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College of Engineering

Department of Mechanical, Industrial & Manufacturing Engineering

# Layout and Machine Usage Analysis of the Marino Fitness Center

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# Layout and Machine Usage Analysis of the Marino Fitness Center

IE 2310 Introduction to Industrial Engineering

by

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## Abstract

The Marino Recreation Center is one of the busiest centers on campus. The weight room, the busiest section of Marino, is an unfortunate display of poor planning. The way the weight room is set up lends people to using free weights in aisles, causing others to be unable to walk around in the already cramped room. In order to obtain a better understanding of how and why Marino has so many bottlenecks in the process of working out, a weeklong time study was done and the data was analyzed to find where the bottlenecks occur most often in the gym. As anticipated, the biggest back-up was due to the wait times during weight lifting workouts. The other major problem found was the amount of people lifting free weights in aisles. These two problems cause lifting at Marino to be a longer, more wasteful process than other gyms on campus (such as Squashbusters) where the equipment has been set up in a more optimal way. After analyzing these problems, the conclusion was to reorganize the machines in the gym based on the muscles that were being exercised. In making this change, as well as rearranging where the equipment lies in the gym, it will make lifting at Marino an easier, less time-consuming workout.

# Problem Statement

This investigation explores and analyzes Northeastern's Marino Center gym, in order to identify problem areas and discuss optimal solutions. The main issue at hand regarding the Marino Center is that the gym becomes extremely congested, especially during peak times, and wait times for gym equipment become long and stressful. Other than long wait times, problem areas include the overcrowding of the third floor weight room, and difficulty completing workouts due to inefficiencies in equipment layout. One essential observed problem in the layout of the weight room is that while there are two clear paths for walking, the free weights (dumbbell) area against the wall is consistently crowded, as gym goers will use their free weights to perform exercises right there in the walkway. The proposed floor plan and cellular manufacturing technique of rearranging equipment in the weight room addresses this issue.

The problem at hand carries significant ties to Industrial Engineering. One definition of Industrial Engineering is "engineering that deals with the design, improvement, and installation of integrated systems as of people, materials, and energy in industry." There is a myriad of definitions associated with terminology that identify entire fields of study, but the common factor lies in optimization and improvement. The investigation at hand utilizes Industrial Engineering techniques and tools to analyze the current layout, flow, and overall design of Northeastern's Marino Center in order to discuss possible solutions to the problem, thus optimizing and improving the current state.

The investigation focuses on the floor layout for the third floor weight room as well as the machines located on the opposite side of the third floor. The data and analysis provided in this report is pertinent to the discussion of general solutions. The most important raw data, time studies done on sample workouts, serve to illustrate the issue at hand which is excessive wait times for machines that cause bottlenecks. The studies were analyzed and the obvious causes for wasted time in a workout were defined and plotted using pareto charts, which identify and organize the causes by order of importance.

While a workout is like a manufacturing process in which the person, divided into sub groupings defined by the body part being worked, is the part, and the machines are the manufacturing equipment, a coefficient similarity matrix between the parts was made and used to organize the machines into cells. Finally, the layout of machines was optimized and redrawn. All of these Industrial Engineering tools are presented in this report, with analysis and discussion to present how the improvements would provide benefits.

The presented redesign of Northeastern's Marino Center's machine layout would have significant benefits for users. Users include students, faculty, and certain members of the community that also use the gym. The gym would become less congested, and wait times would decrease. This ultimate goal is the aim of the investigation, and would mean that gym users would have shorter and simpler workouts that are not hindered by a crowded weight room.

# Analysis

In order to effectively analyze the movement of students within the Marino Center, it was essential to collect meaningful data. The data serves the purpose of either supporting or disproving initial hypotheses, and/or bringing new solutions to light. Although no conclusions can be derived strictly from the raw data itself, it can be used to construct pertinent charts which help to better visualize the complexities of human behavior.

One of the core objectives of this study was to identify components of the gym that contribute to wasted time during students' workouts. Accordingly, the primary data that was collected in a week-long time and motion study. A time study is a procedure for measuring how fast a person or machine moves from one activity to the next in a system. In the case of this particular project, the time study measured how fast an individual is able to move from one lifting machine to the next in the Marino gym. The total movement time between machines and equipment is broken up into five distinct components: The transition time taken to get from the previous equipment to the current equipment (transition), the amount of time an individual must wait before the equipment is unoccupied (wait), the time taken to gather and attached the desired amount of weight to the equipment (gather), the time taken to clean the equipment with a wet wipe after it has been used (clean), and the amount of time taken to return the weights on the equipment to their correct weight racks (put back). Because the focus of the study was to identify time wasted during the transition from one machine to the next, it was decided not to include the time spent on the machine. Theoretically, the time on each machine is a constant value, so it cannot be shaved of any unnecessary time.

Once the data had been collected it was then formatted into orderly tables. It was decided that the time data would be formatted into three distinct tables: time spent on leg equipment, time spent of chest equipment, and time spent on back equipment. The various tables represent core muscle groups that weightlifters generally target on individual days. For example, a weight lifter may target chest on Monday, legs on Wednesday, and back on Friday. Additionally, the average of each time wasted category was calculated for each type of machine. By taking the average values, the analysis section of the study

is protected against abnormal outlier values. All of the data collected in this procedure is included in Appendix F.

Once the data was easier to work with, it was used to construct three charts. It was decided to format the data as three separate pareto charts. A pareto chart is a hybrid between two basic chart types: the bar chart, and the line chart. The bar chart portion of the graph measures the frequency of the target categories. In the case of this study, the target categories are the five different means by which time is wasted during transition from one machine to the next, and they are measured in minutes. The linechart portion of the graph measures the cumulative percentage of the each successive category. In the case of this study, the line chart measures the cumulative percentage of each time wasted category. The pareto chart is perfect for analyzing the time and motion study data because it helps to identify the leading contributing factors to time wasted in the gym.

