ACL Reconstruction, Microfracture, etc. For rehab, patients would do a lot of range of motion exercises to get the knee muscles working again and to slowly progress on the movement of the knees to walking around, extension, flexing, and going from a passive range of motion to an active range of motion. This project is focused on adults who are younger than 60 years old because the older generation might need knee replacement which is a different section from knee surgery.

By using AR devices and having an interesting interactive way with patients - such as clearly showing muscle rebuilding, and adding achievements to exercises - patients will be more interested in rehab and improve their recovery. A variety of interactive tools will be used to help develop a comprehensive design for users.

There is a need for a design like this since there is nothing else similar for patients on the market. There are traditional devices for people who had knee surgery that do not use digital interaction. There is AR for doctors to help with surgery, but not for rehab. Most of the patients are not paying attention to get effective rehabilitation. The majority don’t take rehab as their first choice because they need to go to a specific place to exercise and the process has no passion, instead they just leave the hurt knee alone.

This product will contribute to fields of both design and health. Through user interaction, user experience, motion graphics, interactivity and augmented reality, patients can have a good experience while rehabbing. Motion graphics will be used to help with fine motor skills and augmented reality will be used for the study of human movement. Since this project is focused on the interface part, motion graphics will also help with the interface design.
Motivating Mirror:

This thesis project explores interaction, user interface, and experience design for patients taking rehabilitation after knee surgery. By using this platform, it is intended that patients will be inspired to take a more active role in their own rehabilitation. The project aims to help them maintain their health level or to have the passion to explore ways to improve it, and recover their physiological and psychological health.

The concept uses an Augmented Reality (AR) design with an interactive display interface, which may be in common use within several years. It is intended to help patients have a better user experience and be more active during their rehab session. Users may interact with the device using visual sensor, voice order, etc.

This project explores interactive designs for the interface to this AR device. Motion graphics provide video prototypes to help viewers better understand this platform.

Although there is a device on the market that can help doctors operate better by seeing through a patients' body and getting detailed information of bones and muscle in real time, there is nothing similar for knee surgery patients. The technology of this project is likely achievable in several years and would be helpful to patients willing to do rehabilitation.

Thesis Statement

Providing an interactive experience to knee surgery patients to assist them with a more effective rehabilitation
**Books**

  This book discusses web usability and how designers need to be aware of what their audience wants and needs. Krug focuses on how designers need to keep in mind what they are designing and how they are implementing the content, and how to make it the most effective for their audience.

  Don Norman discusses the concept of usability in design. Bad design is prevalent and the need for thoughtful design with the user in mind is a necessity. Norman points out why some designs are successful and how the designs and the design decisions affect their users.

  This book lists author’s understanding and summary about elements of the user experience. He have five Plane for user experience: 1) The surface plane 2) The skeleton plane 3) The structure plane define the placement of pages, using process and navigational elements 4) The scope plane 5) The strategy plane. The author’s purpose appear to be explain user experience in his own eyes and give us a simplify understanding with user experience. This book is more focus on basic understanding than others and can give us a clearer view about user experience. It’s really useful as a guide to introduce user experience.

  This book is talking about how to design a product and help people to interactive with it. This is a classic book about interaction design. It has the basic interaction design knowledge we need to use and helpful with our research and design.
**SURVEY OF LITERATURE**

**Books**

**Norman, Donald A. Emotional Design: Why We Love (or Hate) Everyday Things. New York: Basic Books, 2004.**

In this book the author explains the importance of emotion in design based on three different dimensions: visceral, behavioral level, reflective level. Emotion in many cases has great impact of our decisions. This book gives us a different perspective to learn how to make better interaction design, The author came up with examples and science understanding about exploration.


This is a book that UX people must read. It helps people get an step by step idea about how to test the usability for your product. This book provides an knowledge about what kind of products are users want to have. This book helps designers to consider limit usability and decide when will they need to do user test.


This book described complicated problems encountered in knees surgery, wrote by the authority of the field of reconstruction of the knee. Readers can learn from their own and others’ experience to improve their technology. This book focus on technique that experts prefer to use, and want readers to know that mastering knees surgery and managing not only requires a deep understanding of the scientific basis of the surgery, but also the ability to know the clinical decision and surgical subtle discrimination.


This book covers all the important diseases and injuries of the knee joints, for each part of the joint it has a comprehensive description from the normal image
to the disease. Clinical evaluation of imaging is based on detailed diagnosis, disease stage and treatment results from each case data.

**Articles & Websites**


This article discussed if physical therapy helpful for patients after arthroscopic partial meniscectomy. The author did a test with patients who were supervised physical therapy and patients who with a home program to evaluate the effectiveness.


[https://doi.org/10.1177/0363546509359763](https://doi.org/10.1177/0363546509359763)

This article is about comparing a home-based rehabilitation with a standard physical therapy program. It is a long run analysis about the difference between a patient who did home-based rehab and a patient who did a clinically supervised rehab.


This article claimed the rehab exercises after knee surgery need to focus on improve voluntary activation. And physical therapy should make sure to increase the muscle strength.

This article is a long term study about does the material patients used matter for patients’ recover. And for a reliable result, this study keep tracked some case in 6 years.


This article is about a study about does semitendinosus tendon graft help patients recover. For a better result, there was a two years case study and finally get a reliable data.


This article wanted to determine the difference of different training for knee surgery patients. And found out there are some certain training are good for patients. This article suggested that patients need more effective training.


This article is trying to find a different way to help patients who had ACL reconstruction. In this test, they asked patients immediate have weight bearing one day after surgery, then they had a long term follow up and get information.


This article studied the effect of two different autogenous patellar tendon graft for patients’ recover speed, and this is a follow up study.
Articles & Websites

This article performed a prospective randomized clinical trial in which two different occupational rating systems were tested on 50 patients.

This article described a new model for ACL rehabilitation, the Knee Symmetry Model. This article introduced this model and how this model been used. Then described details involved in the development and implementation of this rehabilitation program. And they have some data analysis for this model to clear this model is helpful for ACL rehab.

This study is about study the difference between patients who get standard rehabilitation program and patients who had home based rehab program. To get accurate data. 40 patients was participate in this study, they were randomly put in two rehab programs.

This is a website focuses on body’s musculoskeletal system injuries, they get lots of reliable information including videos and articles about the rehabilitation.

This website is talking about AR help doctor with surgery at the first time.

This website is about 10 interactive ways to redefine human-computer interaction. To give some new idea about different platform for interaction.

A study of future computer interaction and talk about the deficiencies in the use of computer interaction and top three direction for computer interaction.

http://www.cn-healthcare.com/article/20160807/content-484783.html
An article about how AR will influence medical treatment and shared some medical cases that used AR technique.

http://m.yigoonet.com/index.php?&a=show&catid=224&typeid=&id=32220
AR technique in Rio 2016 Summer Olympics and currently the application of AR technology in medical field.

This website have six cases in medical treatment field that including AR technique.
<table>
<thead>
<tr>
<th>Videos</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MindovermatterSC. “Knee Exercises - Strengthening Exercise after Knee Surgery 1/8.” YouTube. YouTube, 07 Feb. 2012. Web. 17 Oct. 2016. <a href="https://www.youtube.com/watch?v=N1si4chpz7E">https://www.youtube.com/watch?v=N1si4chpz7E</a></td>
<td>This video is about a series of knee rehab exercises. And talk about not only strengthening exercises is important, but the perfect movement for the exercises.</td>
</tr>
<tr>
<td>PhysioFitnessAust. “ACL Reconstruction: Rehab Program Essentials Seminar IFeat. Tim Keeley I FILEX.” YouTube. YouTube, 21 Aug. 2011. Web. 04 Oct. 2016.<a href="https://www.youtube.com/watch?v=Yp4eYFal0-g">https://www.youtube.com/watch?v=Yp4eYFal0-g</a></td>
<td>This video described what is the most important thing for patients from one patient’s opinion. And showing what’s the best way to have better outcome.</td>
</tr>
<tr>
<td>Matthew Boes M.D. “Best ACL Exercises</td>
<td>How to Recover From ACL Reconstruction Surgery</td>
</tr>
</tbody>
</table>
**Design Ideation**

**Design Implementation**

To have a clear visual enjoyment for this interactive experience, a perspicuous, effective video prototype will be produced, along with a series of interactive interface design for user and motion graphic design for attractive visual feedback. The plan is to unify the results from research and the conclusions I came up into an interactive design that will be helpful for target audience. With the video prototype production, I will also have social networking sites and personal website to help me share this platform and get feedback.

