Final Report for the Taubman 3rd Floor Recommendations

Virginia Walter – Project Client, Director of Clinical Operations, University of Michigan Hospital System
Tammy Ellies – Project Coordinator, Project Manager, Internal Medicine, University of Michigan Hospital System
Mary Duck – Instructor, IOE 481

IOE 481 Team 2:
Program and Operations Analysis
Taylor Andrews
Gerald Lou
Jennifer Rothbarth

December 13, 2011
# Table of Contents

Introduction.................................................................................................................. 1  
Background.................................................................................................................. 1  
Key Issues................................................................................................................. 2  
Goals and Objectives ............................................................................................... 2  
Project Scope.......................................................................................................... 3  
Methodology............................................................................................................. 3  
  Observations......................................................................................................... 3  
  Time Studies........................................................................................................ 3  
  Patient Surveys.................................................................................................... 4  
  Patient Arrival Data............................................................................................. 4  
  Simulations.......................................................................................................... 5  
Findings....................................................................................................................... 6  
  Part 1 Findings.................................................................................................... 6  
    Observations..................................................................................................... 6  
    Time Studies Findings...................................................................................... 6  
    Patient Surveys Findings................................................................................ 6  
    Patient Arrival Findings.................................................................................. 8  
    Simulations Findings....................................................................................... 9  
  Part 2 Findings.................................................................................................... 9  
Conclusions............................................................................................................... 10  
  Part 1 Conclusions.............................................................................................. 10  
    Observations Conclusions.............................................................................. 10  
    Patient Surveys Conclusions......................................................................... 10  
    Simulation Conclusions.................................................................................. 10  
  Part 2 Conclusions.............................................................................................. 13  
Recommendations..................................................................................................... 13  
  Part 1 Recommendations..................................................................................... 13  
    Reception Room Layout................................................................................... 14  
    Eliminate Row of Chairs................................................................................ 14  
    Use Appropriate Signage for Wheelchair Areas........................................... 14  
    Reduce/Eliminate Computer Kiosks............................................................... 14  
    Staffing Plan..................................................................................................... 14  
    Queuing Systems.............................................................................................. 15  
    Visual Management System.......................................................................... 16  
  Part 2 Recommendations..................................................................................... 17  
    Pods A and B Swing Areas.............................................................................. 17  
    Pods C and D Swing Areas............................................................................. 17  
Expected Impact....................................................................................................... 17  
Appendices............................................................................................................... 19  
  Appendix A: Time Study Sheets........................................................................ 19  
  Appendix B: Patient Surveys Distributed to Pods A and B.............................. 23  
  Appendix C: Patient Surveys Distributed to Pods C and D............................. 24  
  Appendix D: Simulations...................................................................................... 25  
  Appendix E: Original Proposed Layouts for Pods A-D...................................... 26  
  Appendix F: Recommended Layouts for Pods A-D........................................... 27
Appendix G: Part 2 Recommendations
List of Figures and Tables

Table 1: Average Service Times for Each Pod in the 3rd Floor Taubman Center.................. 6
Table 2: Percentage of Responses of the Total Number of People at an Appointment......... 7
Figure 1: Pareto Chart Ranking Features Most Important to Patients................................ 7
Table 3: Average and Peak Patient Inter-arrival Times per Pod...................................... 8
Figure 2: Current State Utilization of Pods A-D From Beeper Study Data........................ 8
Figure 3: Current State Utilization of Pods A-D From Simulation.................................... 9
Figure 4: Reception Area Utilization for Original Layout vs. Recommended Layout with Chair Reduction................................................................................................................. 11
Figure 5: Original Queue State vs. Recommended (Reduced) Queue State Based on Simulations................................................................................................................................. 12
Figure 6: Percent Staff-Patient Utilization for the Proposed Number of Staff vs. the Reduced Number of Staff.................................................................................................................. 13
Figure 7: Reception Room Layout Recommendation.......................................................... 14
Figure 8: Recommended Layout of Check-In/Check-Out..................................................... 15
Figure 9: Recommended Single-Line Queue in Pod A......................................................... 15
Figure 10: Recommended Single-Line Queue in Pods B, C, and D...................................... 16
Figure 11: Recommended Visual Management System....................................................... 16
Executive Summary

The Taubman Center third floor houses the Department of Internal Medicine clinics for University of Michigan Hospital System (UMHS). The third floor of the Taubman Center will undergo a renovation beginning approximately February 2012. During this renovation, the layout of pods A-D will be completely changed to accommodate a larger reception area and updated facilities. Pods A and B will have a combined check-in, reception, and check-out area; pods C and D will also be combined into one area. The team has been asked to analyze the current proposed layout and provide recommendations to improve the layout. The team’s recommended design will include location of service desks and layout of reception area. These recommendations need to optimize patient flow and use it as an opportunity to improve patient care.

