Driving Monro Muffler brake with an IT dashboard

April Miller

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Driving Monro Muffler Brake with an IT Dashboard

Graduate Capstone Project
Cross-Disciplinary Professional Studies Program
April R Miller
Spring 2006

Submitted as a Capstone Project Report in partial fulfillment of a Master of Science Degree in Cross-Disciplinary Professional Studies at the Rochester Institute of Technology
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1. Executive Summary

In order to improve reporting and understanding of IT Department status, Monro Muffler Brake’s IT Director proposed creating a dashboard to present department metrics. The IT Department currently relies on spreadsheet-based reports to track call activity for the Point of Service (POS) Help Desk, and an IT Dashboard will present metrics graphically improving the usability both within the department and in meetings with the Executive Vice-President and Chief Financial Officer.

Monro Muffler Brake has pursued growth through acquisition and conversion for several years, challenging the IT Department’s ability to provide consistent support to their Point of Service (POS) users. In fact, during the course of this project, Monro acquired 75 stores bringing their total to more than 700 stores in 17 northeastern states. The metrics currently used to track POS Help Desk activity change based on the number of stores, making it impossible to compare performance over an extended period of time. The inability to evaluate the metrics over an extended period of time makes it difficult to identify actionable information in the current reports – there is no way to tell if the current performance has improved or gotten worse, and no baseline to compare performance against.

To address these problems the current POS Help Desk reports were reviewed and the data was analyzed statistically to identify metrics that have meaning regardless of the number of stores being supported at any given time. Based on the results of the analysis and evaluation of reporting needs, a combination of new and existing metrics are recommended in the high-level solution. The IT Dashboard mock-up pulls the recommended metrics together into a graphical presentation. Expected values and limits are an important part of the recommended metrics included on the IT Dashboard because these make the dashboard information actionable and provide baselines to evaluate performance.

The IT Dashboard can be partially or fully implemented by using the mock-up and the requirements included in the detailed design. Long-term evaluation recommendations are included for Monro to evaluate the performance of the IT Dashboard after it has been in use for several months. A short-term evaluation is positive, with completion of the project on schedule and the client providing positive feedback.
2. Introduction

Monro Muffler Brake, Inc started in 1966 when the founder Charles (Chuck) J. August discontinued his franchise affiliation in order to expand the service offered at his muffler shops. A locally owned and managed company, Monro went public in 1991. Monro has grown from 20 locally owned stores in 1977 to over 700 stores located in seventeen states.

I made contact with my Monro client, John Appleman, through a professional networking group. We met and discussed two areas of the business that had potential Capstone Project opportunities – an inventory project and the creation of a dashboard for the IT Department. After discussing the two opportunities with my mentor and advisor I decided that creating an IT Dashboard offered the best opportunity for a cross-disciplinary project.

Definition of the problem to be solved started during the proposal process and continued to be focused during project execution. Refining the scope of the dashboard was a necessary part of the project, and is described in Section 3.

2.1. Problem Description

Dated metrics that offer no actionable information currently hinder the ability of the Monro IT Department to respond to changes in user support needs. Typical reports show data from several months, but a lack of historical context in the reports means that trends and patterns are not easily identified.

The current spreadsheets provide little intuitive insight into the status of the IT Department and lack easily understandable graphical components. The lack of intuitive metrics results in difficulties communicating the status of the IT Department to company executive officers and division Vice-Presidents. When the IT Director meets with the Executive Vice-President and Chief Financial Officer meeting time is often spent explaining where the metrics come from instead of discussing the status of the department and if action is required in order to respond to changing user support needs.

Since its inception in 1966 Monro has followed a philosophy of expansion that includes large acquisitions. In fact, during the course of this project Monro announced plans to
acquire a company with 82 retail locations – a move that could potentially increase the number of Monro retail locations by over 10%. This type of rapid growth places significant demands on the IT Department and reports based on last month’s data do not adequately address the needs of a rapidly growing organization.

The goal of developing a dashboard for the Monro IT Department is to identify actionable information and present it in an easily understood interface. A dashboard with these characteristics will allow the IT managers to respond to changes in departmental status, and to effectively communicate this status to company executives.

2.2. Current Reporting Solutions

The Monro IT Organization consists of four primary areas: financial systems support, inventory support, point of sales development, and operations support. The client for this project is the IT Director in charge of the operations support area, and the focus of this project is the reporting within this area.

Within the operations support group there are four groups: network server administration, system administration, desktop support, and helpdesk support. Each of these groups collects metrics, and some reports combine metrics from two or more of the groups.

Current reports are primarily based on data from the previous month. The data is collected from a variety of sources and systems and then compiled manually by the IT Operations Manager into a series of spreadsheets. The spreadsheets present the data in tabular format – rows and columns of numbers. The managers consider this format to be an artifact of the finance department that does not adequately represent the IT Department metrics.

A new software application, TrackIT, has been purchased and is currently being used by the Desktop Support group. TrackIT will be deployed to the POS Help Desk at a future date. TrackIT offers increased metric capturing and will allow for a broader range of reports to be generated from the Help Desk activities.
2.3. Target Audience

There are several potential audiences for an IT Operations dashboard, and they have differing needs when it comes to reporting. Some of these audiences use the current reports, while others do not. The Executive Vice-President and Chief Financial Officer, the IT Director in charge of Operations, and the Operations Manager are the primary users of the current reports. The Division Vice-Presidents and line supervisors don’t use the current IT Operations reports, but would benefit from having access to appropriate metrics.

The IT Director and Operations Manager are quite familiar with the metrics being gathered and the reports generated from them since they manually compile these reports. An IT Operations dashboard would allow them to spend less time creating reports and more time utilizing the information supplied by the reports. They would typically use a dashboard on a daily or weekly basis to respond to current events, but would also need a higher-level view in order to identify and address medium and long-range considerations, such as staffing levels.

The Executive Vice-President and Chief Financial Officer typically reviews IT Operations reports monthly. An ideal dashboard would provide monthly, quarterly, and even yearly views showing metrics that are indicators of the ongoing health of IT Operations and metrics that would signal changes that need to be addressed. A dashboard for this user needs to be presented such that an infrequent user can quickly grasp the material and not spend an excessive amount of time figuring out what the metrics are and what they might mean to the business.

