DESIGN PROCESS IMPROVEMENT:
RIT MULTIDISCIPLINARY SENIOR DESIGN AT NAZARETH COLLEGE PHYSICAL THERAPY CLINIC
Introduction

Overview of Design

- Tool Kit
- Recommendation Package

Results

Preparation for Future Work

Objective Review
Introduction

- The Nazareth College Physical Therapy Clinic (NCPTC) offers a multitude of services to clients who normally could not afford physical therapy.
- Past RIT Senior Design teams tried to provide NCPTC with helpful assistive devices; unfortunately many projects have been failures.
- Multiple mechanisms have been developed in this project to improve the success of future RIT Senior Design projects at the NCPTC.
High Level Customer Needs

- Our team considered many stakeholders:
  - Dr. JJ Mowder-Tinney (NCPTC)
  - Physical Therapy Students
  - Physical Therapy Patients
  - RIT MSD Teams
  - RIT Faculty

- All of our needs are encompassed within the following categories:
  - Maintain Integrity of MSD
  - Contextual Learning
  - Effective Communication between stakeholders
  - Intelligent Design
  - Effective Scope and Planning
Two Pronged Approach

- Tool Kit
  - Solutions to immediate problems
- Recommendations Package
  - Documents and tools for future implementation
Overview of Design
Overview of Design

- Tool Kit
  - Flexible Grading Rubric
  - Communication of Methodologies
  - Closed Loop Communication Tool
  - Stakeholder Interaction Guidelines
  - Detailed Instructions on Templates

- Recommendation Package
  - Detailed Research Matrix
  - Defined Optimal Criteria for Planning
  - Standard Trend Evaluation Method
  - Created Recommendations
Closed Loop Communication

- This tool is designed to avoid miscommunication of information gathered from stakeholders.

**Closed Loop Communication**

**Methodology:** Clarifying gathered information from your stakeholders is very important in order to proceed to the next level of a project. By clarifying the team will be able to avoid confusion with the stakeholders and be more focused. The following template will also act as a standard method to store information from interviews with the stakeholders. The stakeholder guidelines would be included in this template to help you find the maximum ease in execution of this template.

**Instructions:**

1. As shown in the template below, the note taker of the team should fill in all the necessary fields.
2. The Q&A section should be used as transcript to document the interview.
3. In the field which says summary; summarize all the important topics covered.
4. Communicate with the customer either through phone, email or in person and clarify the summarized information.
5. The person editing this document should print and sign their name for authenticity.

**Q&A:**

Q: (the interview question would be here)

A: (answer for the question in details)

Q:

A:

**Summary:** (summarize important details of the interview in this space; please make sure to review with your team)

**Additional details:** (insert details that will be added during clarification, if none, enter as “NONE” in this space)

**Was the information clarified with the customer: YES----------NO----------**

If so,

Date: ________________ Time: ________________

Member who clarified the information:

How was it clarified: by phone____________ Email____________ other__________

Signature: ____________

**Relevance:** This will be a standard document for the project which will help standardize documentation for interviews and authenticate the gathered information. Eventually from these information customer needs, project specifications would be derived.
Detailed Instructions on Templates

- Detailed instructions on templates are provided for students in order to better understand the purpose and execution of the tool.

- Two components of this tool:
  - Instructions to execute the template
  - Book references to understand key concepts
Detailed Instructions on Templates

**Template for Templates**

**Methodology:** This section would indicate the objectives of this template and the importance of using this template. In addition, this section would include the book references to help the student understand important concepts and for execution of the tool.

**Relevance:** how this tool fits in the bigger picture.

**Instructions:** This section contains the necessary instruction on how to execute the process of using the template in a very efficient and easy method.

---

**Tool/Mechanism**

The above section would contain the template or the actual tool where this would serve as a standard document at the same time. The objective of this tool is to help students work efficiently where within the tool it will contain an example or a description on the use of the tool.

**Comments:** this section is a place where the team can make note of any irregularities and specific actions needed.

**Reflections:** This section would mention how this can be executed differently and some obstacles that might occur while using the tool.
Detailed Instructions on Templates: Customer Needs

Customer needs Table

Methodology: This table will act as a very important tool that will identify customer needs for the project, since any project is based on customer needs, it is crucial to identify the customer needs properly. In order to execute the customer needs template effectively refer the following pages from the product design and development book,

- Gathering raw data: page 55
- Interpreting raw data: see the example on page 62 and the example in page 63
- In order to fully understand how customer needs should mentioned within the template refer page 65

Relevance:

Customer can be the most crucial stage in a project and recording the needs properly is essential. The customer needs would be the starting point in generating engineering specifications and concepts.