Background

The Taubman Center clinics on the third floor consist of 4 pods, with each pod housing a different specialty. The clinics are currently outdated, and the infrastructure is not set up for today's technology. Clinics on other floors of the Taubman Center have been recently renovated, leaving the 3rd floor clinics looking old and out of place. The Hospitals and Health Systems Executive Board (HHCEB) approved the renovation project in May 2011. This renovation project presents the opportunity to improve patient care and patient flow by altering the reception areas, check-in and check-out stations, exam rooms, and nursing and physician rooms. The project has been divided into two parts: (1) the layout of the clinics post-renovation, and (2) the improvements to patient flow during the renovation process.

Methodology

Both parts of this project require recommendations that can be based on the same data and observations, so all data collected and analyzed was used for all recommendations. In order to develop these recommendations, the team accomplished the following:

- Conducted and analyzed time studies
- Conducted and analyzed patient surveys
- Analyzed patient arrival data provided by the coordinator
- Created simulations to model the current and future states

Time Studies

The team used time studies to measure check-in and check-out process times in pods A-D of third floor Taubman. The team performed these time studies during the workweek of October 10th during normal operating hours of the clinics. During the week of data collection, the team visited each pod and validated the time studies by hand timing each process and making sure the staff was correctly filling out the time studies on three consecutive trials. In total, 313 data points were collected and analyzed. The team analyzed the data using the pivot table tool in Microsoft Excel 2010. The pivot tables generated average process times for each pod. The process times were used as inputs into the simulation that helped the team make recommendations.

Patient Surveys
The patient survey was used to help populate data in the simulation and understand the impacts of layout on patient satisfaction. Patients filled out the survey throughout their visit and left the completed surveys with the check-out staff. Patient surveys were distributed in pods A-D from October 24th through October 28th during normal operating hours of all the clinics. The team analyzed the 414 collected surveys using the pivot table tool in Microsoft Excel 2010.

**Patient Arrival Data**
The coordinator provided the team with two sets of data for each pod. The first set of data was patient arrival data, collected for one full year. The team analyzed the arrival times for each pod using Microsoft Excel and Minitab Statistical Software. Using Microsoft Excel, the team found the inter-arrival times for patients, with a total of 56,921 data points. These inter-arrival times were used as inputs into the simulation.

The second set of data was the results from a beeper study conducted by hospital employees. They would record how many staff were being utilized at check-in and check-out, how many patients were being helped by the staff, how many patients were in line to check in or check out, as well as how many people were waiting in the reception area. The team analyzed this data using pivot tables and bar graphs in Microsoft Excel. The results from the tables and graphs were used to validate the accuracy of the simulations.

**Simulations**
The team developed two simulations, which were run using ProModel 2011. The inputs for the model came from the data collected in the time studies, patient surveys, and patient arrival data. The outputs were analyzed with ProModel 2011 and used in the team’s recommendations to the client. The first simulation was modeled after the current state. The results from the current-state simulation were validated against the utilization analysis performed by the team.

The team created a future-state simulation, and incorporated the original proposals as inputs into it. The future-state simulation produced the same outputs as the current-state simulation, and the team used the results to develop recommendations.

**Findings**
The team analyzed all of the data from the time studies, patient surveys, and patient arrival data to use as inputs into the simulation. The team then analyzed the outputs from the simulations to help develop recommendations.

**Patient Surveys Findings**
Patient surveys allowed the team to calculate the average number of people visiting with the patient, and this value was used as an input into the simulation. The team calculated that the patient brings 0.7742 people on average with him/her.

**Simulations Findings**
The current state simulation shows that the reception areas in pods B, C, and D are full 0% of the time. In all pods, the check-in area is being occupied approximately 40% of the time, and the check-out area is occupied approximately 50% of the time.
Conclusions
The team concluded that the four features patients find the most important are: comfortable chairs, drinking water, television with volume, and wireless internet.

The simulations indicate that the check-in, check-out, and cash-out staff are fully utilized less than 20% of the time. Based on this realization, the team ran the future-state simulation with one less receptionist desk in pods B, C, and D than originally proposed. The team concluded that reducing the number of receptionist desks in pods B, C, and D has no effect on the number of people waiting in line. The team also concluded that a reduction in desks would not greatly increase the staff utilization based on the simulation outputs.

Recommendations
Based on the previous conclusions, the team came up with the following recommendations.

Reception Room Layout
The team recommends to eliminate row of chairs nearest to the entrance of the clinic in all pods. While this will decrease the seating capacity by 6 seats, it will provide more privacy for the check-in/check-out patients as well as allow more visibility for the reception staff.

Staffing Plan
The team recommends that the staff be decreased by one in pods B, C, and D. This reduction would decrease the maximum serving capacity by one, but it would allow extra room for receptionists and medical assistants behind the desk area.

Queuing Systems
To control patient flow during peak and busy hours, the team recommends that the clinics use a single-line queuing system. In this system, all patients will line up in one area to check in and to check out. This system gives no preference to either service. All receptionists will also utilize a visual management system that will alert patients which receptionists are available and which are not.