The line supervisors are involved in the day-to-day activities of the IT Operations group, and the current reports are of little value to them since the reports focus on the previous month’s activities. By the time the reports are compiled it is too late for them to respond to events that happened days ago. These users need daily views into the activities of the groups they lead, and the other groups with which they interact. Long-term trends are less important to these users.
Division Vice-Presidents don’t use the current reports because they are not familiar with the metrics and they don’t have regular exposure to the IT Operations group in order to gain familiarity. The Division Vice-Presidents have valuable insights and influence the way point-of-sales (POS) users utilize IT Operations. Providing them with a dashboard that presents relevant metrics in an intuitive format will help establish a stronger link between IT Operations and the POS users.

2.4. Client and Mentor Information

2.4.1. Client – John Appleman, IT Director Monro Muffler Brake

Monro Muffler Brake is a Rochester based company with 626 stores in 17 states. Monro provides under car service to individual and fleet owners, and had $340 million in sales for the 2005 fiscal year. A warehouse located in Rochester, NY is the primary supplier for all locations.

John Appleman is one of two IT Directors for Monro Muffler Brake. The 35 member IT Department supports the corporate applications and network, and the computers located in the company-operated stores. IT goals for the upcoming year include broadening the role of QA, implementing new trouble ticketing software, and updating network security. The dashboard this project focuses on will provide the IT managers, directors, and higher management with a view into the day-to-day operating status of the helpdesk, and an indication if any of the tracked parameters are out of expected range.

2.4.2. Mentor – Dr. Steven M. LaLonde

Steven LaLonde is an Assistant Professor at the John D. Hromi Center for Quality and Applied Statistics at the Rochester Institute of Technology. In his twelve years at Eastman Kodak Company he developed and applied statistical methods in product development, manufacturing, management, and marketing. In addition to his experience grounded in practical application, his expertise in multivariate modeling will be a valuable resource in the statistical analysis part of the project.
3. Project Approach

The project had five primary areas: data review, statistical analysis, high-level solution, detailed solution, and implementation. During execution of the project these areas overlapped and progress was iterative rather than linear. There is a section devoted to each area, but during the project the activities in each area often interacted, for example, changes while creating the high-level solution meant that additional statistical analysis was required.

3.1. Data Review

Data analysis started with a review of over a hundred files containing spreadsheets of data related to IT Department operations. Several factors were considered while evaluating the files to determine if they were suitable candidates for inclusion in the IT dashboard, and the files were grouped based on type of data and the corresponding IT support area. Based on this review the Point of Service (POS) metrics were chosen as the focus of the project.

3.1.1. Data Evaluation

One factor used to evaluate the spreadsheets was the amount of data available in a given spreadsheet and the completeness of that data. When looking for trends and patterns in data more is definitely better, and those spreadsheets that contained large amounts of data were marked for further consideration. Most of the data collected by the IT Department is calendar based – recorded daily, weekly, or monthly. This type of data recording is useful when using statistical analysis to look for seasonal patterns, or when comparing activity from one time period to another time period. It is possible to estimate missing data if only a small amount is missing, but spreadsheets with large amounts of data missing were eliminated from consideration.

While large amounts of historical data provide a point of reference, it is of no use if current metrics are not available. Some files contained data that is no longer being collected by the IT Department so those files were not included in data analysis. On the other hand, metrics that were newer but had less historical data available were considered for the dashboard.
Some files contained data related to specific, one-time projects and these were not considered for use in the dashboard. The focus of the dashboard is the status of on-going support operations, and project information would become outdated too quickly.

3.1.2. Data Grouping
The available data fell into five broad categories: Point of Service (POS) metrics, POS development group status, server statistics, old and orphaned data, and inventory control data. The old and orphaned data was easy to eliminate from consideration, as was inventory data since it offers little insight into the health of the IT department.

The data for the POS development group status was plentiful and fairly complete, but was narrowly focused on the activities within that group. The data from this group was not suitable for the focus of the dashboard, but it does supply information that could be used in a dashboard that summarized the overall IT Department status.

The server statistics offered a significant amount of complete historical and current data, but once again the narrow focus was not ideal for the dashboard. A subset of this data could be useful in an overall IT Department status. This data also lends itself to the creation of a dashboard focused on server performance and capacity.

The POS metrics contain data on several areas of IT performance. Some of the data categories have several years of historical data available, while others are relatively new and only have one to two years worth of data. A majority of the data in this category is current and is actively being collected by the IT department. This group provided the best source of data for the creation of an initial IT Department Dashboard, and further analysis was focused in this area.
3.1.3. **Point of Service Metrics**

The POS metrics are currently being used by the IT Department managers for internal department tracking and for monthly reporting to the Executive Vice-President and Chief Financial Officer. Of the target audiences identified in section 2.3, only the Division Vice-Presidents are unfamiliar with the POS metrics. This familiarity with the metrics will allow the dashboard to be more easily accepted by the target audiences.

Maintaining computer functionality at the POS has a major impact on Monro’s ability to bring in revenue. When an office computer is down productivity suffers and deadlines may be missed. If a POS computer goes down it can mean customers lost to the competition. This factor makes having useful POS metrics vital to Monro.

Since these metrics are used regularly at several levels within Monro, improving their presentation can have practical and real effects on the ability of the IT Department to respond to, and report on, changes in POS activities. If the dashboard is well received it is likely that the IT Department will receive support from the executive level for expanding the dashboard approach to other areas of reporting.

Since the POS metrics are already being collected most of the necessary data is already available for the dashboard. Additional data may be required, or some changes in format, but the basic pool of data is currently available. This makes implementation of the dashboard an extension of current reporting which will be easier than defining an entirely new set of metrics.

A negative aspect of using these metrics is the inertia that can affect users who are accustomed to seeing a certain set of data. Some of the current metrics may not be useful, but since the users expect to see them it may be difficult to convince them that they are not needed.
3.2. Statistical Analysis

Statistical analysis offers insight into the data and objective ways of viewing it. The primary purpose of the statistical analysis is to identify metrics that offer useful information so they can be included on the dashboard. A key characteristic of useful data is the ability to identify when the current conditions do not match what is expected, possibly indicating a need for action.

The data was investigated at three different levels – yearly, quarterly, and weekly. While the same data was analyzed each time, different characteristics became apparent by looking at it from these three different resolutions.

3.2.1. Missing Data

Missing data is not unusual when dealing with datasets compiled manually and some of the data sets I worked with had this problem. For some analyses, missing data causes little problem, but for others the analysis cannot be completed if data is missing. For this application the goal when replacing the missing data is not to determine what the actual data was, but rather to find neutral data that does not influence the analysis.