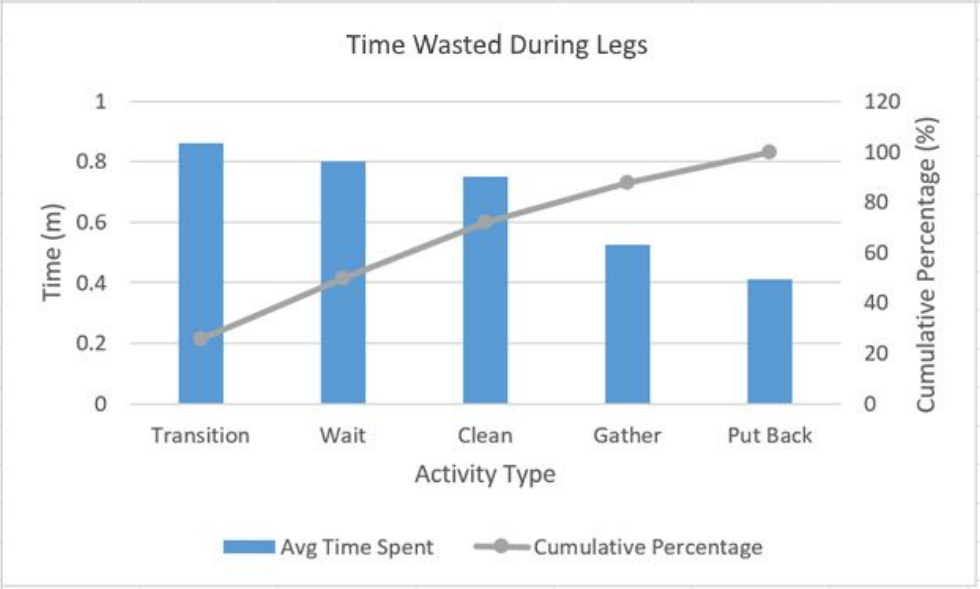



**Figure 1: Pareto Chart of Time Wasted During Leg Workout**

The first pareto chart that was constructed was for the leg machines. Relative to the other type of machines in the gym, the layout of the leg machines contributed to a surprisingly efficient workout experience. The three leading contributors to wasted time were the transition from one machine to the next, the waiting time, and the time taken to clean down the equipment. However, all three of the categories were, on average, less than one minute each. Though room for improvement is relatively small, the placement of an additional wet wipe dispenser central to all of the machines may decrease the amount of time spent cleaning the machines.

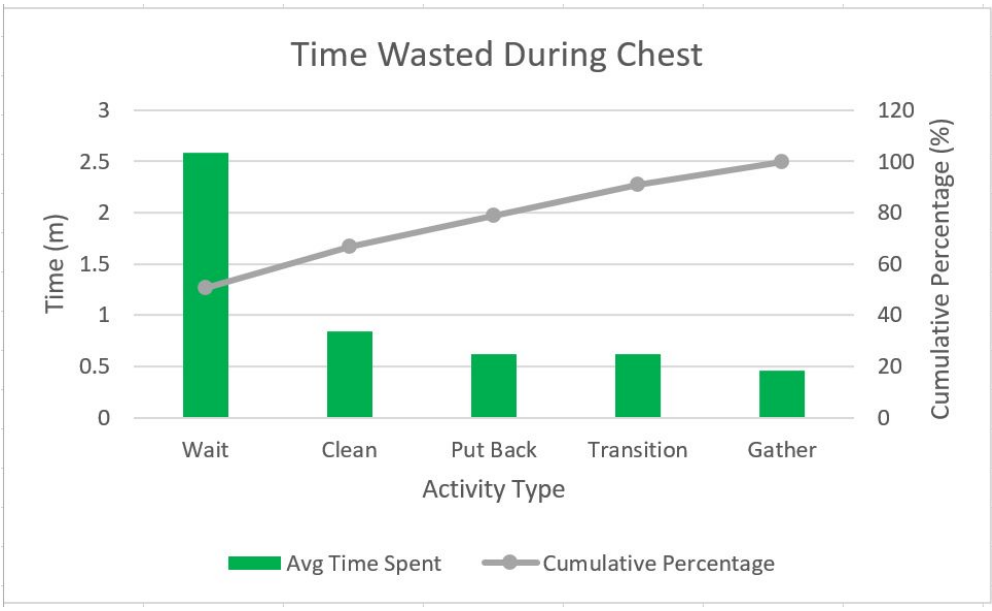



**Figure 2: Pareto Chart of Time Wasted During Chest Workout**

The second pareto chart that was constructed measured the time wasted during a chest workout. The biggest problem is clearly the waiting time. The time spent waiting for a machine to become unoccupied averages 2.5 minutes and accounts for just over 50% of the total time wasted. Accordingly, this becomes a target area for improvement. An immediate response may be to just add more machines. However, as the floor layout plan shows, there is limited space for new machines. As a result, solutions to this problem are most likely going to be somewhat indirect. For example, the put back time between machines takes an average of 0.7 minutes, and is evident primarily with the bench press, where users must bring weight plates to and from wherever they can find them. If there were a more efficient route for an individual to take in order to return weights to where they belong, the queue of people at each machine would theoretically process faster.