Swing Area Recommendations
When pod A or B is being renovated, patients should check in, wait, and check out in the central swing area. Three to four multifunctional reception desks should be used, and all additional staff can help direct patients. Keeping all services in one area will reduce patient confusion, and therefore help to increase patient satisfaction during the construction phases.

During renovation in pod C or D, patients should check in and wait in the south area and check out in the central area. Pods C and D see a higher number of patients, so these renovation phases will need three to four check-in and check-out desks in each location. Proper signage and possible volunteers should be utilized to direct patient flow.
Introduction

The Taubman Center third floor houses the Department of Internal Medicine clinics for University of Michigan Hospital System (UMHS). The third floor of the Taubman Center will undergo a renovation beginning approximately February 2012 and lasting 18-24 months. Third floor Taubman consists of four pods; each pod holds a clinic specializing in a different type of internal medicine. During this renovation, the layout of pods A-D will be completely changed to accommodate a larger reception area and updated facilities. Pods A and B will have a combined check-in, reception, and check-out area; pods C and D will also be combined into one area. The Director of Clinical Operations has asked a student team from the University of Michigan to analyze the current proposed layout (see Appendix E for the proposed layout) and recommend a design for the check-in, reception, and check-out areas of each pod both during renovation and after renovation. The team’s design will include location of service desks and layout of reception area. These recommendations need to optimize patient flow and use the patient flow as an opportunity to improve patient care. This report presents the team’s analysis of the current state of these areas before the renovation, recommendations to improve patient flow during the renovation, and recommendations to optimize patient flow after the renovation is completed.

Background

The Taubman Center clinics on the third floor consist of 4 pods; pod A specializes in rheumatology; pod B specializes in general medicine; pod C specializes in pulmonary medicine, nephrology, and medical genetics; and pod D specializes in infectious disease and gastroenterology. The patient traffic for each pod varies. The clinics have not been renovated since the center’s original construction in 1986 resulting in an outdated facility, and an infrastructure that is not set up for today’s technology. Clinics on other floors of the Taubman Center have been recently renovated, leaving the 3rd floor clinics looking old and out of place. The Hospitals and Health Systems Executive Board (HHCEB) approved the renovation project in May 2011. This renovation project presents the opportunity to improve patient care and patient flow. The reception areas, check-in and check-out stations, exam rooms, and nursing and physician rooms will be changed during the renovation.

The project has been divided into two parts; the first being the layout of the clinics post-renovation, and the second part being the improvements to patient flow during the renovation process. The team designated “swing” areas for patient reception during the renovation phases, which includes check-in, waiting, and check-out. The deadlines for renovation design are more important, and the recommended layout is a more long-term solution, therefore giving this part of the project preference.

Beginning in February 2012, the Health System is going to implement a new electronic medical record system called MiChart. This new medical record system may affect patient care, but the effects are unknown, and therefore MiChart has not been considered in the team’s recommendations.
Key Issues

The following key issues are driving this project:

- Too small of reception areas
- Poor patient flow
- Outdated facilities that do not match other parts of the hospital
- Older infrastructure that cannot support modern technology
- Patient accommodations during renovation phases

Goals and Objectives

The goal of this project is to optimize patient care. The first objective is to design the clinic renovation layout. This goal will be realized by achieving the following:

- Recommend seating capacity
- Recommend patient flow
- Recommend queuing system

The second objective is to maintain optimal patient flow during the renovation period, which will be achieved through the following:

- Recommend designated “swing” areas for each phase of renovation
- Recommend methods to direct patients to and from the “swing” areas

Project Scope

This project was divided into two parts. Part one required recommendations for the new layout plan, and part 2 required a plan to provide a seamless transition for patient flow during the renovation. The layout recommendations only include the check-in, reception, and check-out areas for pods A-D on the third floor of the Taubman Center. The patient process begins when a patient queues up to check-in and ends when the patient checks out. The scope includes only the time spent during check-in, waiting in the reception area for intake, and check-out. The scope also includes the team’s recommendations to incorporate visual management to help improve patient flow.

In addition, the recommendation for patient flow during renovation only includes the temporary seating area and reception area (swing areas) for pods A-D on the third floor of the Taubman Center.

This project does not involve any task or area other than the reception area, specifically the exam rooms and nursing and physician rooms. Services or areas outside pods A-D on the third floor of the Taubman Center were also not be studied or included in this project. The scope does not include the actual tasks performed during check-in or check-out. In addition, the introduction and subsequent effects of MiChart were not considered.
Methodology

The only department affected by the team’s methodology was the internal medicine department on the 3rd floor of the Taubman Center. This project also affected the reception staff and medical assistants in all four pods of the 3rd floor.