In the weekly call data seven points were missing: week 1 from fiscal year 2000, weeks 50-52 from fiscal year 2004, and weeks 50-52 from fiscal year 2005. In order to run certain analysis I needed to find suitable estimates for the missing data. The missing data was in three different types of locations – the beginning of the data, a point in the middle of the data, and the end of the data. The differences in location led me to use three different techniques to find replacements for the missing data.

Week 1 from FY2000 is the first data point available, and without any prior data there is no way to determine what the previous trend might have been. With a single point missing, a neutral choice of replacement data is to simply repeat the value in week 2, which can be seen in panel 1 of Figure 1.
The missing data in fiscal year 2004 has both predecessor and successor data. I replaced this data by projecting a line from the two existing data points that bookend the missing data, and then choose points on that line as shown in panel 2 of Figure 1.

The final set of missing data was in weeks 50-52 in fiscal year 2005. This data has predecessor data, but no successor data. I used a moving average to estimate the missing values as shown in panel 3 of Figure 1.

Figure 1 Estimating Missing Data

3.2.2. Data Distribution

A prerequisite for using many methods of statistical analysis is that the data must be normally distributed. I tested the calls per week data using probability plots and a statistical test for normalcy. Normally distributed data will show the points in a roughly straight line, and for this test a p-value of greater than 0.05 would indicate that the data is normally distributed at a 95% confidence level.
The plot of calls/week, shown in the left panel of Figure 2, clearly does not show a straight line, and the p-value is much smaller than 0.05 indicating that this data is not normally distributed. In this form the data cannot be used for many methods of statistical analysis, so I looked at the data in a different form.

The plot in the right panel of Figure 2 was created after transforming the original data by taking the natural log (ln). This is a common transformation used in statistical analysis, and in this case it had the desired effect – the plot now shows a fairly straight line and the p-value of 0.33 greatly exceeds the 0.05 level needed for a 95% confidence level. Only four data points lie outside of the 95% confidence interval lines, and discussions with the client revealed that during those weeks calls were higher due to new hardware installations.

Based on these results, when I used a statistical method requiring normally distributed data I used the transformed data, and not the original data. While this is a useful tool for analyzing the data, it would create additional steps when using statistical forecasting methods since the forecasts would then need to be transformed back to their original format.

![Figure 2 Probability Plots of Calls/Week Fiscal Year 2000-2005](image)
3.2.3. Basic Statistics – Yearly View

A yearly summary of the calls received by the IT Help Desk for fiscal years 2000 through 2005 is shown in Figure 3. The graph in Figure 3 shows that the maximum number of calls per week changes much more between years than either the minimum number of calls per week or the average number of calls per week. This implies that it will be harder to predict the maximum number of calls per week than it is to predict the average and minimum number of calls.

It also appears that the number of calls received by the IT Department is increasing as time goes on, which makes intuitive sense since the number of POS being supported has increased over time. An analysis of the average number of calls (see Appendix A, section 6.2) shows that the change in mean is statistically significant, verifying the visual observation. It may be surprising that a statistical analysis of the total number of calls per year (see Appendix A, Section 6.1) showed that the change in mean is statistically insignificant, but the limited number of data points and the seemingly unusual value for FY2002 may have led to this result. In this case, based on the increasing average number of calls, visual observation of the total number of calls graph, and the knowledge that the number of users has continued to increase, it is reasonable to say that the total number of calls each year is increasing in a practical sense even though the analysis indicates that the change is statistically insignificant. A review of additional data in the future could either support or refute this decision.
### Fiscal Year Call Statistics

<table>
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<th>Year</th>
<th># of Missing Weeks</th>
<th>Standard Deviation Calls/Week</th>
<th>Standard Deviation of Weekly Averages</th>
<th>Standard Deviation of Yearly Totals</th>
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<tbody>
<tr>
<td>2000</td>
<td>1</td>
<td>74</td>
<td>25</td>
<td>1093</td>
</tr>
<tr>
<td>2001</td>
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</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
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<td></td>
<td></td>
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<tr>
<td>2005</td>
<td>3</td>
<td>68</td>
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</tbody>
</table>

**Figure 3 Fiscal Year Call Statistics**

### 3.2.4. Basic Statistics – Quarterly View

The same data viewed on a quarterly basis offers more insight into the variability of the call data. At this resolution much more variation can be seen in the graph of the average number of calls per week (Figure 4) compared to the yearly view (Figure 3).

Looking at the variation within each quarter there is no clear pattern to the number of calls. When spikes occur they show up in different quarters of each year, and the pattern in each year is different. This lack of pattern indicates that there is no strong seasonal component to the data.

Statistical analysis (see Appendix A, Section 6.3) on the average number of calls per week each quarter showed that the relationship between number of calls and quarter is statistically insignificant. It is not possible to predict the number of calls based on the quarter of the year.
In Figure 3 it was possible to see the rising trend in the total number of calls per year. In Figure 4 this rising trend is lost in the variability of the total number of calls per quarter. It is interesting to note that the high total number of calls for FY2002 seen in the yearly view was caused by four quarters of moderately high call levels, and not by a spike in calls. The spikes seen in individual quarters in 2000, 2004, and 2005 did not have the same impact on the yearly total.

<table>
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<tr>
<th>Quarterly Call Statistics</th>
<th># of Missing Values</th>
<th>Standard Deviation Calls/Week</th>
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<td>Q3</td>
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<tr>
<td>Q2</td>
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<td>31</td>
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<tr>
<td>Q3</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>Q4</td>
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<tr>
<td>Q2</td>
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<td>Q3</td>
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<td>30</td>
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<tr>
<td>Q4</td>
<td>3</td>
<td>19</td>
</tr>
</tbody>
</table>

Figure 4 Quarterly Call Statistics

3.2.5. Basic Statistics – Weekly View

When the calls are viewed weekly as shown in Figure 5 the increasing trend in the average number of calls per week is not as obvious as it is in Figure 3. Three areas stand out on these plots as unusual – week 28 in fiscal year 2002, week 26 in fiscal year 2004, and week 25 in fiscal year 2005. Looking back at Figure 2, these are the same points that were noted there as being unusual and outside the
normality limits. As was previously mentioned, new hardware was installed during these periods and the amount of calls increased for that reason.

As in the quarterly view, there is no clear pattern of the number of calls based on the week of the year. Each year demonstrates a different pattern meaning that it will not be possible to predict the number of calls expected at any given point in time based on the week of the year. A statistical analysis (see Appendix A, Section 6.4) on the average number of calls per week showed that the relationship between number of calls and week of the year is statistically insignificant. It is not possible to predict the number of calls based on this metric.