**Design Methodology**

The primary objective of the project is to design an interface for an interaction device for people doing rehab after knee surgery. A demonstration of this interactive experience is in the form of an animated video, displaying its details and capabilities. To create this demo requires learning about database management, information graphics, user interaction, user experience, motion graphics, interactivity and augmented reality, and related interaction/interface design.

Through comprehensive planning, this project would achieve useful and beneficial investigation method provides a useful interactive experience that knee surgery patients will use and enjoy.
Design Overview

Visual style is one of the most important elements of the whole design. The objective is to have a visual identity system that has good visibility, attractive and easy to identify.

As the most direct and intuitive communication visual performance with users, interface Design is the basic design parts for this interactive experience. The purpose for the interface design is to help user quickly become familiar with this new interactive experience and at the same time have a comfortable interactive flow.

To provide a better demonstration for how the interactive experience works, it was necessary to create a video introduction to show the process and interactive layout. Video Shooting was the first stage to start.

After all steps are done, the last stage is the final design. This thesis project has an interface design and video prototype, and it will be seen by many individuals. Users will give feedback through various ways.
Visual Style

Goals:
The main purpose of the visual style of the project is to have a good interactive experience. This will help users achieve a better understanding for this project and get familiar with it quickly, and it will help them to have a complete, comfortable, meaningful experience.

Attributes:
Succinct
Clean
Organize
Interactivity
Guidance

Brainstorming:
**Visual Style**

**Name:**

Motivating Mirror

The reason why I chose Motivating Mirror as the name of this interactive platform is not only that it includes the main medium of expression of the project, but also expresses the functionality of the project. As a title, it comes straight to the point, it is highly readable and intense.

**Color Exploration:**

Primary:

- #D5DFE1
- #D7E4F4
- #7292A9
- #2E5771

Secondary:

- #EFFFD8
- #F9F18C
- #FE0000
VISUAL DEVELOPMENT

Logo Development

Along with the name of this project, the letter "M" will be the main shape of the logo. After having the main element, I came up with several different concepts to match the product position. In order to have a better visual effect, I added a pattern related to skeletal structure to make the logo more consistent with the product’s image.

Logo Inspiration:
Letter M

Restructuring

Skeletal structure
VISUAL DEVELOPMENT

Logo Development

Sketches

Motivating Mirror

Graphics Development
VISUAL DEVELOPMENT

Logo Development

Color study

[Images of logo development and color study]
Interface Design

**Goals:**

This user interface is designed for patients who need to perform rehabilitation exercises for knee surgery, it is designed to provide a more effective and attractive choice for patients.

In order to meet the needs of patients, the interface design is simple, readable, relaxing and educational.

**Visual Development:**

**Sketches:**

Start page: Choose user:
Interface Design

Sketches:

Homepage:

Exercise page:
Interface Design

Sketches:

Exercise page:

1. **Strengthening**
   - Nunnibet quadriceps
   - Gluteal quad standing
   - Calf raise
   - Hip abduction
   - Hip extensions
   - Hamstring curls/straight leg
   - Overhead squats
   - Lunges
   - Leg press
   - Plié squats
   - Binge exercises

2. **Proprioception**
   - Basic balance - Step 1
   - Basic balance - Step 2
   - Basic balance - Step 3

3. **Functional and dynamic skills**
   - Resistance band lunge
   - Heel drop exercise
   - Step bear
   - Box jumps
   - Sports specific aisle
Interface Design

Sketches:

Finish exercise page:

Reward page:
VISUAL DEVELOPMENT

Video shooting

Goals:
The purpose of video shooting is to help the interface design visualized. To do that, the person in the video will interact with mirrors that do not actually have the interface design on it, then to match the interface motion path with the video.

Equipment:
NIKON D810

Process:
Scene:
Location: RIT dance classroom
VISUAL DEVELOPMENT

Video shooting

Video clips:
Logo Design

Software:
Adobe Illustrator CC

Typeface:
Helvetica Neue Light

AaBbCcDdEe0123,./!

Color choice:

Final Design:
## Interface Design

<table>
<thead>
<tr>
<th>Software</th>
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<tbody>
<tr>
<td>Adobe Illustrator CC</td>
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<tr>
<td>Adobe Experience Design CC</td>
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</tbody>
</table>

## Typeface

- **Helvetica Neue Light**
  - AaBbCcDdEe0123,./!

- **Helvetica Neue Regular**
  - AaBbCcDdEe0123,./!

- **Helvetica Neue Medium**
  - AaBbCcDdEe0123,./!
Final Design

Stand by | Choose users:
Interface Design

For New Users:

Hello, Joseph!
To secure your account please set your password:
Interface Design

For New Users:
Interface Design

For Returning Users:

Hello, Mary!

Enter your password to login:

Login
Back
Interface Design

For Returning Users:
Interface Design

Exercise part:
Interface Design

Exercise part:
Interface Design

Message part:

![Message part image]
Interface Design

Redeem part:
Interface Design

Redeem part:
<table>
<thead>
<tr>
<th>Video Design</th>
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<tbody>
<tr>
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</table>
Final Design:

Video link: https://vimeo.com/218472552

Motivating Mirror

An interactive experience to knee surgery patients to assist them with a more effective rehabilitation.
Video Design

Final Design:

Video link: https://vimeo.com/218472552
Video Design Final Design:

Video link: https://vimeo.com/218472552
FINAL DESIGN

MFA Thesis Show  Location:
James Booth Hall 07a
Room 1305
Rochester Institute of Technology

Questionnaire:

Motivating Mirror

Age
☐ 20-35  ☐ 35-45  ☐ 45-55  ☐ Other

Gender
☐ Male  ☐ Female

1. Have you been through knee surgery and want to know the rehab exercises?
☐ Yes  ☐ No

2. What do you think about these rehab exercises?
Boring  Excited
1 2 3 4 5 6 7 8 9 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
Not interested  Interested
1 2 3 4 5 6 7 8 9 10

Feel free to go through the digital prototype video and play with the interface

4. How likely is it that you would recommend this interface to a friend or a company?
Not at all likely  Extremely likely
1 2 3 4 5 6 7 8 9 10

5. Overall, how would you rate this interface?
☐ Excellent  ☐ Very good  ☐ Good  ☐ Fair  ☐ Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?
☐ Extremely helpful  ☐ Very helpful  ☐ Somewhat helpful  ☐ Not so helpful  ☐ Not at all helpful

7. How satisfied are you with the reliability of this interface?
☐ Extremely satisfied  ☐ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

8. How satisfied are you with the look and feel of this interface?
☐ Extremely satisfied  ☐ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?
☐ Extremely satisfied  ☐ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):
Motivating Mirror
May 10, 2017

An interactive experience to knee surgery patients to assist them with a more effective rehabilitation.

Yu He
Visual Communication Design
UI/UX design | Motion UI
Being aware of the needs of a particular group of people, it is a very challenging task to propose a technical solution aimed at specific needs. I was inspired by the observation of daily life and the experiences of people around me. The completion of rehabilitation therapy and the insufficiency of the final results of rehabilitation is a practical problem that is worth serious study. The main problem is the lack of mobility and the lack of good rehabilitation experience. Although patients understand that rehabilitation is the only way to fully recover after surgery, it is a question worth pondering that the final outcome of tradition rehabilitation is not ideal.

The goal of this project was to motivate knee surgery patients to have a better interactive experience while they are doing rehab exercises. In order to achieve this goal, I designed an AR interactive experience, hoping to encourage and attract patients to actively participate in the rehabilitation exercise, and to help users get good rehabilitation results.