Instructions:

1. Customer needs # should be unique to each need since this will be used in the future to reference the project concepts and the engineering specifications that will be generated in terms of the need.
2. Ask the customer to rate the importance numerically (from 1-9, where 9 would be the maximum importance level)
3. Describe the need, assuming that the need would work as desired, please note not to mention this need plans to achieve this goal. Refer the example on page 65 of the book.
4. Questions that needs to be answered, changes that need to be made should be mentioned in the comments section

<table>
<thead>
<tr>
<th>Revision</th>
<th>Importance</th>
<th>Description</th>
<th>Comments/Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(from 1-9)</td>
<td>The screwdriver operates normally in the rain</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reflections

Comments:

- Refer chapter 4 of the product design and development book which would be useful in executing customer needs effectively. Make sure to address the importance of the customer need from the customer and ask why the customer needs this requirement.
Detailed Instructions on Templates: Engineering Specifications

**Template for Engineering Specification**

**Methodology:** This template provides the teams identify and sort the importance of the components in a given project. This would help students to come up with the components and value them in a quantitative manner. Following topics from the Product Design and Development (fourth edition) would help execute this tool better.

- Guidelines on Specifications (page 72, 73)
- Metrics for specifications (page 75, 76)
- Setting marginal and ideal values (page 79, 80)
- Finalizing specifications (page 83-85)
- Example of a good specification Table (page 90)

**Instructions:**

1. Before beginning this process identify the components in the project
2. The 1st column (Engr. Spec. #) would serve as an identification number of the component
3. Importance would be graded in a subjective manner where the value would depend on the ratings which the teams give.
4. Source would be the customer needs number in the customer needs mapping matrix.
5. Specification description would contain what the specification is an example would be given within the template.
6. Unit’s measure would be the measurement that will be used to measure this component.
   It can be in time (as in minutes, hours, etc.), length (meters, feet, etc), weight, etc.
7. Marginal value would serve as the tolerance of the measurement
8. Ideal value section would be the value that the team would hope to achieve if possible while executing the project
9. Comments section would contain a description for the user to make necessary notes.

<table>
<thead>
<tr>
<th>Engr Spec. #</th>
<th>Needs</th>
<th>Importance</th>
<th>Specification (description)</th>
<th>Unit of Measure</th>
<th>Marginal Value</th>
<th>Ideal Value</th>
<th>Comments/Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES1</td>
<td>1.3</td>
<td>(1-9)</td>
<td>Size of device</td>
<td>Inch</td>
<td>32-42</td>
<td>28-44</td>
<td>Trade off must be made b/w performance and usability</td>
</tr>
<tr>
<td>ES2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments:** This is an area which can be used to include any information not covered in the table.

**Reflections:** This section can be used to provide reflections on the specifications not only for the current and also for the future teams.
Stakeholder Interaction Guidelines

- These instructions will help students better communicate with the customer
- The guidelines were requested by Dr J.J. Mowder-Tinney
- Guideline categories:
  - The administration at the Nazareth clinic
  - The administration at RIT (project advisors, TA's, etc)
Stakeholder Interaction Guidelines

- The stakeholders at the clinic
  - Preparation for an interview (inviting stakeholders for design reviews, etc)
  - Procedure during the interview
  - Post interview procedure
  - Closing the communication loop
Stakeholder Interaction Guidelines

- The stakeholders at RIT
  - Follow the same idea as guidelines for the administration at the clinic
  - More flexible than the administration at the clinic
  - Closing the communication loop
Flexible Grading Rubric (FGR)

- 6 different rubrics generated in order to facilitate improved performance
- Two variables – descriptions and weighting
- Variable is determined based upon two classifications – project type and product type
The methodologies are delivered in a “MSD Manual” which includes methodologies of phases and tasks.

Introduction

Description of Phases
- Phase 0: Planning
- Phase 1: Concept Development
- Phase 2: System Level Design
- Phase 3: Detailed Design
- Phase 4: Build and Test
- Phase 5: Final Documentation
Recommendation Packet
Quantitative Analysis:
MSD 1 Project Planning – P09006