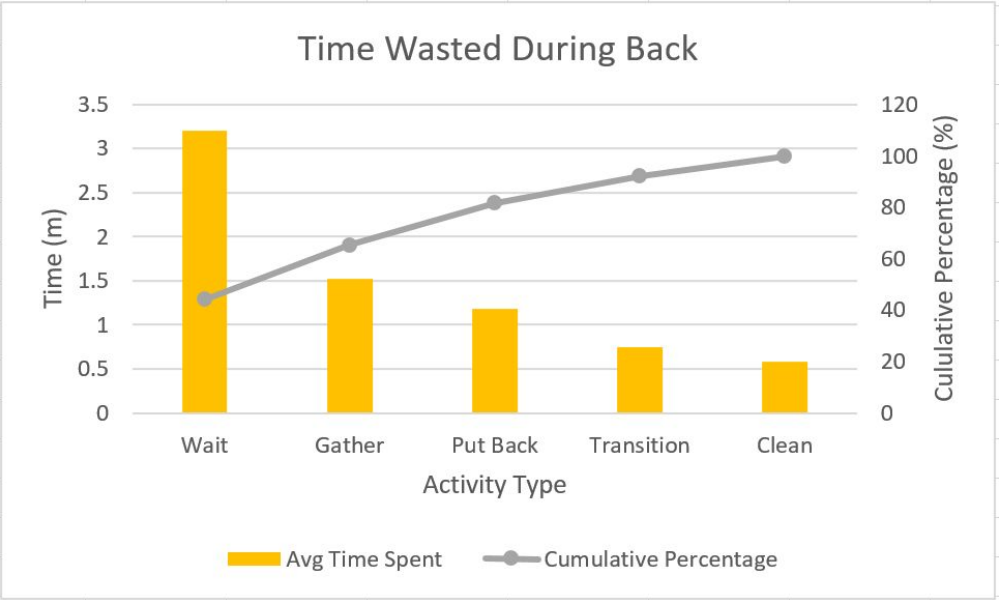



**Figure 3: Pareto Chart of Time Wasted During Back Workout**

The third and final chart that we designed describes the time wasted during a back workout. Similar to the chest machine layout, the leading contributor to wasted time was the waiting period, which contributed to 50% of the total time wasted. Again, because of limited floor space, solutions to this problem are not as easy as merely buying more machines. Instead, it appears as if new layout designs for both the chest and the back machines would be extremely beneficial.

Knowing that people who are working out generally use the free weights or machines suited for a certain workout, a Part by Machine matrix was created (See: Appendix A.1) with the general muscle groups that are worked on in a workout. Those muscle groups were categorized as the "part", categorized as Back/Biceps ("Pull" workout), Chest/Triceps ("Push" workout), Legs, Core, and Free Weights. A Part by Part similarity matrix was then created using the Dice equation for similarity (See: Appendix A.2). Finally a row/column rearrangement was done to figure out how to design the cells to maximize the efficiency of Marino. This cell design information, found in Tables 1 and 2 below and on the next page, is the primary focus of this analysis.

**Table 1: Weight Machine Cells 1 - 3**

| | | Back/Biceps | Chest/Triceps | Legs | Core | Free Weights |
|---|---|---|---|---|---|---|
| **Cell 1: Back and Biceps** | Back Extension | 1 | 0 | 0 | 0 | 0 |
| | Assisted Pullup Machine | 1 | 0 | 0 | 0 | 0 |
| | Row Rear Delt | 1 | 0 | 0 | 0 | 0 |
| | Lateral Pull Down | 1 | 0 | 0 | 0 | 0 |
| | Bicep Curl | 1 | 0 | 0 | 0 | 0 |
| | Pec Rear Delt | 1 | 1 | 0 | 0 | 0 |
| | Lateral Raise | 1 | 0 | 0 | 0 | 0 |
| | Rear Row | 1 | 0 | 0 | 0 | 0 |
| | Overhead Pulldown | 1 | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Cell 2: Chest, Shoulders and Triceps** | Chest Press | 0 | 1 | 0 | 0 | 0 |
| | Shoulder Press | 0 | 1 | 0 | 0 | 0 |
| | Pullup/Dip Station | 1 | 1 | 0 | 0 | 0 |
| | Incline Press | 0 | 1 | 0 | 0 | 0 |
| | Pec Fly/Rear Delt | 1 | 1 | 0 | 0 | 0 |
| | Tricep Press | 0 | 1 | 0 | 0 | 0 |
| | Chest/Shoulder Rope Machine | 0 | 1 | 0 | 0 | 0 |
| | Overhead Tricep | 0 | 1 | 0 | 0 | 0 |
| | | | | | | |
| **Cell 3: Legs** | Leg Extension | 0 | 0 | 1 | 0 | 0 |
| | Multi-hip | 0 | 0 | 1 | 0 | 0 |
| | Seated Leg Curl | 0 | 0 | 1 | 0 | 0 |
| | Seated Leg Press | 0 | 0 | 1 | 0 | 0 |
| | Prone Leg Curl | 0 | 0 | 1 | 0 | 0 |
| | Lift/Squat Machine | 0 | 0 | 1 | 0 | 0 |
| | Leg Raise Station | 0 | 0 | 1 | 0 | 0 |
| | Smith Rack | 0 | 0 | 1 | 0 | 0 |

**Table 2: Weight Machine Cells 4 - 6**

| | | Back/Biceps | Chest/Triceps | Legs | Core | Free Weights |
|---|---|---|---|---|---|---|
| **Cell 4: Core** | Seated Abdominal | 0 | 0 | 0 | 1 | 0 |
| | Ab Crunch | 0 | 0 | 0 | 1 | 0 |
| | | | | | | |
| **Cell 5: Free Weights** | Dumbbell Rack | 0 | 0 | 0 | 0 | 1 |
| | Incline/Flat Bench | 0 | 1 | 0 | 0 | 1 |
| | Sit-up Bench | 0 | 0 | 0 | 1 | 1 |
| | Balance Balls | 0 | 0 | 0 | 1 | 1 |
| | Hex Bar | 0 | 0 | 1 | 0 | 1 |
| | Incline Bench Press | 0 | 1 | 0 | 0 | 1 |
| | | | | | | |
| **Cell 6: Multigyms** | Bodymaster Multigym | 1 | 1 | 1 | 0 | 0 |
| | Matrix Multigym | 1 | 1 | 1 | 0 | 0 |
| | Synergy 360 Multigym | 1 | 1 | 1 | 0 | 0 |

With the three table created, the six cells above were then designed to categorize each machine into a group organized by muscle group used in the workout. Cell 1 was created as the Back/Biceps cell and contains the machines (important note: in cells 1-3 only machines were used as free weights are being given their own cell) that aim to target these muscles in particular. Cell 2 was created as the Chest/Shoulders/Triceps cell and contains the machines that target these muscles. Cell 3 was created as the Legs cell and contains the machines that target these muscles. Cell 4 is the Core cell. It only contains two machines as most people tend to use dumbbells, weight plates, or their own body weight to do core exercises, but still requires adequate space to perform these exercises. Cell 5 is the Free Weights cell, which contains dumbbells racks, weight plates/bars and benches. Finally cell 6 is the multigym cell. It contains the three large multigym machines in Marino.