![Calls Per Week Fiscal Year 2000 - 2005](image)

**Figure 5 Weekly Call Statistics**

### 3.2.6. Additional Statistical Analysis

When investigating the data I considered time series analysis and multivariate analysis, but in the context of this project these methods were not useful.
Time series analysis looks at seasonal and trend influences in an effort to forecast future events. It is possible to predict future events in a changing system if the system is changing in a predictable manner. At this point in time the number of POS users supported by the IT Department can change dramatically and unpredictably, limiting the value of forecasting based on time series analysis.

While this section of the report focused on just one variable (calls per week), the IT Department actually tracks many more metrics. The availability of these metrics makes multivariate analysis a possible tool, but the results of such analysis would offer limited value to the actual implementation of the dashboard this project focuses on.

3.2.7. Summary

Basic statistical analysis of the calls per week data indicates that the number of POS support calls being handled each year by the IT Department is increasing. Due to the changing number of POS users being supported it is not possible to predict call levels based on the current metrics. The inability to establish this baseline means that it is not possible to identify conditions that require action with this set of metrics. The high-level solution will identify how a baseline can be established to provide metrics useful for creating a dashboard.

3.3. High-Level Solution

In order to present actionable data the IT Dashboard will need to have metrics that can be compared to reference points. Ideally, many of the metrics and their corresponding reference points should be independent of normal changes to the IT environment, such as the addition of new users to the system. While the addition of new stores is important to the business it is not valuable to have each change in user base be reflected in the IT Dashboard. An example of this is the average number of calls per week, which have been increasing each year, but currently there is no good way to relate this to previous years because the user base undergoes frequent changes. It is likely that this increase is simply a reflection of the increased user base – a metric that can be viewed directly without bringing the number of Help Desk calls into the picture.
Some of the current POS metrics will provide useful, but simple modifications and additions will offer valuable improvements to the IT Dashboard. Recommendations regarding current metrics and new metrics are explained in the following sections. Several of the new metrics are recommended because they are not affected by normal changes in the IT environment, an important consideration if the IT Dashboard is to remain viable over a period of time.

3.3.1. Summary of Recommended IT Dashboard Metrics

Many potential Dashboard metrics are available, but the goal is to select those that offer insight into the status of the IT Department, and metrics that identify actionable issues. The items on this list of recommended metrics for the IT Dashboard are described in Sections 3.3.2 and 3.3.3.

- Number of Help Desk calls
- Number of expected calls
- Number of calls per workstation
- Number of workstations being supported
- Number of PCs down
- Response time – average per call, percent instant response calls
- Calls by age of POS location
- Calls by call type
- Calls by length of time calls are open
- Calls per Help Desk Technician
- Comment section

3.3.2. Dashboard Metrics – Existing

Continue to report on number of Help Desk calls received, but add reference points to put it in appropriate context. This number offers a view of the magnitude of calls handled by the Help Desk, but requires too much interpretation to determine if things are getting better, worse, or staying the same with respect to user support. Since the number of calls in the previous year is not
a good predictor at any given point in time, do not include it on the IT Dashboard.

Response time has an impact on user satisfaction, and ultimately the revenue stream. The current metrics, average response time and percent of calls that receive instant response (i.e. get answered by a person and do not go to voicemail), appear to be good choices. Goals already exist for calls received during business hours, but need to be established for the after hours calls. Additionally, reference points need to be defined around these goals that will indicate when response time is outside of acceptable limits.

Average length of call, when combined with average number of calls, gives an indication of how much time the Help Desk technicians spend on the phone with users, but if this metric is of interest it can be reported on more directly. I would recommend not including this metric on the IT Dashboard, and instead add new metrics that show a breakdown of calls based on length of call, as described in Section 3.3.3.

Calls in open status and calls in follow-up status don’t give a detailed enough view of the underlying issue – are there calls that linger unresolved? Metrics on how long it takes to resolve calls would better answer this question, and are discussed in Section 3.3.3.

The current POS hardware metrics seem to offer little actionable information, and the only one I would recommend including on the IT Dashboard is number of PCs down. It may be useful to present this number within the context of how many PCs are currently being supported, and an acceptable limit should be defined.

### 3.3.3. Dashboard Metrics – New

Number of calls per workstation is an important new metric since it will show the level of activity independent of changes in the total number of POS locations.
Once a goal and limits are established for this metric it will remain valid even after new POS locations are added, an important factor in making the IT Dashboard resilient to frequent business changes. Once enough historical data is available from this metric, expected calls for a given period can be calculated by multiplying the average number of calls per workstation by the number of computers being supported.

In addition to being used to calculate number of calls per workstation, the number of workstations being supported can be reported directly on the IT Dashboard. Presenting total number of workstations in the hardware section with the number of PCs down will give context to this metric.

Categorizing calls by the length of time the POS location has been with Monro will allow Help Desk calls to be analyzed with respect to age of the location. I would expect that new locations typically have different types and frequency of calls to the Help Desk than established locations, and being able to break out the total number of calls on the basis of age could offer useful insight into Help Desk activities. It is likely that the IT Department already has an intuitive understanding of the cut-off points that separate a new location from an existing location, and recommendations on initially setting those levels should come from within that department.

There are several call characteristics that can provide useful information about the demands on the IT Department. Ticket types should be defined, tracked, and the corresponding metrics shown on the IT Dashboard. The types should not be too narrow, and typical categories are software, hardware, user error, and configuration, though the Monro IT department may have insight into alternate categories that would better describe their typical call types.

Length of time calls are open is another call characteristic that can reported on, and would provide more useful information than the current metrics number of calls open and number of calls in follow-up. When looking at number of calls
open it is difficult to tell whether you are seeing one call open for six days, or six calls open for one day each. Reporting on length of time calls are open eliminates that confusion. This is another area where the IT Department likely has the best sense of appropriate limits to define length of call.

A metric that may prove useful in the long run is number of calls per Help Desk Technician over a given period of time. As the number of supported users increases this metric can be one of several indicators that can help determine when additional Help Desk Technicians will be needed.

Adding a dated comment section to the Dashboard would provide valuable historical information, independent of personal recollections. Brief entries such as “May 12, 2005 lightning strike fried server” can go a long way toward explaining an unexpected spike in the number of Help Desk calls.
3.4. Detailed Solution

Based on the High-Level Solution presented in Section 3.3, an IT Dashboard mock-up was created using Microsoft Excel and randomly generated data. A reduced version of the mock-up is shown in Figure 6 and a full size version can be seen in Appendix B Figure 25.