<table>
<thead>
<tr>
<th>Planning Process:</th>
<th>Criteria:</th>
<th>Score:</th>
<th>Research Areas:</th>
<th>Research Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1: Identity Tasks and Milestones</td>
<td>Milestones established for each major task</td>
<td>0</td>
<td>Planning Process</td>
<td>Otto &amp; Wood</td>
</tr>
<tr>
<td></td>
<td>Deliverables are clearly defined</td>
<td>0</td>
<td>Preliminary Technical Questions</td>
<td>Ulrich &amp; Eppinger</td>
</tr>
<tr>
<td></td>
<td>Deliverables are realistic</td>
<td>1</td>
<td>Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Major tasks broken into sub tasks</td>
<td>3</td>
<td>Points Earned</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Start and end points are clearly defined</td>
<td>3</td>
<td>Points Possible</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Significant tasks are not stated as generalities</td>
<td>1</td>
<td>Percentage Earned</td>
<td>47.61</td>
</tr>
<tr>
<td>Step 2: Supplement Product Tasks with Team Tasks</td>
<td>Team building exercises</td>
<td>0</td>
<td>Rating</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Team evaluations</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time to plan, scheme, and imagine</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 3: Estimate Project Resources and Time</td>
<td>Schedule was updated in regular intervals</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resources are defined for each task</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advance budget analysis</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 4: Assign Tasks to a Timeline</td>
<td>Dependencies among tasks should be completed</td>
<td>1</td>
<td>Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use of Gantt Chart or similar scheduling tool</td>
<td>3</td>
<td>Points Earned</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Use Critical Path Method or PERT analysis</td>
<td>0</td>
<td>Points Possible</td>
<td>21</td>
</tr>
<tr>
<td>Preliminary Technical Questions:</td>
<td>What is the problem really about</td>
<td>3</td>
<td>Percentage Earned</td>
<td>47.61</td>
</tr>
<tr>
<td></td>
<td>What avenues are open for creative design</td>
<td>1</td>
<td>Rating</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>What characteristics or properties should the design encompass</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>What characteristics or properties should the design not have</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>What aspects of the design can and should be quantified now</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discussion of scope</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Trend Analysis: MSD 1 Project Planning

<table>
<thead>
<tr>
<th>Planning Process</th>
<th>Criteria</th>
<th>Score</th>
<th>Percentage</th>
<th>Trends</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1: Identify Tasks and Milestones</td>
<td>Milestones established for each major task</td>
<td>0</td>
<td>0</td>
<td>No one did this</td>
<td>No expectation?</td>
</tr>
<tr>
<td></td>
<td>Deliverables are clearly defined</td>
<td>5</td>
<td>83.33</td>
<td>Most did this</td>
<td>The concept of Deliverables are clearly explained to all teams in MSD 1, and guides ask teams for lists of deliverables early on during the project.</td>
</tr>
<tr>
<td></td>
<td>Deliverables are realistic</td>
<td>5</td>
<td>83.33</td>
<td>Most did this</td>
<td>The concept of Deliverables are clearly explained to all teams in MSD 1, and guides ask teams for lists of deliverables early on during the project.</td>
</tr>
<tr>
<td></td>
<td>Major tasks broken into sub tasks</td>
<td>3</td>
<td>50</td>
<td>Almost all did this</td>
<td>Use of project scheduling tools was not required.</td>
</tr>
<tr>
<td></td>
<td>Start and end points are clearly defined</td>
<td>3</td>
<td>50</td>
<td>Almost all did this</td>
<td>Use of project scheduling tools was not required.</td>
</tr>
<tr>
<td></td>
<td>Significant tasks are not stated as generalities</td>
<td>2</td>
<td>33.33</td>
<td>Almost no one did this</td>
<td>Use of project scheduling tools was not required.</td>
</tr>
<tr>
<td>Step 2: Supplement Product Tasks with Team Tasks</td>
<td>Team building exercises</td>
<td>0</td>
<td>0</td>
<td>No one did this</td>
<td>Probably occurred, though never documented.</td>
</tr>
<tr>
<td></td>
<td>Team evaluations</td>
<td>0</td>
<td>0</td>
<td>No one did this</td>
<td>Probably occurred, though never documented.</td>
</tr>
<tr>
<td></td>
<td>Time to plan, schema, and imagine</td>
<td>1</td>
<td>16.66</td>
<td>Almost no one did this</td>
<td>Use of project scheduling tools was not required.</td>
</tr>
<tr>
<td>Step 3: Estimate Project Resources and Time</td>
<td>Schedule was updated in regular intervals</td>
<td>1</td>
<td>16.66</td>
<td>Almost no one did this</td>
<td>Use of project scheduling tools was not required.</td>
</tr>
<tr>
<td></td>
<td>Resources are defined for each task</td>
<td>2</td>
<td>33.33</td>
<td>Almost no one did this</td>
<td>Use of project scheduling tools was not required, and lack of training in project management.</td>
</tr>
<tr>
<td></td>
<td>Advance budget analysis</td>
<td>0</td>
<td>0</td>
<td>No one did this</td>
<td>Teams do not find out their budgets until week 3 or 4, so this might be impossible.</td>
</tr>
<tr>
<td>Step 4: Assign Tasks to a Timeline</td>
<td>Dependencies among tasks should be completed</td>
<td>2</td>
<td>33.33</td>
<td>Almost no one did this</td>
<td>Use of project scheduling tools was not required, though perhaps many engineers are not familiar with the concept of project dependencies. (Maybe most people do not articulate this need to order parts before the build.)</td>
</tr>
<tr>
<td></td>
<td>Use of Gantt Chart or similar scheduling tool</td>
<td>2</td>
<td>33.33</td>
<td>Almost no one did this</td>
<td>Use of project scheduling tools was not required, and lack of training in project management.</td>
</tr>
<tr>
<td></td>
<td>Use Critical Path Method or PERT analysis</td>
<td>0</td>
<td>0</td>
<td>No one did this</td>
<td>Most engineers do not know what this is, and they were not told to do it. Simple early start / latest finish calculations could have significantly helped teams meet deadlines.</td>
</tr>
<tr>
<td>Preliminary Technical Questions</td>
<td>What is the problem really about</td>
<td>5</td>
<td>83.33</td>
<td>Most did this</td>
<td>Many teams documented early phases of their projects. It is likely that most teams would talk about what they are actually trying to do on the first day of MSD 1.</td>
</tr>
<tr>
<td></td>
<td>What avenues are open for creative design</td>
<td>4</td>
<td>66.66</td>
<td>Most did this</td>
<td>This should be instinctive in RIT engineering students.</td>
</tr>
<tr>
<td></td>
<td>What characteristics or properties should the design encompass</td>
<td>6</td>
<td>100</td>
<td>All did this</td>
<td>This is something most teams can talk about on the first day, or within the first week. Even before interviewing the customer, teams can focus on this.</td>
</tr>
<tr>
<td></td>
<td>What characteristics or properties should the design not have</td>
<td>3</td>
<td>50</td>
<td>Half did this</td>
<td>This is easy to do for follow-on projects, and in other cases, some teams will not have constraints about things not to include.</td>
</tr>
<tr>
<td></td>
<td>What aspects of the design can and should be quantified now</td>
<td>1</td>
<td>16.66</td>
<td>Almost no one did this</td>
<td>No requirement, and teams might be unsure of any quantification possible before specs, metrics, and needs are refined.</td>
</tr>
<tr>
<td></td>
<td>Discussion of scope</td>
<td>1</td>
<td>16.66</td>
<td>Almost no one did this</td>
<td>Probably occurred, though never documented.</td>
</tr>
</tbody>
</table>
Recommendations: Planning Milestones