In order to get a top-level view of how these new cells were to be arranged in the fitness center, a floorplan was generated for both the current layout and for the suggested layout. While the layout for the fitness center's zones was available through its website[1], the location of the equipment was gathered by manually mapping and counting them within the center. The equipment counting was used to help generate the cellular layout design, but it is unnecessary to analyze this data beyond its use there. The full list can be found in Appendix B.

As seen below in Figure 4, the current design of the Marino Fitness Center generally places similar machines within the same areas. This design works well for the cardio equipment, particularly on Floor 2, as the space requirement for machines is strictly confined to the size of the machine. Furthermore, it was found that gym-goers who use cardio machines typically only use one or two machines per visit. Because of these two factors, there is much less travel congestion in these areas. The suggested layout only makes changes to Floor 3, as the Floor 2 layout is mostly cardio machines and overflow from Floor 3 equipment.

Users of machine weights and free weights, however, have different space requirements. Machine weights are similar to cardio machines in that users do not take up any more space than the size of the machine. However, unlike cardio machines, users of machine weights will travel to several different machines during any given workout day. Free weights are the most variable of all three, because unlike the machine equipment, the space requirements for free weights increases proportionally with population. The space allotted in the enclosed weight room does not accommodate for this requirement. Since Floor 3 is comprised mostly of these types of equipment, the most changes are found here. A larger, full-page version of this floorplan can be found in Appendix C.