Both parts of this project require recommendations that can be based on the same data and observations, so all data collected and analyzed was used for all recommendations. In order to develop these recommendations, the team accomplished the following:

- Observed the current process and layout of the clinics
- Conducted and analyzed time studies
- Conducted and analyzed patient surveys
- Analyzed patient arrival data provided by the coordinator
- Created simulations to model the current future states

Observations

The team observed the process and patient flow of each pod. This process included check-in, waiting in the reception area, cash-out (for pods C and D), and check-out. The team also observed the current state of the reception room and hallways to help develop the part 1 recommendations.

To help develop the part 2 recommendations, the team observed the entire 3rd floor Taubman center to identify spaces that could serve as potential swing areas.

Time Studies

The team used time studies to measure check-in and check-out process times in pods A-D of third floor Taubman. The team drafted time collection sheets to be filled out by clinic staff to record the various process times with input from the client and coordinator. A pilot time study ran from October 7th – October 8th. Based off of the input from the reception staff and medical assistants in the pilot study, the team learned that each pod had a unique process and, as a result, developed a specific data collection sheet for each pod. After the pilot, the team administered the official time studies in each pod and trained the staff to fill the studies out. See Appendix A for all four official time studies. The team administered these time studies during the workweek of October 10th during normal operating hours of the clinics. During the week of data collection, the team visited each pod and validated the data by hand timing each process and making sure the staff was correctly filling out the time studies on three consecutive trials.

The team picked up and analyzed the data collection sheets from October 15th through October 18th. In total, 313 data points were collected and analyzed. Problems with the data included incompleteness due to staff not having time to fill out data sheets; however, this did not pose a problem in the analysis because the sample size exceeded 30 samples, allowing the assumption of normality.

The team analyzed the data using the pivot table tool in Microsoft Excel 2010. The pivot tables generated average process times for each pod and were stratified based on date to identify
outliers in the data. In pods A and B, the cash-out process is combined with the check-out process, but they are separate in pods C and D. When using these times for inputs into the simulations, the cash-out and check-out times were combined into one entire check-out time. The process times were used as inputs into the simulation that aided the team in making recommendations.

**Patient Surveys**
The patient survey was used to help populate data in the simulation and understand the impacts of layout on patient satisfaction. The team developed a first draft of the patient survey, which was revised by both the coordinator and the team. In addition, the team met with the client and coordinator to discuss the impacts of the survey on the clinics and patients. After several revisions, the patient surveys were approved and distributed to each pod for the check-in staff to provide the patient with a survey (see Appendices B and C). The patients filled out the survey throughout their visit and left the surveys with the check-out staff. Patient surveys were distributed in pods A-D from October 24th through October 28th during normal operating hours of all the clinics.

The team collected 413 completed patient surveys on October 28th and entered the data into Microsoft Excel on November 4th. The team analyzed the data using the pivot table tool to organize the findings. Data was stratified by pod, date, and time of day. The team used the findings as inputs for the simulation and to help develop recommendations.

**Patient Arrival Data**
The coordinator provided the team with two sets of data for each pod: the first set of data was patient arrival data and the second set of data was a beeper study utilization analysis. The patient arrival data was collected for one full year from July 15, 2010 though July 14, 2011. This data included patient identification numbers, scheduled appointment times, arrival times, check-in times, and check-out times. The team analyzed the arrival times for each pod using Microsoft Excel and Minitab Statistical Software. Using Microsoft Excel, the team found the inter-arrival times for patients, with a total of 56,921 data points. The team then found the average inter-arrival time in Microsoft Excel. The team created histograms of the inter-arrival times for each pod in Minitab and stratified the data by time of day. The team used these histograms to identify the peak periods for each pod. The team reduced the number of inter-arrival data points to include only those that fell in the peak period, and they found the average inter-arrival time for patients during peak periods in each pod. These inter-arrival times were used as inputs into the simulation.

The second set of data was the results from a beeper study conducted on three different days in July. The beeper was set to go off every 15 minutes during normal operating hours. When the beeper went off, an administrator would look at the check-in, waiting, and check-out areas. The administrator recorded how many staff were at check-in and check-out, how many patients were being helped by the staff, how many patients were in line to check in or check out, as well as how many people were waiting in the reception area. The team analyzed this data using pivot tables and bar graphs in Microsoft Excel. The results from the tables and graphs were used to validate the accuracy of the simulations.
Simulations
The team developed two simulations, which were run using ProModel. The inputs for the model came from the data collected in the time studies, patient surveys, and patient arrival data. The model was a static model, which gave the team outputs used in the recommendations. Outputs included:

- Average visit time
- Average reception time
- Capacity and percent utilization of the reception area
- Queue formation and length
- Staff utilization

These outputs were analyzed with ProModel 2011 and used to develop the team’s conclusions and recommendations to the client.