The project involves the comprehensive research and analysis of the conception, strategic planning, program evaluation and implementation. The final design, along with the user’s curiosity, should hopefully be able to attract users to actively participate in rehabilitation. In addition, the project, with its innovative interface, provides a new way of thinking, a different platform.

It is delightful that audiences reacted positively. It is not only the target audience that is appreciative of this design, but it also has positive support from the relatives and friends of the target audience. The questionnaire I did during Imagine RIT revealed that participants were interested in the project and thought it was a design worthy of real development. In addition, the video prototype is a more intuitive way to express the purpose of this project to the audience. They are looking forward to seeing the project visualized.
Through this thesis project, I gained new design experience of Augmented Reality, and gained knowledge in related fields, and broadened my horizons. This is also a design project that is completely different from the previous experience I have. To understand the user needs and to design suitable interactive interface based on users’ needs will be my continuous goal in the future.
A: Imagine RIT Surveys

Motivating Mirror

<table>
<thead>
<tr>
<th>Age</th>
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<th>☐ 35-45</th>
<th>☐ 45-55</th>
<th>☐ Other</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>☑ Male</th>
<th>☐ Female</th>
</tr>
</thead>
</table>

1. Have you been through knee surgery and get to know the rehab exercises?  
☐ Yes ☑ No

2. What do you think about these rehab exercises?  
Boring Excited  
1 2 3 4 5 6 7 8 9 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?  
Not interested Interested  
1 2 3 4 5 6 7 8 9 10

Feel free to go through the digital prototype video and play with the interface

4. How likely is it that you would recommend this interface to a friend or a company?  
Not at all likely Extremely likely  
1 2 3 4 5 6 7 8 9 10

5. Overall, how would you rate this interface?  
☐ Excellent ☑ Very good ☐ Good ☐ Fair ☐ Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?  
☑ Extremely helpful ☐ Very helpful ☐ Somewhat helpful ☐ Not so helpful ☐ Not at all helpful

7. How satisfied are you with the reliability of this interface?  
☐ Extremely satisfied ☑ Very satisfied ☐ Somewhat satisfied ☐ Not so satisfied ☐ Not at all satisfied

8. How satisfied are you with the look and feel of this interface?  
☑ Extremely satisfied ☑ Very satisfied ☐ Somewhat satisfied ☐ Not so satisfied ☐ Not at all satisfied

9. How satisfied are you with the interface's readability and design of this interface?  
☑ Extremely satisfied ☑ Very satisfied ☐ Somewhat satisfied ☐ Not so satisfied ☐ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):

   Very cool concept Can't wait for the tech to catch up
Motivating Mirror

Age
☐ 25-35  ☐ 35-45  ☑ 45-55  ☐ Other

Gender
☐ Male  ☑ Female

1. Have you been through knee surgery and get to know the rehab exercises?
☐ Yes  ☑ No

2. What do you think about these rehab exercises?
Boring  Excited
☐ 1 2 3 4 5 6 7 8 9 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
Not interested  Interested
☐ 1 2 3 4 5 6 7 8 9 10

Feel free to go through the digital prototype video and play with the interface.

4. How likely is it that you would recommend this interface to a friend or a company?
Not at all likely  Extremely likely
☐ 1 2 3 4 5 6 7 8 9 10

5. Overall, how would you rate this interface?
☑ Excellent  ☐ Very good  ☐ Good  ☐ Fair  ☐ Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?
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☑ Extremely satisfied  ☐ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?
☑ Extremely satisfied  ☐ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):

   Very creative idea!
APPENDIX

A: Imagine RIT Surveys

Motivating Mirror

Age
☐ 20-35 ☐ 35-45 ☐ 45-55 ☑ Other

Gender
☑ Male ☐ Female

1. Have you been through knee surgery and get to know the rehab exercises?
☐ Yes ☑ No

2. What do you think about these rehab exercises?
Boring Excited
1 2 3 4 5 6 7 8 9 ☑

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
Not interested Interested
1 2 3 4 5 6 7 8 9 ☑

Feel free to go through the digital prototype video and play with the interface.

4. How likely is it that you would recommend this interface to a friend or a company?
Not at all likely Extremely likely
1 2 3 4 5 6 7 8 9 ☑

5. Overall, how would you rate this interface?
☑ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?
☑ Extremely helpful ☐ Very helpful ☐ Somewhat helpful ☐ Not so helpful ☐ Not at all helpful

7. How satisfied are you with the reliability of this interface?
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☑ Extremely satisfied ☐ Very satisfied ☐ Somewhat satisfied ☐ Not so satisfied ☐ Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?
☑ Extremely satisfied ☐ Very satisfied ☐ Somewhat satisfied ☐ Not so satisfied ☐ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):

Keep up the good work.
A: Imagine RIT Surveys

Motivating Mirror

Age
☑️ 20-35  □ 35-45  □ 45-55  □ Other

Gender
□ Male  ☑️ Female

1. Have you been through knee surgery and get to know the rehab exercises?
□ Yes  ☐ No

2. What do you think about these rehab exercises?
Boring  Excited
1 2 3 4 5 6 7 8 9 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
Not Interested  Interested
1 2 3 4 5 6 7 8 9 10

Feel free to go through the digital prototype video and play with the interface.

4. How likely is it that you would recommend this interface to a friend or a company?
Not at all likely  Extremely likely
1 2 3 4 5 6 ☑️ 7 8 9 10

5. Overall, how would you rate this interface?
□ Excellent  □ Very good  ☑️ Good  □ Fair  □ Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?
□ Extremely helpful  ☐ Very helpful  □ Somewhat helpful  □ Not so helpful  □ Not at all helpful

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8. How satisfied are you with the look and feel of this interface?
□ Extremely satisfied  ☐ Very satisfied  □ Somewhat satisfied  □ Not so satisfied  □ Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?
□ Extremely satisfied  ☐ Very satisfied  □ Somewhat satisfied  □ Not so satisfied  □ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):
A: Imagine RIT Surveys

Motivating Mirror

Age
- [ ] 20-35
- [ ] 35-45
- [ ] 45-55
- [ ] Other

Gender
- [ ] Male
- [✓] Female

1. Have you been through knee surgery and get to know the rehab exercises?
- [ ] Yes
- [✓] No

2. What do you think about these rehab exercises?

<table>
<thead>
<tr>
<th>Boring</th>
<th>Excited</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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<td>3</td>
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<td>7</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?

<table>
<thead>
<tr>
<th>Not interested</th>
<th>Interested</th>
</tr>
</thead>
<tbody>
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<tr>
<td>3</td>
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<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

Feel free to go through the digital prototype video and play with the interface.

4. How likely is it that you would recommend this interface to a friend or a company?

<table>
<thead>
<tr>
<th>Not at all likely</th>
<th>Extremely likely</th>
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<tr>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

5. Overall, how would you rate this interface?

- [ ] Excellent
- [✓] Very good
- [ ] Good
- [ ] Fair
- [ ] Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?

- [ ] Extremely helpful
- [✓] Very helpful
- [ ] Somewhat helpful
- [ ] Not helpful
- [ ] Not at all helpful

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- [✓] Very satisfied
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- [ ] Not satisfied
- [ ] Not at all satisfied

8. How satisfied are you with the look and feel of this interface?

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- [✓] Very satisfied
- [ ] Somewhat satisfied
- [ ] Not satisfied
- [ ] Not at all satisfied

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- [ ] Extremely satisfied
- [✓] Very satisfied
- [ ] Somewhat satisfied
- [ ] Not satisfied
- [ ] Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):
A: Imagine RIT Surveys

Motivating Mirror

Age
☐ 20-35 ☐ 35-45 ☐ 45-55 ☐ Other

Gender
☐ Male ☑ Female

1. Have you been through knee surgery and get to know the rehab exercises?
☐ Yes ☑ No

2. What do you think about these rehab exercises?
Boring ☐ 1 2 3 4 5 6 7 8 9 10
Excited

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
Not interested ☐ 1 2 3 4 5 6 7 8 9 10
Interested

Feel free to go through the digital prototype video and play with the interface.