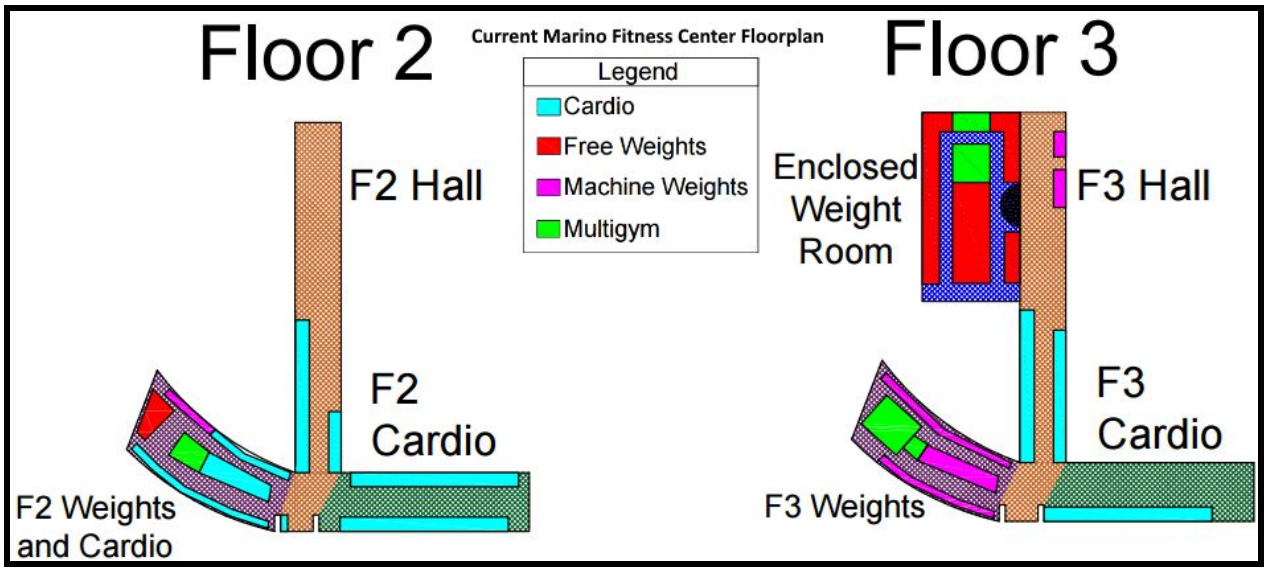



**Figure 4: Current Marino Fitness Center Floorplan**

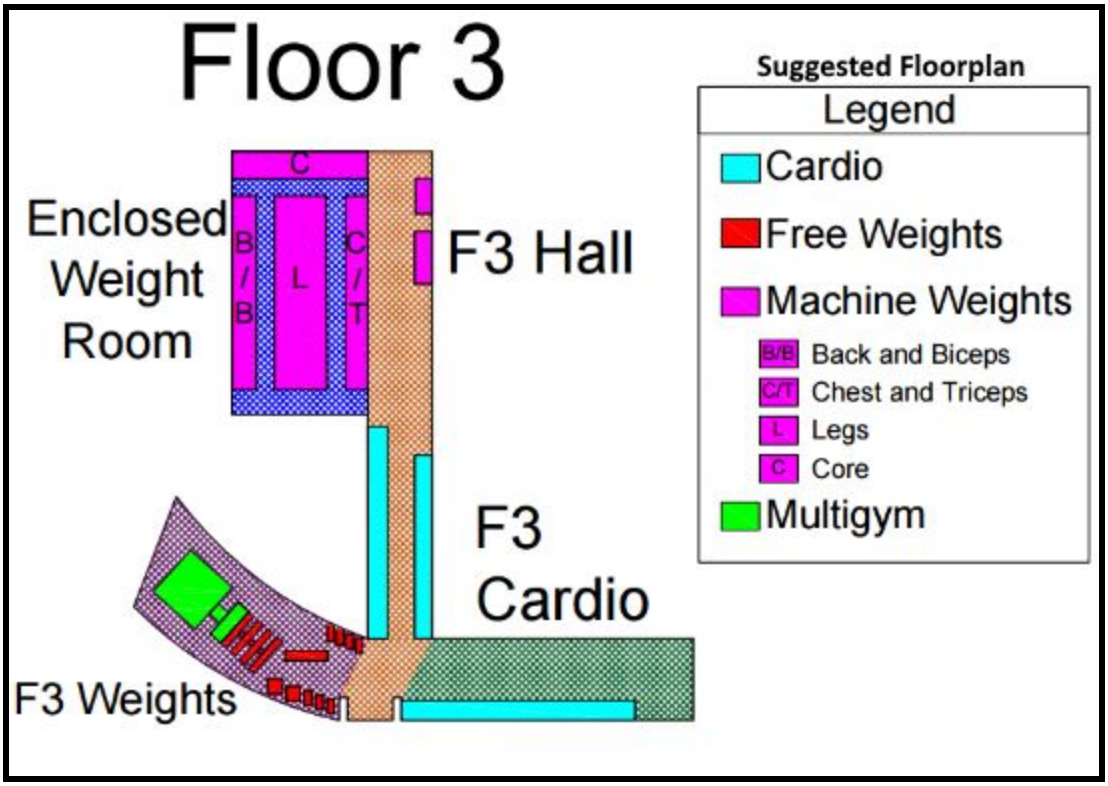



**Figure 5: Suggested Third Floor Floorplan**

The suggested floorplan as depicted above in Figure 5. A full page side-by-side comparison of Floor 3 both current and suggested can be found in Appendix D. The major changes in this iteration include swapping the zones for machine weights with the zone for free weights and in utilizing the cells discussed earlier in this analysis section. The Enclosed Weight Room is a much better fit for machine weights since there is less mobility and space requirements. Another significant improvement to the Enclosed Weight Room is the removal of a large piece of furniture depicted as a black semicircle in Figure 4 on the previous page and also as a photograph in Appendix E. There is currently an extremely large round desk that takes up much-needed space in the weight room and serves no useful function. Otherwise, all multigym and free weight equipment was moved to the much more spacious F3 Weights area, where gym-goers have much more room to exercise, travel, and stretch. Additionally, because much less space is taken up by equipment, there is more flexibility to the human capacity of this area. Weight racks are placed in a more central and visible location, making it faster and easier to take and put back needed equipment.

# Discussion

The analysis of the usage of the cardio and resistance machines and free weights in the Marino Fitness Center presented three major observations of significance. First, that the poor organization of equipment in the third floor enclosed weight room contributed heavily to long wait times in using equipment and also in increased congestion in that area. Second, that there was an apparent imbalance in space requirements for certain pieces of equipment. Thirdly, that the average wait times for cardio equipment were exceptionally lower than originally anticipated and, to that extent, not an issue.

The primary methods used to reach these conclusions was through time studies, observation of machine and available floor space usage by gym-goers, and zone mapping of the facility. With the result of our time studies and the resulting pareto charts generated from them, it became more apparent which machines types experienced the most time waste. By laying out all the times next to each other, this also gave rise to the observation that cardio equipment experienced very few wait times at all, which was the opposite of what was expected going into the investigation. Even during peak times, there is enough equipment in the fitness center such that there is rarely, if ever, a wait time for cardio equipment. However, as noted in the analysis section, the time studies also showed significant time waste from queueing for back and chest equipment.

The other major observation was that open space in the enclosed weight room was sparse despite a pressing safety and general need to have space to move around and stretch. In stark contrast, the weight area on the opposite side of the facility had a large amount of open space despite a smaller space requirement for the weight machines used in that section. Generating a floorplan for the before and after layouts helped to show how the problem areas could be rearranged to address the issues. Meanwhile, using a cellular manufacturing technique to categorize machines by body parts trained, a more efficient cellular design for clustering equipment was created to reduce waste due to travel time, increase visibility of available machines, and reduce wasted space from unused machines. Another smaller human-factors observation, where gym-goers would not consistently return weights to their appropriate locations, prompted the design of the new free weights section to have more centralized and visible weight racks, as well as plate racks between each of the heavily-used barbell benches. Users now have a tendency to place the weight plates inappropriate and unorganized places, or not return them at all. By creating visible racks that also make use of constraints that show that the larger plates must be placed only at the bottom of the racks, which contribute heavily to organization of plates, therefore simplifying the process of grabbing and returning those weights, thus reducing the time wasted in chest workouts and elsewhere.

# Recommendations and Conclusion

The main objective of this project was to study the current floor plan of the Northeastern University Marino Recreation Center to find an optimal floor plan solution. Specifically, a central focus of the project was to revise the positioning of related lifting machines in order to reduce the amount of time spent by individuals transitioning from one machine to the next. The first method used to identify problem areas was a time and motion study. Group members collected and categorized different transition activities over the course of one week. The data collected was then used to create three pareto charts, which broke down the different types of time wasting activities for each category of machine. From that, problem areas were identified and assessed. It was discovered that both the chest and back cells were subjected to long waiting periods for machine use. Although there is not enough floor space to simply add more chest and back machines, it is suggested that redesigning the spatial proximity of machines that target the same groups of muscles would serve as an indirect solution. In order to solve for the optimal floorplan layout, a part by part matrix was created in order to find the strength of similarity between all of the different types of machines. Machines were then categorized and placed into five distinct cells based on the strength of their relationships with other machines. By creating five different, but optimized cells, it was suggested that traffic within those individualized cells would be reduced, thus enhancing the overall lifting experience of any given individual at the Marino Center.