The following sections provide details on each of the graphs included in the IT Dashboard mock-up. Limits and goals are shown to demonstrate usage, but values for these items should be defined in the implementation phase based on data analysis and practical business implications.

Figure 6 IT Dashboard Mock-up
3.4.1. Response Time Graphs

Average Response Time and % Instant Response graphs are shown in Figure 7. These metrics are currently being captured and reported on, but would benefit from the establishment of limits to provide a better understanding of performance levels.

Dashboard Item: Average Response Time

**Purpose:** Compares the average call response time to the goal time. If the average response time is consistently high compared to goal action should be taken to identify the cause of the slow response time.

**Type:** Line Chart

**Input Data:**

\[
\text{Average Response Time} = \frac{\text{sum of all response times for the week}}{\text{total number of calls for the week}}
\]

**References and Limits:** Current goal of 2 minutes shown (yellow line). Upper limit of 6 minutes based on 3\(\sigma\) (red line). Standard deviation (\(\sigma\)) of average response time in fiscal year 2005 was 2 minutes.

Dashboard Item: % Instant Response

**Purpose:** Compares the % of calls answered directly by a Help Desk technician to the goal %. If the % of instant response is consistently low compared to goal action should be taken to identify the cause of the slow response time.

**Type:** Line Chart

**Input Data:** Instant response is when the incoming call is answered by a Help Desk technician and does not go to voice mail.

\[
\text{% Instant Response} = \frac{\text{number of calls answered directly for the week}}{\text{total number of calls for the week}}
\]

**References and Limits:** Current goal of 80% shown (yellow line). Upper and lower limits not shown because standard deviation (\(\sigma\)) of % instant response in fiscal year 2005 was 10% which would place 3\(\sigma\) at 50% and 110%, which are not of much practical value. During the implementation may wish to establish upper and lower limits based on business expectations.
3.4.2. Total Calls/Week vs. Expected Calls

The Total Calls/Week vs. Expected Calls graph is shown in Figure 8. Total calls/week is currently tracked, but an expected call rate needs to be established to provide context for this data.

**Dashboard Item:** Total Calls/Week vs. Expected Calls

**Purpose:** Compares the total number of calls received each week to the expected number of calls. If the actual number of calls received exceeds the limit of expected calls in a short-term spike the cause should be investigated and documented in the notes section. If the actual number of calls consistently exceeds or approaches the expected limits this may signify an ongoing problem that should be identified and resolved.

**Type:** Line Chart

**Input Data:** Total calls – collected in Help Desk database

Expected # Calls = # of supported stores) x (calls/store) where calls/store is a rate based on historical data.

**References and Limits:** A hypothetical expected number of calls is shown (yellow line), with upper and lower limits. During implementation limits would be established based on the standard deviation of the number of calls received weekly and practical application.
3.4.3. Calls/Store

The Calls/Store graph is shown in Figure 9. This metric is not currently tracked, but is needed in order to provide context for the total calls/week metric. During implementation the usefulness of this metric should be compared with tracking calls/computer.

Dashboard Item: Calls/Store

Purpose: Compares the average number of calls/store with a baseline. If the calls/store consistently exceeds or approaches the limits this may signify an ongoing problem that should be identified and resolved.

Type: Line Chart

Input Data: Calls/Store = \( \frac{\text{number of calls}}{\text{number of stores}} \)

References and Limits: A hypothetical baseline is shown (yellow line), with upper and lower limits. During initial implementation limits could be estimated based on recent performance, but it will take several months to have enough data to establish a baseline and limits with statistical meaning.
3.4.4. Calls/Help Desk Technician

The Calls/Help Desk Technician graph is shown in Figure 10. This metric is not currently tracked, but will provide insight into Help Desk activity levels. This is not a measure of individual performance, but a measure of workload for the entire group.

**Dashboard Item:** Calls/Help Desk Technician

**Purpose:** Compares the calls/Help Desk technician to limits set based on business goals. If the number of calls/Help Desk technician consistently exceeds or approaches the upper limit it may indicate that additional Help Desk personnel is needed.

**Type:** Line Chart

**Input Data:**

\[
\text{Calls/Help Desk Technician} = \frac{\text{number of calls/week}}{\text{number of Help Desk technicians working that week}}
\]

**References and Limits:** The limits shown here are for demonstration purposes only and are not based on data analysis or business goals. After several months worth of data has been collected historical context will help identify appropriate levels.

Figure 9 Calls/Store Graph

Figure 10 Calls/Help Desk Technician
3.4.5. **Calls by Level of Difficulty**

The Calls by Level of Difficulty chart is shown in Figure 11. This metric is not currently tracked, but will provide insight into Help Desk activity. Difficulty can be measured in many ways, and how this metric will be defined should be addressed during implementation.

**Dashboard Item:** Calls by Level of Difficulty

**Purpose:** Breaks calls down into level of difficulty categories. Understanding the types of calls being handled can provide insight into the mix of experience and qualifications needed by the Help Desk technicians.

**Type:** Pie Chart

**Input Data:** Number of calls sorted by level of difficulty

**Categories:** Basic, Normal, and Complex are shown, but investigation of existing data and input from the Help Desk technicians during implementation will be valuable in identifying suitable categories. Level of difficulty could be based on a combination of several factors, including resolution time, number of follow-up calls needed, and escalation.

![Calls by Level of Difficulty](image1)

![Calls by Age of Store](image2)

*Figure 11 Calls/Level of Difficulty and Calls by Age of Store Graphs*
3.4.6. **Calls by Age of Store**

The Calls by Age of Store chart is shown in Figure 11. This metric is not currently tracked, but will provide insight into the level of help needed by stores of various ages. Since Monro adds stores regularly this metric will offer valuable insight into level of activity expected based on the composition of stores by age.

**Dashboard Item:** Calls by Age of Store

**Purpose:** Breaks calls down into categories based on age of store. If one category of stores tends to dominate the calls it may indicate a need for additional training or a modification in support strategy.

**Type:** Pie Chart

**Input Data:** Number of calls sorted by age of store

**Categories:** 0-3 months, 3-6 months, and greater than 6 months are example categories. Help Desk technicians may have insight into appropriate categories, and after several months of data have been collected categories can be redefined.

3.4.7. **Calls by Type**

The Calls by Age of Store chart is shown in Figure 12. This metric is not currently reported on, but similar data is collected during Help Desk calls. Reporting on this metric will offer insight into the types of problems the Help Desk is responding to, which may influence decisions on upgrade and maintenance strategies, or training.