4. How likely is it that you would recommend this interface to a friend or a company?
Not at all likely ☐ 1 2 3 4 5 6 7 8 9 10
Extremely likely

5. Overall, how would you rate this interface?
☑ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

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10. Comment (if there's no enough space, feel free to write it on the back):

__________________________________________________________

__________________________________________________________
A: Imagine RIT Surveys

Motivating Mirror

Age
☑ 20-35    ☐ 35-45    ☐ 45-55    ☐ Other

Gender
☐ Male    ☑ Female

1. Have you been through knee surgery and get to know the rehab exercises?
☐ Yes    ☐ No

2. What do you think about these rehab exercises?
Boring    Excited
☐ 1    ☐ 2    ☐ 3    ☐ 4    ☐ 5    ☐ 6    ☐ 7    ☐ 8    ☐ 9    ☐ 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
Not interested    Interested
☐ 1    ☐ 2    ☐ 3    ☐ 4    ☐ 5    ☐ 6    ☐ 7    ☐ 8    ☐ 9    ☐ 10

Feel free to go through the digital prototype video and play with the interface

4. How likely is it that you would recommend this interface to a friend or a company?
Not at all likely    Extremely likely
☐ 1    ☐ 2    ☐ 3    ☐ 4    ☐ 5    ☐ 6    ☐ 7    ☐ 8    ☐ 9    ☐ 10

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10. Comment (if there's no enough space, feel free to write it on the back):
A: Imagine RIT Surveys

Motivating Mirror

Age

☐ 25-35  ☐ 35-45  ☐ 45-55  ☐ Other

Gender

☐ Male  ☑ Female

1. Have you been through knee surgery and get to know the rehab exercises?

☐ Yes  ☑ No

2. What do you think about these rehab exercises?

Boring  Excited

1 2 3 4 5 6 7 8 9 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?

Not interested  Interested

1 2 3 4 5 6 7 8 9 10

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Not at all likely  Extremely likely

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10. Comment (if there's no enough space, feel free to write it on the back):
A: Imagine RIT Surveys

Motivating Mirror

Age
☑ 20-35    ☐ 35-45    ☐ 45-55    ☐ Other

Gender
☐ Male    ☑ Female

1. Have you been through knee surgery and get to know the rehab exercises?
☐ Yes    ☑ No

2. What do you think about these rehab exercises?
Boring
□ 1    □ 2    □ 3    □ 4    □ 5    □ 6    □ 7    □ 8    □ 9    □ 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
Not interested
□ 1    □ 2    □ 3    □ 4    □ 5    □ 6    □ 7    □ 8    □ 9    □ 10

Feel free to go through the digital prototype video and play with the interface

4. How likely is it that you would recommend this interface to a friend or a company?
Not at all likely
□ 1    □ 2    □ 3    □ 4    □ 5    □ 6    □ 7    □ 8    □ 9    □ 10

5. Overall, how would you rate this interface?
☑ Excellent    ☐ Very good    ☐ Good    ☐ Fair    ☐ Poor

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☐ Extremely helpful    ☑ Very helpful    ☐ Somewhat helpful    ☐ Not so helpful    ☐ Not at all helpful

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☐ Extremely satisfied    ☑ Very satisfied    ☐ Somewhat satisfied    ☐ Not satisfied    ☐ Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?
☐ Extremely satisfied    ☑ Very satisfied    ☐ Somewhat satisfied    ☐ Not satisfied    ☐ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):
A: Imagine RIT Surveys

Motivating Mirror

<table>
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<td>Other</td>
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<td>▪</td>
<td>□</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gender

▪ Male       □ Female

1. Have you been through knee surgery and get to know the rehab exercises?
   ▪ Yes        □ No

2. What do you think about these rehab exercises?
   Boring          Excited
   ![Rating Scale](1 2 3 4 5 6 7 8 9 10)

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
   Not interested        Interested
   ![Rating Scale](1 2 3 4 5 6 7 8 9 10)

Feel free to go through the digital prototype video and play with the interface

4. How likely is it that you would recommend this interface to a friend or a company?
   Not at all likely        Extremely likely
   ![Rating Scale](1 2 3 4 5 6 7 8 9 10)

5. Overall, how would you rate this interface?
   ▪ Excellent        □ Very good        □ Good        □ Fair        □ Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?
   □ Extremely helpful        ▪ Very helpful        □ Somewhat helpful        □ Not so helpful        □ Not at all helpful

7. How satisfied are you with the reliability of this interface?
   □ Extremely satisfied        ▪ Very satisfied        □ Somewhat satisfied        □ Not satisfied        □ Not at all satisfied

8. How satisfied are you with the look and feel of this interface?
   ▪ Extremely satisfied        □ Very satisfied        □ Somewhat satisfied        □ Not satisfied        □ Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?
   □ Extremely satisfied        ▪ Very satisfied        □ Somewhat satisfied        □ Not satisfied        □ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):
A: Imagine RIT Surveys

**Motivating Mirror**

1. Have you been through knee surgery and get to know the rehab exercises?
   - Yes
   - No

2. What do you think about these rehab exercises?
   - Boring
   - Excited

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
   - Not interested
   - Interested

Feel free to go through the digital prototype video and play with the interface.

4. How likely is it that you would recommend this interface to a friend or a company?
   - Not at all likely
   - Extremely likely

5. Overall, how would you rate this interface?
   - Excellent
   - Very good
   - Good
   - Fair
   - Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?
   - Extremely helpful
   - Very helpful
   - Somewhat helpful
   - Not helpful
   - Not at all helpful

7. How satisfied are you with the reliability of this interface?
   - Extremely satisfied
   - Very satisfied
   - Somewhat satisfied
   - Not satisfied
   - Not at all satisfied

8. How satisfied are you with the look and feel of this interface?
   - Extremely satisfied
   - Very satisfied
   - Somewhat satisfied
   - Not satisfied
   - Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?
   - Extremely satisfied
   - Very satisfied
   - Somewhat satisfied
   - Not satisfied
   - Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):

   *I want one, too!!!*
A: Imagine RIT Surveys

Motivating Mirror

Age
☐ 20-35  ☒ 35-45  ☐ 45-55  ☐ Other

Gender
☐ Male  ☒ Female

1. Have you been through knee surgery and get to know the rehab exercises?
☐ Yes  ☒ No

2. What do you think about these rehab exercises?
Boring  Excited
1 2 3 4 5 6 7 8 9 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
Not interested  Interested
1 2 3 4 5 6 7 8 9 10

Feel free to go through the digital prototype video and play with the interface.

4. How likely is it that you would recommend this interface to a friend or a company?
Not at all likely  Extremely likely
1 2 3 4 5 6 7 8 9 10

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☐ Extremely satisfied  ☒ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?
☑ Extremely satisfied  ☐ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):

__________________________________________________________
## A: Imagine RIT Surveys

### Motivating Mirror

**Age**
- [ ] 20-35
- [ ] 35-45
- [ ] 45-55
- [x] Other

**Gender**
- [x] Male
- [ ] Female

1. Have you been through knee surgery and get to know the rehab exercises?
   - [ ] Yes
   - [x] No

2. What do you think about these rehab exercises?
   - Boring
   - Excited
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6
   - [ ] 7
   - [ ] 8
   - [x] 9
   - [x] 10

3. What do you think if there’s some interactive mirror feedback while you are doing those rehab exercises?
   - Not interested
   - Interested
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6
   - [ ] 7
   - [ ] 8
   - [ ] 9
   - [x] 10

Feel free to go through the digital prototype video and play with the interface

4. How likely is it that you would recommend this interface to a friend or a company?
   - Not at all likely
   - Extremely likely
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6
   - [ ] 7
   - [ ] 8
   - [ ] 9
   - [x] 10

5. Overall, how would you rate this interface?
   - [x] Excellent
   - [ ] Very good
   - [ ] Good
   - [ ] Fair
   - [ ] Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?
   - [x] Extremely helpful
   - [ ] Very helpful
   - [ ] Somewhat helpful
   - [ ] Not so helpful
   - [ ] Not at all helpful

7. How satisfied are you with the reliability of this interface?
   - [ ] Extremely satisfied
   - [ ] Very satisfied
   - [ ] Somewhat satisfied
   - [ ] Not so satisfied
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8. How satisfied are you with the look and feel of this interface?
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   - [ ] Somewhat satisfied
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   - [ ] Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?
   - [ ] Extremely satisfied
   - [ ] Very satisfied
   - [ ] Somewhat satisfied
   - [ ] Not so satisfied
   - [ ] Not at all satisfied

10. Comment (if there’s no enough space, feel free to write it on the back):
A: Imagine RIT Surveys

Motivating Mirror

Age

☑ 20-35 ☐ 35-45 ☐ 45-55 ☐ Other

Gender

☑ Male ☐ Female

1. Have you been through knee surgery and get to know the rehab exercises?

☐ Yes  ☑ No

2. What do you think about these rehab exercises?

Doing  Exercised

1 2 3 4 5 6 7 8 9 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?