# References

[1] Campusrec.neu.edu, 'Marino Center - Campus Recreation', 2012. [Online]. Available: http://www.campusrec.neu.edu/general/marino.php. [Accessed: 14- Nov- 2015].

[2] Merrium-Webster Dictionary - Industrial Engineering, 2015 [Online]. Available: http://www.merriam-webster.com/dictionary/

# Data Appendices

### Appendix A.1

Part by Machine matrix used for the cellular reorganization of Marino

| | Back/ Biceps | Chest/ Triceps | Legs | Core | Free Weights |
|---|---|---|---|---|---|
| Dumbbell Rack | 0 | 0 | 0 | 0 | 1 |
| Incline/Flat Bench | 0 | 1 | 0 | 0 | 1 |
| Sit-up Bench | 0 | 0 | 0 | 1 | 1 |
| Leg Extension | 0 | 0 | 1 | 0 | 0 |
| Chest Press | 0 | 1 | 0 | 0 | 0 |
| Multi hip | 0 | 0 | 1 | 0 | 0 |
| Back Extension | 1 | 0 | 0 | 0 | 0 |
| Shoulder Press | 0 | 1 | 0 | 0 | 0 |
| Seated Leg Curl | 0 | 0 | 1 | 0 | 0 |
| Bodymaster Multigym | 1 | 1 | 1 | 0 | 0 |
| Assisted Pullup Machine | 1 | 0 | 0 | 0 | 0 |
| Pull-up/Dip Station | 1 | 1 | 0 | 0 | 0 |
| Incline Press | 0 | 1 | 0 | 0 | 0 |
| Pec Fly / Rear Delt | 1 | 1 | 0 | 0 | 0 |
| Seated Leg Press | 0 | 0 | 1 | 0 | 0 |
| Row Rear Deltoid | 1 | 0 | 0 | 0 | 0 |
| Lateral Pull Down | 1 | 0 | 0 | 0 | 0 |
| Bicep Curl | 1 | 0 | 0 | 0 | 0 |
| Tricep Press | 0 | 1 | 0 | 0 | 0 |
| Pec Rear Delt | 1 | 1 | 0 | 0 | 0 |
| Lateral Raise | 1 | 0 | 0 | 0 | 0 |
| Chest and Shoulder Rope Machine | 0 | 1 | 0 | 0 | 0 |
| Matrix Multigym | 1 | 1 | 1 | 0 | 0 |
| Synergy 360 Multigym | 1 | 1 | 1 | 0 | 0 |
| Prone Leg Curl | 0 | 0 | 1 | 0 | 0 |
| Overhead Tricep | 0 | 1 | 0 | 0 | 0 |
| Abductor/Adductor Combo | 0 | 0 | 1 | 0 | 0 |

| | Back/ Biceps | Chest/ Triceps | Legs | Core | Free Weights |
|---|---|---|---|---|---|
| Hamstring/Abductor/Adductor Combo | 0 | 0 | 1 | 0 | 0 |
| Rear Row | 1 | 0 | 0 | 0 | 0 |
| Lift/Squat Machine | 0 | 0 | 1 | 0 | 0 |
| Balance Balls | 0 | 0 | 0 | 1 | 1 |
| Seated Abdominal | 0 | 0 | 0 | 1 | 0 |
| Leg Raise Station | 0 | 0 | 1 | 0 | 0 |
| Smith Rack | 0 | 0 | 1 | 0 | 0 |
| Incline Bench Press | 0 | 1 | 0 | 0 | 1 |
| Ab Crunch | 0 | 0 | 0 | 1 | 0 |
| Overhead Pulldown | 1 | 0 | 0 | 0 | 0 |
| Hex Bar | 0 | 0 | 1 | 0 | 1 |

### Appendix A.2

Part by Part matrix with similarity coefficients (found using the Dice equation)

| | Back/ Biceps | Chest/ Triceps | Legs | Core | Free Weights |
|---|---|---|---|---|---|
| **Back/Biceps** | X | (3/7) | (3/14) | 0 | 0 |
| **Chest/Triceps** | | X | (3/14) | 0 | (1/5) |
| **Legs** | | | X | 0 | (1/10) |
| **Core** | | | | X | (2/5) |
| **Free Weights** | | | | | X |