The first simulation was modeled after the current state. The team created a simulation that would run for all four pods. Because each pod operates differently, this simulation ran each pod separately with data specific to each pod. The inputs for this simulation included:

- Average and peak patient inter-arrival times
- Average check-in, waiting, and check-out times
- Average number of people accompanying patients
- Three receptionists at check-in
- Three receptionists at check-out

The results from the current-state simulation were compared with the utilization analysis performed by the team. After showing the results from the simulation and utilization analysis to the client and coordinator, the simulation was deemed accurate based on their experience and expectations.

The team created a future-state simulation, and incorporated the original proposals as inputs into it. These inputs include:

- Combined check-in, cashiering, and check-out staff
- 4 receptionists for pod A
- 6 receptionists for pod B
- 7 receptionists for pods C and D
- Reception room seating capacity increased by 30%

The future-state simulation produced the same outputs as the current-state simulation, and the team used the results to develop recommendations.
Findings

The team used the findings from the time studies, patient surveys, and patient arrival data as inputs into the simulation. The team then used the findings from the simulation to draw conclusions and develop recommendations. The team also made observations of the layout of the 3rd floor to develop possible swing areas for part 2 of the project.

Part 1 Findings

The team observed, collected, and analyzed many different types of data to create inputs for the simulation. The findings were used in the simulation, and are all summarized here.

Observations

The team made many observations about the current state of each pod, including the following:

- There is no designated wheelchair seating
- Many patients wait on benches in the hallway, outside of the reception area

Time Studies Findings

A summary of the time studies analysis can be seen below in Table 1:

<table>
<thead>
<tr>
<th>Pods</th>
<th>Average Check-In Time</th>
<th>Average Waiting Room Time</th>
<th>Average Cash-Out Time</th>
<th>Average Check-Out Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1:27</td>
<td>24:55</td>
<td>--</td>
<td>5:00</td>
</tr>
<tr>
<td>B</td>
<td>0:33</td>
<td>11:43</td>
<td>--</td>
<td>4:29</td>
</tr>
<tr>
<td>C</td>
<td>1:34</td>
<td>20:57</td>
<td>0:46</td>
<td>1:31</td>
</tr>
<tr>
<td>D</td>
<td>2:06</td>
<td>26:13</td>
<td>1:00</td>
<td>6:15</td>
</tr>
</tbody>
</table>

As shown in Table 1, times for each service vary for each pod. These values were used as inputs for both the current-state and future-state simulations, so the results from the simulations depend, in part, on the results above.

Patient Surveys Findings

The patient surveys provided the team with two important pieces of information: the number of people visiting with the patient, and the waiting room features the patients desired most. First, the surveys asked patients the number of people with them at their appointment. Table 2 below summarizes the results. This allowed the team to calculate the average number of people visiting with the patient, and this value was used as an input into the simulation.
Table 2: Percentage of Responses of the Total Number of People at an Appointment (IOE481, Team 2, Taubman Renovation, N=413, Collected 10/24/2011-10/28/2011)

<table>
<thead>
<tr>
<th>Total Number of People at Appointment</th>
<th>Percentage of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>37.97%</td>
</tr>
<tr>
<td>2</td>
<td>49.80%</td>
</tr>
<tr>
<td>3</td>
<td>9.50%</td>
</tr>
<tr>
<td>4</td>
<td>2.30%</td>
</tr>
<tr>
<td>5</td>
<td>0.43%</td>
</tr>
</tbody>
</table>

Using Table 2, the team calculated the weighted average of the total number of people at the appointment to be 1.7742. This value means that for every one patient coming into the clinics, the patient brings 0.7742 people with him/her.

The second piece of information the team was patient preferences for various features of their visit. The survey asked patients to check any feature that they wanted as part of their visit. A summary chart of this data is below in Figure 1:

Figure 1: Pareto Chart Ranking Features Most Important to Patients (IOE481, Team 2, Taubman Renovation, N=413, Collected 10/24/2011-10/28/2011)

Figure 1 shows that patients desire the nine possible amenities in the following order:

1. Comfortable chairs
2. Drinking water
3. Television with volume
4. Wireless internet
5. Bright lighting
6. Privacy from main hallway
7. Music
8. Computer kiosks
9. Television with no volume

Patient Arrival Findings
The team used the patient arrival findings as inputs into the simulation. Table 3 below shows the average and peak inter-arrival times for patients in each pod:

Table 3: Average and Peak Patient Inter-arrival Times per Pod (m:s) (IOE481, Team 2, Taubman Renovation, N=56,921, 07/15/2010-07/14/2011, Data provided by Tammy Ellies, Project Manager)

<table>
<thead>
<tr>
<th>Pod</th>
<th>Average Patient Inter-arrival Time</th>
<th>Peak Patient Inter-arrival Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6:23</td>
<td>3:58</td>
</tr>
<tr>
<td>B</td>
<td>8:16</td>
<td>5:56</td>
</tr>
<tr>
<td>C</td>
<td>5:18</td>
<td>3:37</td>
</tr>
<tr>
<td>D</td>
<td>4:57</td>
<td>3:30</td>
</tr>
</tbody>
</table>

The team also analyzed the second piece of data provided by the coordinator: the beeper study data. The team created graphs of the utilization of the reception in each pod, which can be seen below in Figure 2:

Figure 2: Current State Utilization of Pods A-D From Beeper Study Data (Data provided by Tammy Ellies, Project Manager)
Figure 2 shows that all pods are empty to some degree in check-in, check-out, cash-out, and the reception areas, meaning that the reception staff are not being fully utilized or the reception room is not at full capacity. In fact, Figure 2 shows that the reception areas are never full in any of the pods.