Not interested  Interested

1 2 3 4 5 6 7 8 9 10

Feel free to go through the digital prototype video and play with the interface

4. How likely is it that you would recommend this interface to a friend or a company?

Not at all likely  Extremely likely

1 2 3 4 5 6 7 8 9 10

5. Overall, how would you rate this interface?

☐ Excellent  ☑ Very good  ☐ Good  ☐ Fair  ☐ Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?

☐ Extremely helpful  ☑ Very helpful  ☐ Somewhat helpful  ☐ Not so helpful  ☐ Not at all helpful

7. How satisfied are you with the reliability of this interface?

☐ Extremely satisfied  ☑ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

8. How satisfied are you with the look and feel of this interface?

☐ Extremely satisfied  ☑ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

9. How satisfied are you with the typeface readability and design of this interface?

☐ Extremely satisfied  ☑ Very satisfied  ☐ Somewhat satisfied  ☐ Not so satisfied  ☐ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):
A: Imagine RIT Surveys

Motivating Mirror

Age
20-35 □ 35-45 □ 45-55 □ Other

Gender
□ Male □ Female

1. Have you been through knee surgery and get to know the rehab exercises?
□ Yes □ No

2. What do you think about these rehab exercises?
Boring Excited
1 2 3 4 5 6 7 8 9 10

3. What do you think if there’s some interactive mirror feedback while you are doing those rehab exercises?
Not Interested Interested
1 2 3 4 5 6 7 8 9 10

Feel free to go through the digital prototype video and play with the interface

4. How likely is it that you would recommend this interface to a friend or a company?
Not at all likely Extremely likely
1 2 3 4 5 6 7 8 9 10

5. Overall, how would you rate this interface?
□ Excellent □ Very good □ Good □ Fair □ Poor

6. How helpful do you think if patients have this interface while you doing rehab exercises?
□ Extremely helpful □ Very helpful □ Somewhat helpful □ Not so helpful □ Not at all helpful

7. How satisfied are you with the reliability of this interface?
□ Extremely satisfied □ Very satisfied □ Somewhat satisfied □ Not so satisfied □ Not at all satisfied

8. How satisfied are you with the look and feel of this interface?
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10. Comment (if there’s no enough space, feel free to write it on the back):

______________________________

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______________________________
## A: Imagine RIT Surveys

### Motivating Mirror

**Age**
- □ 20-35
- □ 35-45
- □ 45-55
- ☒ Other

**Gender**
- □ Male
- ☒ Female

1. Have you been through knee surgery and get to know the rehab exercises?
   - □ Yes
   - ☒ No

2. What do you think about these rehab exercises?
   - [ ] Boring
   - [ ] Excited
   - 1 2 3 4 5 6 7 8 9 10

3. What do you think if there's some interactive mirror feedback while you are doing those rehab exercises?
   - [ ] Not interested
   - [ ] Interested
   - 1 2 3 4 5 6 7 8 9 10

Feel free to go through the digital prototype video and play with the interface.

4. How likely is it that you would recommend this interface to a friend or a company?
   - [ ] Not at all likely
   - [ ] Extremely likely
   - 1 2 3 4 5 6 7 8 9 10

5. Overall, how would you rate this interface?
   - ☒ Excellent
   - □ Very good
   - □ Good
   - □ Fair
   - □ Poor

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   - □ Not at all satisfied

10. Comment (if there's no enough space, feel free to write it on the back):
Providing an interactive experience to knee surgery patients to assist them with a more effective rehabilitation

Yu He
Thesis Proposal

Rochester Institute of Technology
College of Imaging Arts & Science
School of Design
MFA Visual Communication Design
Thesis Committee approval

**Title**

Using interaction design with motion graphics to providing an interactive experience that can possibly motivate patients who had knee surgery.

**Committee Members**

**Chief Thesis Advisor:**

Dan DeLuna, MFA Visual Communication Design

Signature of Chief Thesis Adviser  
Date

**Associate Thesis Advisor:**

Chris Jackson, MFA Visual Communication Design

Signature of Associate Thesis Adviser  
Date

**Associate Thesis Advisor:**

Nancy Doubleday, School of Interactive Games and Media

Signature of Associate Thesis Adviser  
Date
Abstract

There are many tools for people with a knee injury to use for rehabilitation. Physical Therapists and occupational therapists work with patients on rehabilitation to help them recover, bring them back from illness or injury. For knee surgery patients, they will go through rehabilitation including CPM (Continuous passive movement) and exercises assigned by PT (Physical Therapists) to improve recovery.

The CPM is a passive motion that a machine forces patients to do, and along with and after that, patients need to be active to do other exercises themselves. Lots of patients run into trouble when rehabbing, some of them refuse to do the exercises because they have a negative attitude about this rehabilitation, some of them think it’s troublesome to go to the gym do the rehab exercises, they just stay at home and wait until their leg recovers, and others are afraid of the rehabilitation. Whatever the reason, it turns out they won’t recover very well.

As part of this preliminary study, a survey was presented to patients who had knee injury and doctors who are expert in knee surgery. The patients were asked if they would find it beneficial and appealing to have a more effective experience while they taking rehab exercises. The general consensus was they would find it’s useful as they could be more interested in rehab instead of forcing themselves go to a hospital. On the other side, doctors weren’t so sure about it because we don’t have anything similar on the market. Besides, this project wasn’t so fascinating since the rehab exercises are limited and repeat.

This proposal is trying to help patients spontaneously deal with their rehabilitation in a more active way, help them maintain their health level or to have the passion to explore ways to improve it, and help recover patients’ both physiological and psychological health.

The purpose of this design would be that users could increase flexibility while they have walking limitations, and encourage them with more effective rehabilitation.
Problem Statement

Providing an interactive experience to knee surgery patients to assist them with a more effective rehabilitation

A better rehab experience is needed for those patients who have had knee surgery. Using interaction design to develop an user interface that can explore different function and different methods to help patients actively have a better rehabilitation.

This thesis project explores interaction, user interface and experience design for patients taking rehabilitation after knee surgery. Users will be able to spontaneous take an active part in rehabilitation. Help recover patients' both physiological and psychological health.

The concept is using Augmented Reality(AR) design an interactive display interface, this AR display device may be commonly used in several years, it might help patients have better user experience and be more active while they having rehab sports. While using this device, users may interact with the device by using visual sensor, voice order, etc.

This project will using interactive design to design a interface for this AR device, motion graphic as video prototype to help people better understanding about this project.