Planning - Milestones Established for Each Major Task

- What is the purpose of this recommendation?
  - Teams will spend additional time planning and thinking about what tasks should be completed by specific times, more than just "this has to be done before the design review". Optimal criteria which are more likely to be completed if milestones are established are:
    - Major tasks broken into sub-tasks
    - Start and end points clearly defined
    - Schedule was updated in regular intervals
    - Resources defined for each task
    - Use of Gantt chart or similar scheduling tool
    - Use critical path or PERT method

- Where did this recommendation come from?
  - Our in-depth analysis (M3D Project Planning - Optimal Criteria) has shown that no teams made milestones for each major task.

- How can this recommendation be implemented?
  - Require teams to establish milestones for each major task, as a portion of the planning grade on the rubric.

- What is the time-frame and manpower required to implement this recommendation?
  - Less than one hour to edit the rubric.

- What projects will this benefit the most?
  - All project types will benefit from a more specific project plan.

- What are the pros and cons of this recommendation?
  - Pros
    - Teams will be more likely to perform higher quality planning, and use additional tools outlined above.
  - Cons
    - Many teams will complain that they do not have enough time to spend on additional planning activities.
    - Spending too much time on planning will negatively affect the project outcome.
    - How are these risks to be mitigated?
      - Include planning time in the schedule, so that small updates are done each week. This will not require a significant amount of time.
Results
Recommendations Packet:
MSD 1 Project Planning – Trends

### Planning Process

- Realistic and Clearly Defined Deliverables: 80
- In Depth Initial Scheduling: 60
- Supplement Product Tasks with Team Tasks: 20
- Estimate Project Resources and Time: 40
- Assign Tasks to a Timeline: 20

### Preliminary Technical Questions

- What is the problem really about: 100
- What avenues are open for creative design: 80
- What should the design encompass: 100
- What should the design not have: 60
- What can be quantified now: 40
- Discussion of scope: 20
Tool Kit Results

- The testing was performed the following specifications:
  - Uphold Educational Requirements
  - Applies to Multiple Project Types
  - Individualized Information
  - Flexible to Allow Creativity
  - Better communication tool
  - Improve collaboration
  - Uniformity of interactions
Tool Kit Results

- **Uphold educational requirements**
  - All tools were determined to leave the course outcomes unaffected.