**Simulations Findings**
The team used the current-state simulation to assess the validity of the simulation. The results can be seen below in Figure 3:

The client and coordinator compared Figures 2 and 3 to determine that the simulation is accurate enough in its outputs. Deviation between the model and actual current utilization can be explained through the model assumptions previously discussed in simulation methods.

**Part 2 Findings**
The team’s findings for the renovation plan are based on observations from both the current layout and the proposed layout. These observations include:

- Renovation begins at pod D and moves to pod A
- Only one pod will be renovated at a time
- Pods A and B experience less patient traffic than pods C and D
- There are two possible swing areas
  - South area
Central area

Please see Appendix G for a layout of the 3rd floor with the two potential swing areas highlighted. The team used these findings to draw conclusions and ultimately make its final recommendations.

Conclusions

The team based all of its conclusions on the findings above, and it used these conclusions to develop recommendations for both parts 1 and 2 of the project.

Part 1 Conclusions

The team drew many conclusions from both its observations of the current pods as well as the findings from the patient surveys and the simulations.

Observations Conclusions

Due to the lack of signage for wheelchair seating, patients are often confused on where to park. In many occurrences, patients will park in the hallways.

Patients sit in the hallways because they believe that the reception area is full. While this is often not the case, patients would prefer to sit in the halls than sit next to someone they perceive as sick. These extra seats can increase the reception area’s capacity.

Patient Surveys Conclusions

Based on Figure 1, the team concluded that the four most requested features are:

- Comfortable chairs
- Drinking Water
- Television with Volume
- Wireless Internet

The team incorporated these features into their recommendations for the proposed layout.

In addition, computer kiosks are not highly demanded according to Figure 1. The high demand for wireless internet and the low demand for kiosks suggest that patients have devices that can already utilize the internet. However, the findings do not consider the possible transformation of computer kiosks into self-check stations with MiChart.

Simulation Conclusions

Figure 2 indicates that the reception area is never at full capacity in the proposed layout. This conclusion led the team to run another simulation after reducing the reception area capacity by six chairs in each area. Figure 4 shows the results of this simulation.
Figures 2 and 3 also indicate that the check-in, check-out, and cash-out staff are hardly ever fully utilized. Based on this realization, the team ran the future-state simulation with one less receptionist in pods B, C, and D than originally proposed. Figure 5 below shows the average and maximum number of patients waiting in line for the proposed number of reception staff (top row) and for the reduced number of reception staff (bottom row):
After analyzing these graphs, the team concluded that reducing the number of reception staff in pods B, C, and D has no effect on the number of people waiting in line.

The team also analyzed whether the reduction in reception workstations would greatly increase staff utilization. Figure 6 below shows the percent utilization of the reception staff for the original proposal (4 left bars) and with the team’s recommendations (4 right bars):
The team concluded from Figure 6 that a reduction in workstations would not greatly increase the staff utilization with patients.

**Part 2 Conclusions**

After observing the current and proposed layouts of the 3rd floor Taubman Center, the team came to the following conclusions:

- Pods A and B will require 3-4 reception staff
- Pods C and D will require 6 reception staff
- Pods C and D see too many patients to utilize only one swing area

The team used these conclusions to make its recommendations for the renovation phases.

**Recommendations**

Based on the previous conclusions, the team came up with the following recommendations. These recommendations are broken down into two categories: part one and part two. As mentioned earlier in the report, part one affects the layout and staffing plan for after renovation is completed. Part two affects the plan for patient flow during the nine renovation phases.

**Part One Recommendations**

The following recommendations are for part one of the project.
Reception Room Layout
The team recommends the following changes be made in the plan for the reception room to improve patient satisfaction and care:

- Eliminate row of chairs nearest to the entrance of the clinic in all pods
- Use appropriate signage to designate wheelchair areas
- Reduce or eliminate computer kiosks

Eliminate Row of Chairs. The team recommends that the row of chairs nearest to the entrance of the clinics be removed, as seen in Figure 7 below. This recommendation removes six chairs from the capacity of the combined reception areas. Based on the team’s conclusions (Fig. 4), there is a slight increase in time when the reception area is full. However, this fullness will be marginalized by the fact that there will be additional bench seating outside of the clinic area during and after renovations.