Though there is a device that can help doctors to see through patients' body and get detail informations of bones and muscle to operate better, there is nothing similar on the market for knee surgery patients, this project is achievable in several years and would be helpful to help patients willing to do rehabilitation.
Situation Analysis

Nowadays there are a series of rehabilitation exercises for people who suffer from knee injury\(^1\). It usually take 12 weeks\(^2\) for patients to go back to normal daily life and 16 weeks to regain full muscle strength and increase overall conditioning but only if they follow the instruction from the PT and did rehabilitation well, and after 12 weeks, it’s still important to continue with exercises. While patients go through the rehabilitation, they have to follow the instructions on the equipment in CPM stage, and have to follow doctors’ instructions to do exercises to help with recovery, but the process that patients go through is rather boring and without passion. In addition, there are lots of patients who are suffering from both physiological and psychological trauma. Patients couldn’t get a perfect recovery while they have no power and passion to take part in rehabilitation. Some of them may even be too afraid of pain they need to suffer while exercising to get rehabilitation. As a focus area, people having knee surgery will be the main component of this thesis project.

To get more information from patients, one on-line questionnaire has been published and has gotten responses from doctors and patients. The main questions include:

- What’s the name of the person injured?
- What’s the gender of the person injured?
- How old is the patient?
- How badly does this injury affect him/her?
- Did patient go through the whole rehabilitation?
- If yes, what’s the process for the rehab? If not, why patient didn’t go to rehab?
- What are the commonly used rehab exercises?
- For rehab, will it be different rehab exercises between knee replacement patients and knee surgery patients? And is there any difference between different generations and different occupations?
- If there is any interactive experience for patients to motivate him/her to do the rehab

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Situation Analysis

exercises, what kind of experiences do you think the patients might be interested in?
• If there are some entertainment activities happening while patients are exercising, will these activities diffuse patients’ attention and energies, and have bad influences for the rehab? Or will it be helpful for patients to not pay attention to painful exercises?

Based on the responses this questionnaire got, the exercises for rehab are determined by how badly he/she hurts and how long since the surgery. 84.3% of respondents said physical feedback would be a great way to show the patients overall condition because it can tell them realistically how far along they have come for their recovery. This can give patients a realistic time period of how their progress is doing and how long it will roughly take for their rehab of the surgical knee or replaced knee. At the same time, 72.9% of participants said digital interaction would be optimal too because at the same time, it will represent the knee of the patient and it can show them how the overall healing process works and what the body is going through to recover his/her knee function. However, it also comes down to price and how much can the patient afford for recovery as opposed to physical feedback with PT covered by insurance or so. And 78.2% of respondents feel if there are entertainment activities, it will motivate the patients if they can be more interactive with their recovery in rehab. Usually patients are really tired or frustrated about how long the healing process typically takes. But, it is important that patients keep up with their rehab because it will help them recover following surgeries. It will be a good distracting tool to not have patients be so worried about the pain and rather focused on the exercises in a fun and engaging manner. Sometimes with our pain, we perceive a lot of pain, but at the same time, we can trick our brain with imagery and distraction to not think too much about the pain.

The goal of this thesis project is to provide a solution that people who need rehab for knee surgery may use to willingly take part in rehabilitation and will improve their rehab quality. According to the questionnaire and research, there are different kinds of knee surgeries such as Arthroscopy: Trimming a Torn Meniscus, Meniscus Repair, ACL Reconstruction,
Situation Analysis

Microfracture, etc. For rehab, patients would do a lot of range of motion exercises to get the knee muscles working again and to slowly progress on the movement of the knees to walking around, extension, flexing, and going from a passive range of motion to an active range of motion. This project is focused on adults who are younger than 60 years old because the older generation might need knee replacement which is a different section from knee surgery.

By using AR devices and having interesting interactive way with patients such as clearly showing muscle rebuilding, adding achievement to exercises, patients will be more interested in rehab and improve recovery. A variety of interactive tools will be used to help develop a comprehensive design for users.

There is a need for a design like this since there is nothing else similar for patients on the market. There are traditional devices for people who had knee surgery that do not use digital interaction. There is AR for doctors to help with surgery, but not for rehab. Most of the patients are not paying attention to get effective rehabilitation. The majority don’t take rehab as their first choice because they need to go to a specific place to exercise and the process has no passion, instead they just leave the hurt knee alone.

This product will contribute to both fields of design and health. Through user interaction, user experience, motion graphics, interactivity and augmented reality, patients can have a good experience while rehabbing. Motion graphics will be used to help with fine motor skills and augmented reality will be used for study of human movement. Since this project is focus on the interface part, motion graphics will also help with the interface design.
Survey of Literature

Books

San Francisco, CA, Peach Pit, 2014.
This book discusses web usability and how designers need to be aware of what their audience wants and needs. Krug focuses on how designers need to keep in mind what they are designing and how they are implementing the content, and how to make it the most effective for their audience.

Don Norman discusses the concept of usability in design. Bad design is prevalent and the need for thoughtful design with the user in mind is a necessity. Norman points out why some designs are successful and how the designs and the design decisions affect their users.

This book lists author’s understanding and summary about elements of the user experience. He have five Plane for user experience: 1) The surface plane 2) The skeleton plane 3) The structure plane define the placement of pages, using process and navigational elements 4) The scope plane 5) The strategy plane. The author’s purpose appear to be explain user experience in his own eyes and give us a simplify understanding with user experience. This book is more focus on basic understanding than others and can give us a clearer view about user experience. It’s really useful as a guide to introduce user experience.

This book is talking about how to design a product and help people to interactive with it. This is a classic book about interaction design. It has the basic interaction design knowledge we need to use and helpful with our research and design.

In this book the author explains the importance of emotion in design based on three different dimensions: visceral, behavioral level, reflective level. Emotion in many cases has great impact of
Survey of Literature

Books

This is a book that UX people must read. It helps people get an step by step idea about how to test the usability for your product. This book provides an knowledge about what kind of products are users want to have. This book helps designers to consider limit usability and decide when will they need to do user test.

This book described complicated problems encountered in knees surgery, wrote by the authority of the field of reconstruction of the knee. Readers can learn from their own and others’ experience to improve their technology. This book focus on technique that experts prefer to use, and want readers to know that mastering knees surgery and managing not only requires a deep understanding of the scientific basis of the surgery, but also the ability to know the clinical decision and surgical subtle discrimination.

This book covers all the important diseases and injuries of the knee joints, for each part of the joint it has a comprehensive description from the normal image to the disease. Clinical evaluation of imaging is based on detailed diagnosis, disease stage and treatment results from each case data.

Articles & Websites

This article discusssed will physical therapy helpful for patients after arthroscopic partial meniscectomy. The author did an test with patients who were supervised physical therapy and patients who with a home program to evaluate the effectiveness.

Survey of Literature

**Articles & Websites**

https://doi.org/10.1177/0363546509359763
This article is about comparing a home based rehabilitation with a standard physical therapy program. It is a long run analysis about the difference between a patient who did home based rehab and patient who did a clinically supervised rehab.

This article claimed the rehab exercises after knee surgery need to focus on improve voluntary activation. And physical therapy should make sure to increase the muscle strength.

This article is a long term study about does the material patients used matter for patients’ recover. And for a reliable result, this study keep tracked some case in 6 years.

This article is about a study about does semitendinosus tendon graft help patients recover. For a better result, there was a two years case study and finally get a reliable data.

This article wanted to determine the difference of different training for knee surgery patients. And found out there are some certain training are good for patients. This article suggested that patients need more effective training.

This article is trying to find a different way to help patients who had ACL reconstruction. In this test, they asked patients immediate have weight bearing one day after surgery, then they had a long term follow up and get information.
Survey of Literature

Articles & Websites

This article studied the effect of two different autogenous patellar tendon graft for patients’ recovery speed, and this is a follow-up study.

This article performed a prospective randomized clinical trial in which two different occupational rating systems were tested on 50 patients.