- **Applies to Multiple Project Types**
  - All tools were able to address at least one criteria for each project type or leave the status quo in tact.

- **Individualized Information**
  - The rubric was customized between 7%-17%.
  - Lower than target value of 25%
Tool Kit Results

- Flexible to Allow Creativity
  - All tools were determined to be versatile enough so as not to limit creativity

- Surveys within the team
  - Two pronged approach enabled objective feedback
  - Rating scale of 1 – 5
    - 5 – Ideal
    - 1 – Significant problems
All the tests had a value over 3 therefore they could be considered successful.
Preparation for Future Work

- **Recommendations Packet**
  - Designed with future use in mind
    - Detailed references for future teams
  - Robust, quantitative analysis method

- **Tool Kit**
  - Documented design decisions and justifications
## Detailed Research Matrix

<table>
<thead>
<tr>
<th>Planning MSD 1</th>
<th>Developed Needs</th>
<th>Specifications</th>
<th>Concept Generation</th>
<th>Concept Selection</th>
<th>Concept Development</th>
<th>Planning MSD 2</th>
<th>Design Execution</th>
<th>Testing</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning Process; Otto &amp; Wood Pg. 75</td>
<td>Customer Satisfaction; Otto &amp; Wood Pg. 112</td>
<td>Why Functional Decomposition; Otto &amp; Wood Pg. 148</td>
<td>Concept Generation Process; Otto &amp; Wood Pg. 414</td>
<td>Concept Selection Process; Otto &amp; Wood Pg. 487</td>
<td>Architecture Types; Otto &amp; Wood Pg. 360</td>
<td>Planning Process; Otto &amp; Wood Pg. 75</td>
<td>Prototyping Essentials; Otto &amp; Wood Pg. 836</td>
<td>Benchmarking Approach; Otto &amp; Wood Pg. 262</td>
<td>People need to write well. Did not find any literature in this area</td>
</tr>
<tr>
<td>Basic Planning and Scheduling Tools; Otto &amp; Wood Pg. 77</td>
<td>Types of Customer Needs; Otto &amp; Wood Pg. 116</td>
<td>Modeling Process; Otto &amp; Wood Pg. 153</td>
<td>Basic Methods: Information Gathering and Brainstorming; Otto &amp; Wood Pg. 416</td>
<td>Pugh Concept Selection Charts; Otto &amp; Wood Pg. 493</td>
<td>Product Modularity: Background; Otto &amp; Wood Pg. 362</td>
<td>Basic Planning and Scheduling Tools; Otto &amp; Wood Pg. 77</td>
<td>Types of Prototypes; Otto &amp; Wood Pg. 839</td>
<td>Support Tools for the benchmarking Process; Otto &amp; Wood Pg. 274</td>
<td></td>
</tr>
<tr>
<td>Mission Statement and Technical Questioning; Otto &amp; Wood Pg. 93</td>
<td>Gathering Customer Needs; Otto &amp; Wood Pg. 118</td>
<td>Establishing System Functionality - Creating a Function Structure; Otto &amp; Wood Pg. 162</td>
<td>Morphological Analysis; Otto &amp; Wood Pg. 454</td>
<td>FMEA Method: Linking Fault States to Systems Modeling; Otto &amp; Wood Pg. 564</td>
<td>Modular Design: Basic Clustering Method; Otto &amp; Wood Pg. 370</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grouping the Needs - Affinity Diagram Method; Otto &amp; Wood Pg. 180</td>
<td>Specification Process; Otto &amp; Wood Pg. 284</td>
<td></td>
<td></td>
<td>Chapter 13 - Modeling of Product Metrics; Otto &amp; Wood Pg. 603</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Objective Review
Objective Review

- **Strengths**
  - Two Pronged approach
  - Constructive criticism
  - Standard In Documentation

- **Weaknesses**
  - Planning
  - Team Coordination
Lessons Learned

- Proper documentation is crucial for the success of future design iterations
- Importance of team coordination
- The breadth of this issue was far greater than anticipated
  - Reasonable scoping enabled tangible results while preparing for future projects.
- It is really difficult to analyze a process when you are not experienced.