**Dashboard Item:** Calls by Type

**Purpose:** Breaks calls down into categories based on types of calls. If a large percentage of calls fall into one category it may indicate a need for training, or a change in maintenance strategy.

**Type:** Pie Chart

**Input Data:** Number of calls sorted by type of call

**Categories:** Hardware, software, configuration, and user error are sample categories. A review of existing data can help identify appropriate categories.
3.4.8. Calls by Time to Resolve

The Calls by Time to Resolve chart is shown in Figure 12. This metric is not currently reported on, but this metric will offer insight into how the Help Desk technicians are utilized.

**Dashboard Item** Calls by Time to Resolve

**Purpose:** Breaks calls down into categories based on time to resolve calls. If many of the calls are resolved quickly it can be expected that the Help Desk technicians can support many calls a day, but if many of the calls take a long time to resolve Help Desk technicians will be able to support fewer calls a day.

**Type:** Pie Chart

**Input Data:** Calls sorted by Time to Resolve

**Categories:** Sample categories are <1 hr, 1-2 hrs, 2-8 hrs, and >8 hrs. Help Desk technicians may have insight into appropriate categories, and after several months the data can be analyzed to further refine levels.

3.4.9. Notes

A sample Notes display is shown in Figure 13. Notes regarding changes and unusual events in the POS environment are currently maintained in various locations, but not in a format that can be easily accessed for use in the IT Dashboard. Brief notes captured in one location will simplify creation of a notes area on the IT Dashboard.
Dashboard Item: Notes

Purpose: Provide quick reference to information related to the IT Dashboard metrics. Having ready access to relevant notes improves usability of the Dashboard displays.

Type: Text field

Input Data: Notes entered into text area

Categories: Potential areas to make notes on include staffing changes, changes in number of stores, software and hardware deployments, and hardware failures.

Figure 13 Notes Display

3.4.10. End of Quarter Stats

A sample End of Quarter Stats display is shown in Figure 14. These metrics are currently not tracked in any one place, but they provide important context for the IT Dashboard.

Dashboard Item: End of Quarter Stats

Purpose: Provide quick reference to statistics about the IT environment

Type: Text field

Input Data: Notes entered into text area or report run against database

Categories: Potential IT statistics to report on include number of stores being supported, number of new stores, and number of Help Desk technicians

Figure 14 End of Quarter Statistics Display
3.5. Implementation

The pending deployment of TrackIT to the POS Help Desk offers an opportunity to implement an IT Dashboard with minimal disturbance of Help Desk activities. The new software will require the Help Desk technicians to learn a new interface and changes to collected data are already planned. If the changes required for the IT Dashboard are implemented in conjunction with TrackIT, training issues or database additions needed for the IT Dashboard will have minimal impact on the overall deployment of the new software.

The following sections provide guidelines to implementing the IT Dashboard, in roughly the order required.

3.5.1. Scope and Resolution

The IT Dashboard mock-up provides several potential graphs and charts that could be included on the final IT Dashboard. These suggested metrics should be reviewed and a decision made on which to include and what additional metrics might be desired.

Initial implementation could include a subset of the desired elements, or be a full implementation. While full implementation would be ideal, partial implementation may be useful in piloting the concept to upper management and working out any implementation issues. An additional advantage of a partial implementation is that some of the metrics may not offer much actionable information until data has been collected for a period of time. Data collection for these metrics should be started as soon as possible, but a delay in implementation of the corresponding dashboard element will have a comparatively small impact in the usefulness of the IT Dashboard.

The IT Dashboard mock-up resolution is to the week level within a quarter, and this is the resolution I recommend starting with. It offers a view of weekly activity which gives a good insight into the level of Help Desk activity without drawing too much attention to random, daily fluctuations. The number of weeks
in a quarter remains constant at 13, which allows the quarters to be compared to each other on a one-to-one basis. Data should be collected on the basis of week of the fiscal year, but to facilitate ease of use week ending dates could be added to the dashboard displays.

A yearly view that showed a combination of quarterly and weekly metrics could be another useful resolution. A monthly view would introduce complications since lengths of months are not consistent, and one-to-one comparison between months is not possible. A weekly view with resolution at the day level may be useful, but careful consideration would need to be given to control limits in order to avoid overreacting to spurious events.

3.5.2. Data Acquisition

Once the desired dashboard elements have been identified, a review of necessary data compared to currently collected data will reveal any changes that need to be made to data collection. If this review identifies some fields that may or may not be needed, it would be easier to collect them initially and eliminate them later if they are unneeded, rather than trying to add them later.

Implementation of the IT Dashboard will be greatly simplified if the necessary data is available from one location. The most likely location to store the data is in the TrackIT database. If necessary, data could be moved from other systems into the TrackIT database in order to support the IT Dashboard. If this becomes necessary it is highly desirable to automate these transfers since manual transfers will create bottlenecks and unpredictable data availability.

3.5.3. Control Limits and Goals

After the dashboard metrics are selected it will be necessary to define goals or expected values, and control limits to define when the data is outside the acceptable limits.
Goals should be set based on business needs and desired results. Care should be taken to choose appropriate goals so that effort is not wasted on trying to achieve performance that cannot be achieved, or performance levels that exceed practical usefulness.

Expected results are based on metrics defined by historical data that is then applied to current conditions. The Total Calls/Week vs. Expected Calls element of the IT Dashboard mock-up is an example. The number of expected calls cannot be defined without enough historical data for analysis. It may be necessary to temporarily use “best guess” estimates, but limited action should be considered when the actual values don’t conform to these estimates.

Typical control chart limits are three times the standard deviation (σ) of the data. When setting up limits for the dashboard metrics this is a good place to start, but may not always result in limits that make good business sense. As the limits are established both statistical and practical considerations should be taken into account in order to define meaningful values.

### 3.5.4. Software Selection

Several software options exist for the creation of the IT Dashboard. Factors to be considered include flexibility, maintainability, portability, features, and cost. Three options are discussed here, though they are not the only ones available.