This article described a new model for ACL rehabilitation, the Knee Symmetry Model. This article introduced this model and how this model been used. Then described details involved in the development and implementation of this rehabilitation program. And they have some data analysis for this model to clear this model is helpful for ACL rehab.

https://doi.org/10.1007/s00167-010-1386-8
This study is about study the difference between patients who get standard rehabilitation program and patients who had home based rehab program. To get accurate data, 40 patients was participate in this study, they were randomly put in two rehab programs.

http://orthoinfo.aaos.org/menus/treatment.cfm#surgical_tx
American Academy of Orthopaedic Surgeons. [Accessed May 19, 2010.];Surgical Treatments. This is a website focuses on body’s musculoskeletal system injuries, they get lots of reliable information including videos and articles about the rehabilitation.
Survey of Literature

Articles & Websites

http://www.gelonghui.com/p/75705.html  
This website is talking about AR help doctor with surgery at the first time.

http://36kr.com/p/203663.html  
This website is about 10 interactive ways to redefine human-computer interaction.

http://tech.163.com/15/0513/08/APFVJ67N000948V8.html  
A study of future computer interaction and talk about the deficiencies in the use of computer interaction and top three direction for computer interaction.

http://www.cn-healthcare.com/article/20160807/content-484783.html  
An article about how AR will influence medical treatment and shared some medical cases that used AR technique.

http://m.yigoonet.com/index.php?&a=show&catid=224&typeid=&id=32220  
AR technique in Rio 2016 Summer Olympics and currently the application of AR technology in medical field.

This website have six cases in medical treatment field that including AR technique.
Survey of Literature

Videos


This video is about a series of knee rehab exercises. And talk about not only strengthening exercises is important, but the perfect movement for the exercises.


Some types of exercises for knee rehabilitation after ACL surgery as soon as the Stitches are removed.


A physical therapist helps a woman through various exercises following her knee replacement surgery. Six exercises are shown and described.


This video described what is the most important thing for patients from one patient’s opinion. And showing what’s the best way to have better outcome.


This video is designed to help maximize your recovery following ACL reconstruction surgery. The goals of Phase 2 program for ACL reconstruction rehabilitation are to improve range of motion to normal and restore normal gait pattern. This phase should be conducted within 2-4 weeks following surgery.
Design Ideation

For patients who had knee surgery, they will need to go through CPM and be advised to have a series of exercises that PT recommended. The intention for these exercises is helping patients recover better, but based on data analysis from the on-line questionnaire, many patients actually didn’t go to hospitals to do the rehabilitation; they just rest at home and wait for their leg to recover. The goal of this proposal is to have a more passionate, comfortable, powerful, effective, compelling and motivated experience. Since the CPM process is passive with movement motivated by the machine, this project will focus on the exercises after CPM.
Design Ideation

Here is mind mapping for this project, for rehabilitation for knee surgery patients.

**Mind tools.** For this thesis mind tools include reading documentation and analysis data, mind mapping.

**Needs.** This project intends to have a faster, smarter, better, more effective and important interactive experience. For interaction design, this project needs to consider users' life style, comfort zones, work-life balance, encouraging users break the limits, and gaining users’ confidence.

**Choices.** This project will study who is the user, what designers need to do, where this design will be used, why and when it will be used, and how to achieve it. The tentative choice is using technology which will be commonly used in few years like AR and may achieve better user experiences and have more effective rehabilitation.

**Key issues.** The key issues for this project will be technology problems for AR, the methods this interaction design will use, having checkpoints during the process, user’ needs and the deadline for this project.

**Communication.** Considering consumer demand, this design attaches great importance to feedback and support from users, user’s praise, correction and reviews, improving interaction design iteratively.
Design Ideation

First we have lots of product problem backlog, for this case is about patients who don’t want to go to rehab and can not get effective recover for knees injury. Then there is the users’ requirements, that is process we use to encourage patients go through effective rehabilitation. Based on those requirements, come up some implement and develop ideas.

According to the concept, using AR interactive display to attract patients, help patients willing to do rehab exercises, that led to a study about what kind of format for this AR device will be used. We need to find a form that patients can easily interactive with but no need to use lots of hands control since their hands will be busy in the rehab exercises.

AR application on phone and tablet was my very first thought. It’s easy to achieve cause electronic products are commonly used nowadays and have AR for application will be much more interesting only have image on the screen. But as more and more research was done, this solution was rejected. Patients needed to use their hands to help support their body while they exercises, they won’t keep their hands on the electronic devices for long time.
Design Ideation

The second thought was AR glasses that already show up on the market. And there is an AR glass for doctors to help them see through patients’ muscle and see skeleton clearly so they can operate better. Therefore it would be nice if we have an AR glass for patients to help them understand how their muscle rebuild and tell them if they’re doing right exercises or not. And patients even no need to go to the rehab center or gym to do the exercises. However, even we have AR glasses for doctor, it’s still not widely used, AR glasses are too expensive for now, not mention as home used devices only for temporary when patients need to do rehab exercises. It would be a bad deal for patients.

These unsuccessful ideas led us to make a summing up of the experience and lessons. This design requirements for this AR device are easy to operation, fun, motivating, show exact information, at a reasonable cost. So the final idea is have an AR mirror in front of patients when they exercising in the rehab center. They can have their basic body condition in that mirror, and have an character shows how exactly they should do in specific movement. This device could use technique doctors used for physical feedback to help patients know how their knees recover. And we can have different mode for help divert patients’ attention form pain. Like music section has beats along with patients’ movement to motivate them do better in motion. Another section is game, patients could have various objects they can interactive with, so they can achieve specific angle the PT demand.
Design Ideation

Personas

Name: Mary
Gender: Female
Age: 37
Location: Los Angeles, CA
Occupation: Receptionist
Income: $38K

Mary is a receptionist who works really hard. She got injury of meniscus of knee joint by accident. After knee surgery, she has thought about doing rehab exercises on time, but she didn’t have time for it because she wants to go to work as soon as possible. Besides, she has a strange thought that she can exercises while she walk to office. Turns out she didn’t recover perfectly, her knee feels pain occasionally. She sometimes regrets about didn’t doing rehab exercises. The painful knee really affect her daily life.

When Mary heard about this project, she was really interested in it. Since she likes fitness at ordinary times. If there is an interactive device that can help her rehab and can combine with gym exercises, she would love to go through rehab exercises. And it doesn’t cost much to use that rehab device. She will be happy if she didn’t cost much but get fine rehabilitation.
Design Ideation

**Personas**

Name: Joseph  
Gender: Male  
Age: 25  
Location: New York, NY  
Occupation: Student  
Income: Part-time job, $13.5/hr  

Joseph is a graduate student, outdoor sports are on his agenda. He had an operation for rupture of knee medial collateral ligament because of one injury from outdoor sports. He was asked to go rehab center do exercises that PT asked him to do, at first he didn’t want to, but his parents force him to rehab. So he did all exercises that PT required. During the exercises, he got too boring to concentrate on those exercises. And since he need to do those movement as PT required, he need to keep his eyes on the injured knee all the time. It’s make him really uncomfortable when he has no pleasure on the rehab process.

He really like the idea about this project cause it’s much more interesting than the old exercises.
Design Ideation

Flowchart
Design Ideation

Flowchart

A

Games

Choose game (updating on schedule)

Ball
Shuttlecock
...

Character jump (Steve-jumping dino)

Patient's knee kick the object

Patient's movement control the character

Patient's knee control shooting

If move perfectly

Get star ★

Music

Play music

Patient movement

Music follow motion (updating on schedule)

Music end

Video

Play video

Patient movement

Video interactive with movement (updating on schedule)

Video end

B

If move perfectly

Get star ★

enough

A

Choose game (updating on schedule)

Ball
Shuttlecock
...

Character jump (Steve-jumping dino)

Patient's knee kick the object

Patient's movement control the character

Patient's knee control shooting

If move perfectly

Get star ★

enough
Design Ideation

Wireframe
Design Ideation

Wireframe

Finished this stage. What would you do next?

Continue

Check score  End for today

Here are coupons you could get

Save to your phone  Print  Keep score for later

Scan QR code to save

Move your body and trying to match the character’s motion

Choose mode

Game  Video  Music
Design Ideation

Storyboard

1. Showing pupil's centric in online
   3 74.

2. Patient walk into what reads: start interaction with menu

3. Menu choose account & next menu

4. Swipe left to new account.

5. Import patient's information.
Design Ideation

Storyboard

1. Scene 1: Character in a room
   - Text: “Welcome! What would you like to do?”
   - Action: Character looks around

2. Scene 2: Character choices
   - Text: “Choose movement mode:”
   - Options: “Chore” and “Train”

3. Scene 3: Movement tutorial
   - Text: “Follow instructions for movement. Remember to pick your mode for exercises that reflect patient’s body.”