Use Appropriate Signage for Wheelchair Areas. The proposed layout designates areas that are reserved for wheelchair seating. However, these areas are not marked, and the team recommends that there is appropriate signage designating these areas.

Reduce/Eliminate Computer Kiosks. From the data collected from the patient surveys, see Figure 1, there is not a need for the proposed computer kiosks. This elimination will have marginal impact on patient satisfaction during their visit. Instead of the kiosks, the team recommends that the clinic provide relevant reading material to the patients to read during their visit. Also, the high demand for the existing wireless internet suggests that patients already can access the material that the computer kiosks would provide.

Staffing Plan
From Figure 6, the team concluded that reducing the number of desks in pods B, C, and D would not greatly effect the staff’s individual patient utilization. Therefore, the team recommends reducing the number of desks by one in pods B, C, and D. This will create a layout shown below in Figure 8:
This reduction would decrease the maximum serving capacity by one, but it would allow extra room for receptionists and medical assistants behind the desk area. With the addition of space behind the desks, the team recommends building a working wall behind the corner desks. This wall would adhere to the “hotel allusion” to conceal clutter and activities in the exam room hallways.

**Queuing Systems**
To control patient flow during peak hours, the team recommends that the clinics use a single-line queuing system. This system can be seen in Figures 9 & 10 below:
In this single-line queuing system, all patients will line up in the same area for check-in and for check-out. The queue will be marked with signage as well as line dividers. The signs will decrease potential confusion, and the dividers will offer patients privacy when checking in and checking out. Another benefit to this option is that the line will not extend into the hallway outside of the clinics. However, because patients line up both to check-in and to check-out, no preference can be given to either. The team does not think that this lack of discrimination will pose a problem to the patient service though.

*Visual Management System*

This queue system will also utilize a visual management system to help direct patients to available receptionists. The team suggests utilizing a dual-monitor system that will be controlled by each receptionist. One monitor (the secondary monitor) will face the patients in the queue, and the other monitor (the primary monitor) will be used by the receptionist. If the receptionist is available to help the patient, the receptionist should set his/her secondary monitor to “Available,” as shown in Figure 11 below. If the receptionist is working on another non-patient oriented task, the receptionist should set the secondary monitor to “Unavailable.”
This visual management system will be used by all receptionists to indicate whether or not they are available to help patients. By using this dual-monitor system, the receptionists can reduce patient confusion as well as ensure they can complete all of their non-patient related work. This dual monitor system will also allow a cost effective method for managers to collect data on the utilization of the reception staff, which could lead to further improvements in the future.

**Part 2 Recommendations**

The recommendations for Part Two include designated swing areas for each of the 9 phases of the renovation. There are two main areas to be used for the swing areas: the central area by the PFT Lab, and the south area where Mott used to be. Please see Appendix G for a layout of the 3rd floor as well as where these swing areas are. These swing areas accommodate reception desks as well as waiting areas for patients. Because pods A and B see fewer patients than pods C and D, the team developed these recommendations differently. The team also recommends utilizing proper signage, as well as potential volunteers or staff to help direct patients.

**Pods A and B Swing Areas**

The team recommends using only the central swing area for patients and receptionists when pods A or B are being renovated because these pods see fewer patients. Three to four multifunctional service desks can be set up with additional space for seating both in the central swing area as well as with benches in the adjacent hallway. Patients will check in at the temporary service desks, wait in the swing area, and be brought back to the exam rooms through pods C or D. When the patient leaves the exam room to check out, the patient will return to the same swing area to do so. Please see Appendix G for a diagram showing the patient flow for this swing area. By keeping the check-in, waiting, and check-out processes all in the same place, the patients will be less likely to be confused.

**Pods C and D Swing Areas**

The team recommends using both the south and central areas as swing areas due to the higher volume of patients pods C and D see. Three to four desks will be set up in each area, with check-in desks at the south swing area, and check-out desks at the central area. When patients arrive, they will check in and wait at the south swing area. They will then go back to the exam rooms through a back hallway, and finally check out at the central swing area. See Appendix G for a diagram showing the patient flow for the renovation of pods C and D. While it is not ideal separating the check-in and check-out services, it will allow for increased patient satisfaction by offering a larger waiting area.