Microsoft Excel is a tool currently available to the Monro IT Department, and using this tool would incur no additional software purchase. While it is an easily accessible and familiar tool, it has several limitations. Data must be manually brought into the spreadsheet, or drivers must be used to connect to an external database (not always an easy task). In order to create the IT Dashboard mock-up several graphs had to be manually manipulated, which does not lend itself to easy maintainability. Excel would not be my first recommendation.
Crystal Reports, by Business Objects, is also currently available to Monro as part of TrackIT. This tool is not as familiar to most users as Excel is, but does offer the advantage of portability – it can access data from Excel or most other database types. This portability could allow a dashboard to be started based on an Excel spreadsheet, and then transition to the TrackIT database when it becomes available. Graphing functionality appears to be similar between Excel and Crystal Reports. Crystal Reports is designed to present data and the tools available appear to be more comprehensive in this application. I have little experience with Crystal Reports but believe it is worth further investigation for use with the IT Dashboard.

Business Objects has recently released a new product called Crystal Vision, which they describe as an “integrated reporting and dashboard suite” that can turn Crystal Reports into interactive business dashboards. A disadvantage of this software compared to Crystal Reports or Excel is that additional software purchase(s) would need to be made, but I would recommend investigating this product to see if the features would justify the investment.

3.5.5. Design Documentation and Help Files

Documentation on the fields and calculations used in the creation of the IT Dashboard will facilitate future changes. Design documentation requires a small amount of effort to create during the implementation process, but to create it at a future date would require a much larger effort.

Help files will make the graphical interface of the IT Dashboard even more user friendly by providing basic descriptions of the metrics being used and the reason behind their use. Ideally help files would be accessible from the IT Dashboard interface via a pop-up window or a drill-down feature supplied by the dashboard software. While the IT Dashboard contents are meant to be intuitive, providing help files will make it easier for new or infrequent users to quickly understand the various graphs and displays.
4. Evaluation of Capstone Project and Personal Observations

Fully evaluating the results of my Capstone Project encompasses two primary areas – short-term and long-term results. The short-term results can be evaluated as the project progresses and during the final phase of the project. The long-term results of the project cannot be evaluated until the dashboard has been in use for a period of time. Ideally, a review of the long-term results should be conducted 6 to 12 months after the completion of the capstone project.

4.1. Short-Term Evaluation

Short-term evaluation of my Capstone Project looks at how well the Capstone Project Proposal was met with regards to achieving the objectives, meeting the schedule, client satisfaction, and project outcome.

4.1.1. Capstone Project Objectives

Several objectives and goals were identified in the Capstone Project Proposal. The overall goal identified in the problem statement of the proposal was to develop a dashboard with actionable information and present it in an easily understood interface, and I am satisfied that this goal was met. Presenting the metrics in visual form using graphs and charts offers an interface that is intuitive and easy to understand. Further work with the client to fine tune terminology used on the IT Dashboard would increase the ease of use for Monro users, and the recommended help function will allow users to access reference material quickly and easily. By including control limits and goals the metrics presented on the IT Dashboard are actionable – when the limits are exceeded action is indicated.

In addition to the IT Dashboard being easily understood, feedback from the clients indicates that the supporting materials included in the Capstone Report are understandable to them. This means that I successfully reached that portion of my target audience. I also engaged two statistics students to do peer reviews, and their feedback indicated that they understood both the body of the report, aimed at a broad audience, and the statistical analysis appendix, which was
aimed at a more technical audience. I am pleased with the response to this format and would use it again for future presentations of products.

4.1.2. Schedule

Early in the project deliverables deviated from the planned schedule, but adjustments along the way allowed the project to be completed on time. Several factors impacted scheduling, including increased work commitments due to a major product deployment at my place of work, and an unexpected acquisition by Monro that reduced availability of their IT personnel to provide feedback and input into the project. These are typical of the issues that all projects face, and they just have to be dealt with.

My initial plan also affected the schedule early on. I had originally scheduled statistical analysis and the high-level solution occurring linearly, but that is not how it worked out in practical application. Once I started working on the two items in tandem the project progressed much faster. I will apply this to future project planning and not try to force activities to fit a plan that isn’t working.

4.1.3. Client Satisfaction

The IT Dashboard mock-up and preliminary report was presented to the Monro IT Director, QA Manager and Help Desk Supervisor the week before the final Capstone Project Presentation. They were pleased that I had been able to move forward with limited input from them, and they saw real value in the results presented in the report. The QA Manager indicated that his initial expectation was that I would give them a functioning dashboard but not necessarily the supporting documentation. After reading the report and reviewing the recommendations he felt that the actual results of the project were more desirable than his initial expectations.

An interesting observation on the QA Manager’s expectation is that the Capstone Project Proposal clearly indicated that the outcome would be an implemented dashboard, or a mock-up and requirements for development of a dashboard. This
is an important consideration to keep in mind when working with clients in the future – documentation of agreements is vital, and even with documentation expectations can vary between the interested parties.

The client will be completing an evaluation that will be available with the submitted Capstone Project Report. Based on their feedback to this point I expect the evaluation to be positive.

4.1.4. Outcome
As indicated in the preceding section, the expected outcome of the project was either an implemented dashboard, or a mock-up and requirements for development of a dashboard. The actual outcome was a mock-up and requirements (documented in the Detailed Solution, Section 3.4). I am satisfied with this outcome – the client has enough information to move forward with implementing an IT Dashboard, and the supporting documentation to gain value from an implemented dashboard. A functioning dashboard without a solid foundation supporting it would offer little long-term value.

4.2. Long-Term Evaluation
Long-term evaluation of the project falls into the hands of the client. The following sections list suggestions for evaluation in six to twelve months.

4.2.1. IT Dashboard Implementation and Acceptance
Has the dashboard been implemented, either fully or partially? If it has been implemented, is it used regularly? Has the Executive Vice-President and Chief Financial Officer accepted the IT Dashboard as an important part of monthly status meetings? Have the Division Vice-Presidents been introduced to the IT Dashboard and do they find it useful? If users outside of the IT Department have not readily accepted the IT Dashboard the reasons should be investigated. Potential reasons might include too much information, too little information, unfamiliar terminology, and information presented not relevant to their needs. If
any of these prove to be true changes to the IT Dashboard, or creation of a custom dashboard might be valuable.

4.2.2. Robustness

Does the dashboard still supply relevant information after routine changes in IT helpdesk operations? An example of a routine change would be an incremental increase or decrease in number of stores supported. If the metrics are not robust it may be necessary to modify the IT Dashboard in order to include metrics that supply meaningful information even when conditions change.

4.2.3. Completeness of Solution

Does the dashboard supply the information needed to assess IT helpdesk operations, or do the managers need to routinely refer to additional metrics in order to know the status of the department? If additional information is sought out infrequently, such as every six months, it may not be a good investment of effort in adding it to the dashboard. If the same information is asked for on a monthly basis it could be worthwhile to establish a metric on the IT Dashboard to supply this information.