**Appendix B**

Count of equipment in the Marino Fitness Center

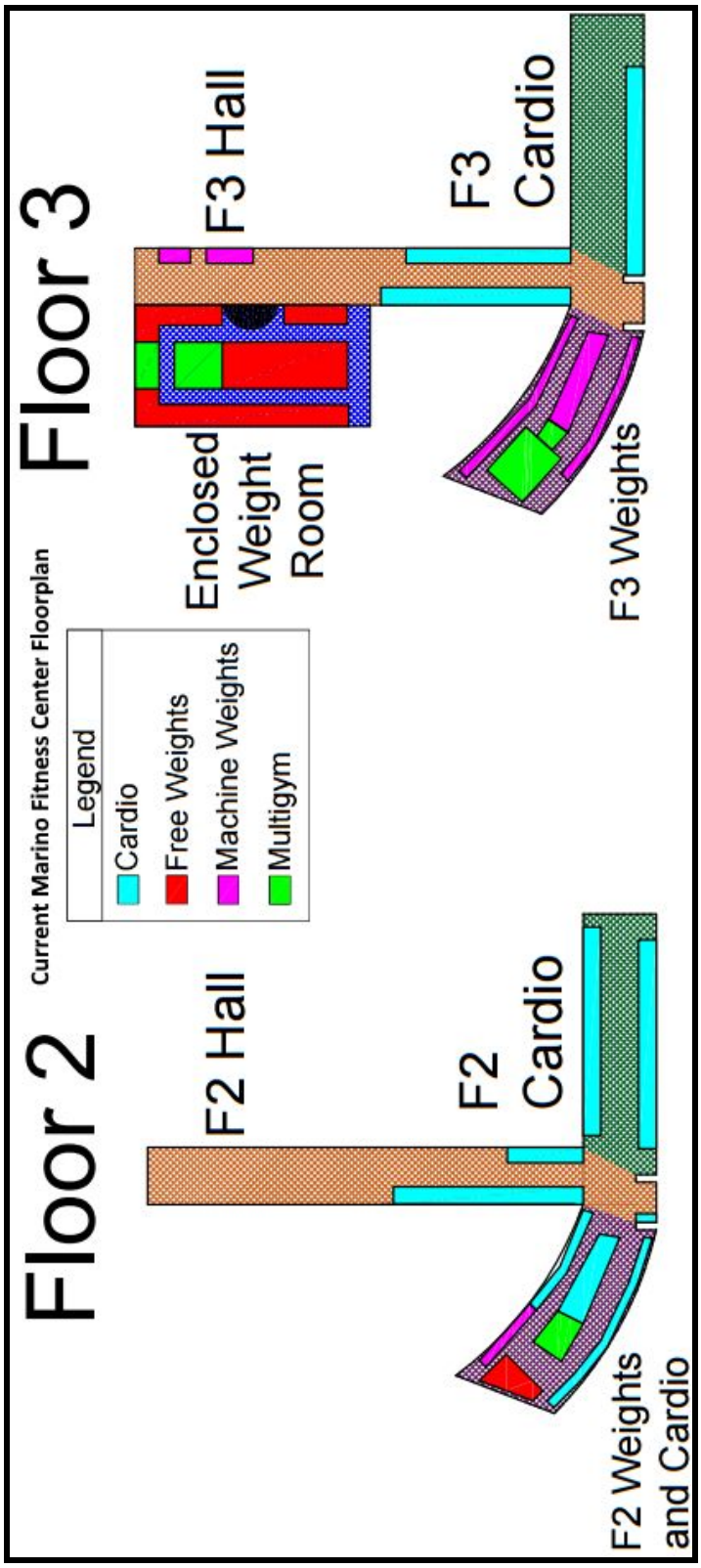
| Machine | Count | Zone |
|---|---|---|
| Cross Country Ski Machine | 7 | F2 Hall |
| Treadwall | 1 | F2 Hall |
| Lateral Machine | 4 | F2 Hall |
| Upright Bike | 4 | F2 Hall |
| Arm Cycle | 1 | F2 Hall |
| | | |
| Dumbell Rack | 2 | F2 Weights and Cardio |
| Incline/Flat Bench | 3 | F2 Weights and Cardio |
| Sit-up Bench | 2 | F2 Weights and Cardio |
| Treadmill | 19 | F2 Weights and Cardio |
| Elliptical | 4 | F2 Weights and Cardio |
| Upright Bike | 4 | F2 Weights and Cardio |
| Rowing Machine | 2 | F2 Weights and Cardio |
| Leg Extension | 1 | F2 Weights and Cardio |
| Chest Press | 1 | F2 Weights and Cardio |
| Seated Abdominal | 1 | F2 Weights and Cardio |
| Multi hip | 1 | F2 Weights and Cardio |
| Back Extension | 1 | F2 Weights and Cardio |
| Shoulder Press | 1 | F2 Weights and Cardio |
| Seated Leg Curl | 1 | F2 Weights and Cardio |
| Bodymaster Multigym | 1 | F2 Weights and Cardio |
| | | |
| Elliptical | 7 | F3 Hall |
| StairMaster | 6 | F3 Hall |
| Assisted Pullup Machine | 1 | F3 Hall |
| Cross Country Ski Machine | 4 | F3 Hall |
| Pull-up/Dip Station | 1 | F3 Hall |
| Standing Bike | 4 | F3 Hall |
| Incline Press | 2 | F3 Hall |

| Machine | Count | Zone |
|---|---|---|
| Pec Fly / Rear Delt | 2 | F3 Weights |
| Seated Leg Press | 1 | F3 Weights |
| Leg Extension | 1 | F3 Weights |
| Seated Leg Curl | 1 | F3 Weights |
| Chest Press | 1 | F3 Weights |
| Row Rear Deltoid | 1 | F3 Weights |
| Shoulder Press | 1 | F3 Weights |
| Pull Down | 1 | F3 Weights |
| Torso Rotation | 1 | F3 Weights |
| Bicep Curl | 1 | F3 Weights |
| Tricep Press | 1 | F3 Weights |
| Chest Press | 1 | F3 Weights |
| Pec Rear Delt | 1 | F3 Weights |
| Lateral Raise | 1 | F3 Weights |
| Chest and Shoulder Rope Machine | 1 | F3 Weights |
| Lat Puller | 1 | F3 Weights |
| Matrix Multigym | 1 | F3 Weights |
| Synergy 360 Multigym | 1 | F3 Weights |
| Prone Leg Curl | 1 | F3 Weights |
| Overhead Tricep | 1 | F3 Weights |
| Abductor/Adductor Combo | 2 | F3 Weights |
| Hamstring/Abductor/Adductor Combo | 1 | F3 Weights |
| Rear Row | 1 | F3 Weights |
| Lift/Squat Machine | 1 | F3 Weights |
| Ab Crunch | 1 | F3 Weights |
| Chest Press | 1 | F3 Weights |
| Balance Balls | 3 | F3 Weights |
| | | |
| Treadmills | 2 | F3 Cardio |
| Elliptical | 4 | F3 Cardio |
| Rowing Machine | 6 | F3 Cardio |
| Ski Machine | 2 | F3 Cardio |
| Recumbent Ellipical | 3 | F3 Cardio |