4. Scene 4: Movement execution
   - Text: “Move as chosen or shared if doing it right, get a start.”

5. Scene 5: Movement completion
   - Text: “Back to movement”

6. Scene 6: Summary
   - Text: “Thank you for choosing our service.”

---

Note: The storyboard is a visual representation of the design ideation process, showing how a patient might interact with a movement system to choose a mode and perform exercises based on their body’s needs.
Design Ideation

Storyboard
Design Ideation

Storyboard
Design Ideation

Helvetica Neue

For this thesis project, Helvetica Neue will be used for the interface design and the prototype design. This typeface is commonly used in multiple ways, and it is clear and easy to read for this thesis concept.

Since this project will have a video prototype to help user understand this project, the video will use the same typeface as the interface design.
Design Ideation

Color studies

The above are optional color choices I studied, then I selected followed color as my main color choice. Because first they are easy to recognized on the mirror which will have reflection of reality environment, then they are all soft color that can make people feel peace and clam.
Methodological Design

The primary objective of the project is to design an interface for an interaction device for people doing rehab after knees surgery. A demonstration of this application will be in the form of an animated video, displaying the details and capabilities. This will require learning about database management, information graphics, user interaction, user experience, motion graphics, interactivity and augmented reality, and related interaction/interface design.

Target audience
A interface for interaction mirror that encourage patients to do rehab will be build. With patients who did knees surgery as target audience, adult patients age range of 25 to 45, they will have active rehab exercises, and get better recover from injury.

Overall Project
This interface will have four modules determined by filling out the patient’s information: Exercises, Mode choose, Personal status update, Setting.

Hardware/Software
The project will be built using:
Adobe Illustrator
Adobe Photoshop
Adobe InDesign
Adobe Experience Design
Adobe Premiere Pro
Adobe After Effects
Adobe Audition
Methodological Design

Process:
- Research related documents
- Collecting and documenting literature
- Speaking with patients and experts
- Market survey, evaluating and assessing current needs
- Prototyping interactive experiences for exercises after CPM
- Usability testing
- Imagine RIT
- Final production and presentation

Scope of Project:
- Motion graphics:
  Video prototype: 1 video, approximately 2:00 to 2:30 minutes.
  The video will have a user interactive with the mirror to help people get better understanding of how to interactive with this mirror.
- Interaction:
  Prototype: Using Adobe Experience Design to design a high quality prototype Interface design for interactive mirror. Including exercises instruction, muscle rebuild study, and personal information.
- Augmented Reality:
  Using illustration/infographics used to help patients get movement in right position.
  Have character in the mirror in the same position with real patients’ projection.

Details of Project:
- Motion graphics dimensions:
  1920p / 1080p
  QuickTime format
  Duration: approximately 2:00 to 2:30 minutes.
Methodological Design

Deliverables

- Interactive Details:
  
  Software: Adobe Illustrator, Photoshop, Animate CC, Experience Design.

  Narrative component: Rehab exercises section (with AR motion graphics) with audio to interact with patients.
# Methodological Design

<table>
<thead>
<tr>
<th>DESIGN</th>
<th>TECHNOLOGY</th>
<th>SUBJECT MATTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>UI/UX design</td>
<td>Adobe Illustrator</td>
<td>Icons for interactive mirror interface</td>
</tr>
<tr>
<td></td>
<td>Adobe Photoshop</td>
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<td></td>
<td>Adobe After Effects</td>
<td></td>
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<tr>
<td></td>
<td>Adobe Experience Design</td>
<td></td>
</tr>
<tr>
<td>Interaction design</td>
<td>Adobe Illustrator</td>
<td>Interactive part: Movement check and comparison for better rehab</td>
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<td>Adobe Photoshop</td>
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<tr>
<td>Motion graphics</td>
<td>Adobe Illustrator</td>
<td>Short animations: Infographics Narratives</td>
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<td></td>
<td>Adobe Photoshop</td>
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<td></td>
<td>Adobe After Effects</td>
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<td>Adobe Audition</td>
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Implementation Strategies

Through comprehensive planning, this project would achieve most useful and beneficial investigation method provides a useful and comprehensive interactive experience that knee surgery patients will use and enjoy.

I will build my thesis project through visual communication design. I have a passion for interaction design and motion. During my graduate study I learn about various aspects and principles of interaction, user interface and user experience design. I learned how to design and edit videos in Adobe After Effect and other Adobe software from the 3D Modeling and Motion, Digital Design in Motion and Digital Media Integration class. And I learned interaction design skills from Web and UI Design, Typography, Interaction Design, UX Design Strategies and Experiential Graphic Design class. I would like to take this knowledge to the next professional level.

I will be working over the course of the fall of 2016 and spring of 2017 to implement all of the aspects of this project.

Using my research and potential customer interview I did on-line questionnaire survey. This was done in www.typeform.com. At the same time I will collect visual data of interface design. The interface will be designed based on the research I did and interview with patients and doctors. It will be done in Adobe Photoshop, Illustrator, Animate CC and InDesign, all of which I have a high degree of comfort using at this time. The video prototype will be crested using Adobe After Effects and Animate CC which I am still leaning but have enough experience with video editing to adequately complete any tasks. The videos will be hosted on my YouTube account and Vimeo account.

Lessons and examples will be reviewed by my committee members with additional input from other resources. The outline and syllabus will also be reviewed for completeness and compliance with RIT guidelines.
Evaluation Plan

• Publishing this thesis project on-line, using comments, likes and dislikes, and social media sharing provides an valuable feedback.

• First round will be paper prototype in order to validate the process and collect suggestions to improve user experience.

• Second round will test the high fidelity prototype. Both rounds will be qualitative with a predetermined target number of participants of up to 5 patients from diverse backgrounds. The location for testing shall be different depends on patients condition and willing.

• In addition to the comments and feedback of peers who will provide validation or dissension, there will be opportunities during Image RIT to get educated and non-educated feedback on articles and lessons.
Dissemination

This thesis project will have interface design and video prototype, and it will be seen by many individuals. Users will give feedback through various ways.

On campus dissemination:

Imagine RIT - May 2017
Thesis Show - May 2017

Off campus dissemination:

Adobe Design Achievement Awards
RedDot Design Awards
iF Design Award
SIGCHI Conferences

Pragmatic Considerations

Budget:

Adobe Creative Cloud: $30 per month for students.

Considerations:

This project require the well planned timeline. To get feedback of real worth, we planned to have different platform to collect information, which may cost apply fee. And have cost for software. Since it’s a prototype for real interactive experience, there will be no cost for further developing.
## Timeline

### Fall 2016

<table>
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<tr>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
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<tr>
<td></td>
<td>Finalize proposal</td>
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<td>Sketches &amp; storyboard develop</td>
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<td>Competitive analysis</td>
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<td>Solution development</td>
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<td>Review Presentation</td>
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<td>Finalize proposal</td>
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<td>User interviews &amp; observation</td>
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<td>Thesis planning &amp; writing proposal</td>
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<td>Ideation, research &amp; problem finding</td>
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# Timeline

## Spring 2017

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<tbody>
<tr>
<td>Final Presentation</td>
<td>Finalize project</td>
<td>Adjustments</td>
<td>Usability test (Imagine RIT)</td>
<td>Adjustments</td>
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<tr>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
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http://tech.163.com/15/0513/08/APFVJ67N000948V8.html

http://www.cn-healthcare.com/article/20160807/content-484783.html


https://www.youtube.com/watch?v=yhvgR3TQQr8

https://www.youtube.com/watch?v=Yp4eYFald-g

https://www.youtube.com/watch?v=QzVdEyyliu4