**Expected Impact**

The team provided a recommendation for the layout plans of Pods A-D on the third floor of the Taubman center. The recommendations will improve patient flow and satisfaction by

- Eliminating rows of chairs to decongest the seating area
- Changing the layout of the reception desks to optimize workspace area
- Creating a working wall that provide privacy and file storage
- Using appropriate signage to designate wheelchair seating
• Reducing computer kiosks to provide more room for patients
• Implementing a single line queue system which minimizes patient confusion
• Implementing a visual management system which minimizes patient confusion

In addition, the team provided a transition plan during the renovation phases to minimize patient confusion and optimize patient flow. This transition plan includes designated swing areas and areas for reception desks.
POD: A

Date: 10 / / 2011

Speciality: Rhematology

<table>
<thead>
<tr>
<th>Process</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check-In</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA Intake Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Patient is Brought to Exam Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check-Out</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Is Patient returned to waiting room after initial intake? Y N

Is there a line at check-out? Y N

Figure A-1: Time Study Distributed to Pod A
Figure A-2: Time Study Distributed to Pod B

<table>
<thead>
<tr>
<th>Process</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check-In</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Patient is Brought to Exam Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check-Out</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Is Patient returned to waiting room after initial intake?  
Y  N

Is there a line at check-out?  
Y  N

Comments:  

**Table:**

<table>
<thead>
<tr>
<th>Process</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check-In</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Patient is Brought to Exam Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check-Out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Start Time</td>
<td>End Time</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------</td>
<td>----------</td>
</tr>
<tr>
<td>Check-In</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Patient is Brought to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exam Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash-Out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check-Out</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Is Patient returned to waiting room after initial intake?  
Y  N

Is there a line at check-out?  
Y  N

Comments:  

Figure A-3: Time Study Distributed to Pod C
POD: D

Date: 10 /  / 2011

Speciality: Infectious Diseases, Gastroenterology

<table>
<thead>
<tr>
<th>Process</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check-In</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>Time Patient is Brought to Exam Room</td>
<td>:</td>
<td></td>
</tr>
<tr>
<td>Cash-Out</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>Check-Out</td>
<td>:</td>
<td>:</td>
</tr>
</tbody>
</table>

Is Patient returned to waiting room after initial intake? Y N

Is there a line at check-out? Y N

Comments:

Figure A-4: Time Study Distributed to Pod D

Appendix B: Patient Surveys Distributed to Pods A and B
We are planning to renovate our clinics on the third floor of the Taubman Center, and would like to ask you about your visit today.

1. What specialty did you see?  
   - Gastroenterology  
   - General Medicine  
   - Infectious Diseases  
   - Medical Genetics  
   - Nephrology  
   - Pulmonary  
   - Rheumatology  
   - Other:  

2. How many people came with you to your appointment?  
   - 0  
   - 1  
   - 2  
   - 3  
   - 4  
   - 5 or more

3. Did you wait in line to check in?  
   - Yes  
   - No

4. Were you brought back to the waiting area after your height and weight were measured?  
   - Yes  
   - No

5. Did you wait in line to check out?  
   - Yes  
   - No

6. Which of the following features are important to you in the reception area of our clinics? Check as many as apply.  
   - Comfortable chairs  
   - Television with volume  
   - Television with no volume  
   - Music  
   - Wireless internet  
   - Computer kiosk  
   - Drinking water  
   - Privacy from main hallway  
   - Bright lighting

7. Anything else you’d like to suggest or share?

Thank you for your feedback! Please turn this form in when you check out.
Appendix C: Patient Surveys Distributed to Pods C and D

We are planning to renovate our clinics on the third floor of the Taubman Center, and would like to ask you about your visit today.

1. What specialty did you see? □ Gastroenterology
   □ General Medicine
   □ Infectious Diseases
   □ Medical Genetics
   □ Nephrology
   □ Pulmonary
   □ Rheumatology
   □ Other:

2. How many people came with you to your appointment? □ 0 □ 2 □ 4
   □ 1 □ 3 □ 5 or more

3. Did you wait in line to check in? □ Yes □ No

4. Were you brought back to the waiting area after your height and weight were measured? □ Yes □ No

5. Did you wait in line to pay? □ Yes □ No

6. Did you wait in line to check out? □ Yes □ No

7. Which of the following features are important to you in the reception area of our clinics? Check as many as apply.
   □ Comfortable chairs
   □ Television with volume
   □ Television with no volume
   □ Music
   □ Wireless internet
   □ Computer kiosk
   □ Drinking water
   □ Privacy from main hallway
   □ Bright lighting

8. Anything else you’d like to suggest or share?

Thank you for your feedback! Please turn this form in when you check out.
Appendix D: Simulations

Figure D-1: Current State Simulation (IOE481, Team 2, Taubman Renovation, 11/07/2011)

Figure D-2: Future State Simulation (IOE481, Team 2, Taubman Renovation, 11/07/2011)
Appendix E: Original Proposed Layouts for Pods A-D

Figure E-1: Pods A and B Proposed Layout

Figure E-2: Pods C and D Proposed Layout
Appendix F: Recommended Layouts for Pods A-D

Figure F-1: Pods A and B
Recommended Layout

Figure F-2: Pods C and D Recommended Layout
Appendix G: Part 2 Recommendations

Figure G-2: Pod B Recommended Swing Area and Patient Flow

Figure H-1: Pod A Recommended Swing Area and Patient Flow
Figure G-4: Pod D Recommended Swing Area and Patient Flow

Figure G-3: Pod C Recommended Swing Area and Patient Flow