| Machine | Count | Zone |
|---|---|---|
| Bench Press | 4 | Enclosed Weight Room |
| Inclined Bench Press | 2 | Enclosed Weight Room |
| Power Cage | 3 | Enclosed Weight Room |
| Smith Machine | 2 | Enclosed Weight Room |
| Leg Raise Station | 2 | Enclosed Weight Room |
| Bodymaster Multigym | 1 | Enclosed Weight Room |
| Incline/Flat Bench | 4 | Enclosed Weight Room |
| Seated Leg Press | 2 | Enclosed Weight Room |
| Chest Press | 1 | Enclosed Weight Room |
| Hex Bar | 1 | Enclosed Weight Room |
| Overhead Pulldown | 1 | Enclosed Weight Room |
| Chest Press | 2 | Enclosed Weight Room |
| Seated Leg Curl | 2 | Enclosed Weight Room |
| | | |
| Treadmill | 6 | Cardio F2 |
| Stairmaster | 6 | Cardio F2 |
| Upright bike | 14 | Cardio F2 |
| Cross Country Ski Machine | 2 | Cardio F2 |
| Recumbent bike | 10 | Cardio F2 |
| Powered Stair Climber | 8 | Cardio F2 |

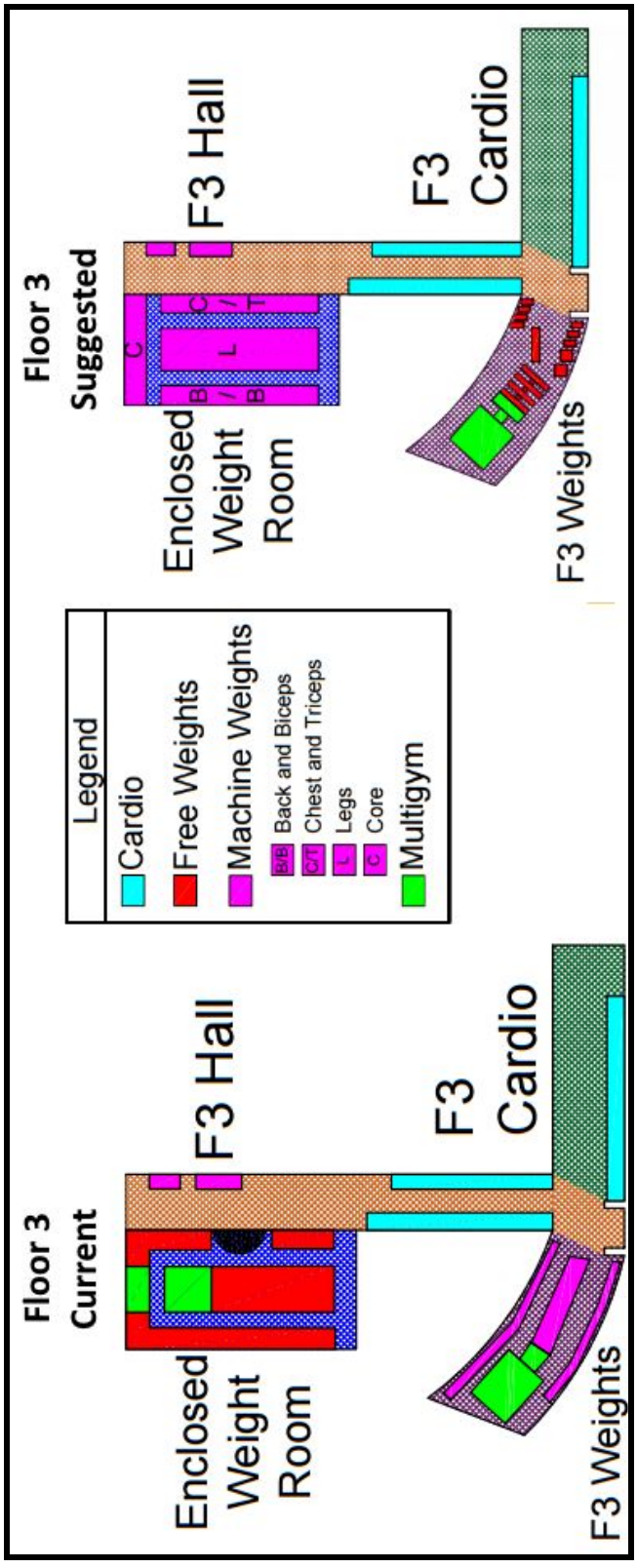
**Appendix C**

Current Marino Fitness Center floorplan



**Appendix D**

Comparison between Current and Suggested floorplan layouts



**Appendix E**

Typical example of a busy weight room on FL 3.

**Appendix F**

Time and motion study data used to construct pareto charts.

| Time Wasted, Leg Workout | | | |
|---|---|---|---|
| **Time Type** | **Avg Time Spent (minutes)** | **Percentage** | **Cumulative Percentage** |
| Transition | 0.863 | 25.746 | 25.746 |
| Wait | 0.800 | 23.881 | 49.627 |
| Clean | 0.750 | 22.388 | 72.015 |
| Gather | 0.525 | 15.672 | 87.687 |
| Put Back | 0.413 | 12.313 | 100.000 |
| **Time Wasted, Chest Workout** | | | |
| **Time Type** | **Avg Time Spent (minutes)** | **Percentage** | **Cumulative Percentage** |
| Wait | 2.583 | 50.455 | 50.455 |
| Clean | 0.840 | 16.406 | 66.861 |
| Put Back | 0.620 | 12.109 | 78.971 |
| Transition | 0.617 | 12.045 | 91.016 |
| Gather | 0.460 | 8.984 | 100.000 |
| **Time Wasted, Back Workout** | | | |
| **Time Type** | **Avg Time Spent (minutes)** | **Percentage** | **Cumulative Percentage** |
| Wait | 3.200 | 44.229 | 44.229 |
| Gather | 1.525 | 21.078 | 65.308 |
| Put Back | 1.180 | 16.310 | 81.617 |
| Transition | 0.750 | 10.366 | 91.983 |
| Clean | 0.580 | 8.017 | 100.000 |