4.2.4. Relevance of Metrics, Goals, and Limits

As business needs change some metrics that once had value may become obsolete. Obsolete metrics should be removed and replaced with metrics that offer value. Goals and limits may also change based on business needs, and in this case since many of the limits and goals are new the initial settings may not be ideal. After the goals and limits have been in place for several months they should be evaluated and adjusted to provide valuable information.

4.3. Personal Observations

One of the most exciting outcomes of the project was that the IT Director and the QA Manager saw real business implications from looking at the data analysis. When I asked what had happened in 2002 to cause such a spike in the total number of calls for the year they traced it back to a change in system software. They then commented that a similar
change is scheduled for the fall of 2006, and that based on the impact seen in 2002 they would be taking this into consideration in the planning phase.

The value of a strong proposal became apparent as the project progressed. The effort to define the problem and understand the client’s needs early in the process made it possible to continue working on the project even when unexpected conflicts prevented them from providing additional support. The work that went into the proposal paid off later in the project and was worth the initial investment of time.
5. Cross-Disciplinary Skills and Applications

The opportunity to apply a wide range of skills from my professional experience and plan of study course work was one of the factors I considered while selecting a Capstone Project. One of the real assets of a cross-disciplinary course of study is the practice of taking skills learned in one area and translating them to another.

5.1. Professional Experience

My cross-disciplinary approach to education and professional pursuits was established when I started my undergraduate career as a music major and graduated nine years later with a bachelor’s degree in electrical engineering. My professional experiences have relied not on any one area of my education, but have instead pulled from the entire collection of coursework I was exposed to in my undergraduate classes. Many of those experiences have direct and indirect application to my Capstone Project.

One of the objectives of the IT Department Dashboard is to take data captured by the IT department, and translate and target it so that people outside of the department can understand it. This type of translation is an activity I have done throughout my professional career. When developing software for subway car climate control systems the format of data I needed to present to the engineer who designed the circuit boards was completely different from the presentation of similar data to the end user who only saw the blinking lights on the outside of the box. This understanding of target audience is an important part of developing the IT Department dashboard.

Developing custom quality assurance metric software has shown me one very important thing – there is a vast amount of data you can collect, but not all of it is useful. My initial efforts in this area involved capturing every piece of information I could think of, and the result was an overwhelming amount of information that was painful to look at. Only after identifying key areas to track and report on did the software become useful. The IT Department Dashboard incorporates this lesson – it’s more effective to present a few important metrics than a large number of meaningless metrics.
I have had the opportunity to do a significant amount of technical writing in my professional career, including the writing of requirements, training, and testing materials. The knowledge from that experience was used throughout my Capstone Project, including the writing of requirements for IT Department Dashboard and the creation of this Capstone Project Report.

5.2. Statistical Methods Concentration

Classes in statistical methods made up the largest part of my Plan of Study. As a whole, the courses in this concentration provide a background that was used throughout my Capstone Project, with some classes being directly applied to the project.

Basic statistics skills classes, such as Regression Analysis, Design of Experiments, and Statistical Computing, provide the foundation to perform the statistical analysis used in the project.

An important concept from Multivariate Analysis Applications is the importance of finding metrics that allow you to discriminate. The application of this can be seen in the selection of metrics included on the IT Department Dashboard [include example from final dashboard here].

Techniques from Time Series Analysis and Forecasting were used to find the criteria to evaluate several of the metrics [insert example]. These techniques are important because it is important to compare the data against the appropriate baseline. In the case of the IT Department dashboard, there are some metrics that are best compared month to month, and others that are compared year to year. [insert example?]

5.3. Instrumentation and Control Concentration

The courses in this concentration focused primarily on manufacturing applications. While the IT Department Dashboard has nothing to do with manufacturing, it does use a lot of data, and concepts from Instrument and Computer Aided Data Acquisition that proved useful while manipulating this data.
5.4. Elective Courses

Introduction to Project Management provides a foundation for defining, planning, and managing my Capstone Project. An idea I found important from this class is that project management isn’t something that is done to a project – it is part of the project. Time and resources have to be allocated to managing the project, and I took that into consideration when creating my Capstone Project schedule.

A key concept from Criterion-Referenced Instruction is: what are you actually testing and what is the best way to test it? This thought process was valuable when answering an important question during the creation of the IT Department dashboard: what do you want to measure, and how are you going to measure it?

Knowledge gained in Creating Technical Proposals has an obvious application in the creation of the initial Capstone Project proposal. Just as important are concepts from the class about effectively presenting information, and writing clear, concise documentation. I’ve learned many concepts in classes at RIT, but I think my favorite one comes from this class – technical writing does not have to be passionless and boring!
6. Appendix A Statistical Analysis

Investigative statistical analysis was performed on the data currently being used by the IT Department to monitor helpdesk performance and activity. Details of the analysis of the calls/week data are included in this section, and a summarized version is included in section 3.2 of the main report. Sections 3.2.1 and 3.2.2 include analysis of missing data and data distribution and will not be repeated here.

6.1. Analysis of Total Calls/Year

Call data from six fiscal years is available. A plot of the total number of calls/year (pane 1 Figure 16) shows a general rising trend in the number of calls/year, with an unusually high number of calls in 2002. A probability plot (pane 2 of Figure 16) of the data shows a normal distribution. Regression analysis to test for the statistical significance of the linear relationship between calls/year and year was performed (pane 1 of Figure 15) and the regression was found to be statistically insignificant.

Based on the unusually high number of calls in 2002, the data was analyzed again without this data. A probability plot (pane 2 of Figure 17) of the abridged data shows a normal distribution. Regression analysis to test for the statistical significance of the linear relationship between calls/year and year was performed (pane 2 of Figure 15) and the regression was found to be statistically significant. Residuals were normally distributed and there were no observations with unusual residuals.

At this point I would not consider the analysis of the abridged data to be conclusive since I have no information on why the number of calls in 2002 appears to be unusually high. If further investigation revealed that 2002 was atypical in the operations area it may be valid to use the abridged analysis.
Regression Analysis
Total Calls/Year versus Year – Original Data

The regression equation is
(Calls/Week) = -787429 + 400 Year

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-787429</td>
<td>426933</td>
<td>-1.84</td>
<td>0.139</td>
</tr>
<tr>
<td>Fiscal Year</td>
<td>399.5</td>
<td>213.2</td>
<td>1.87</td>
<td>0.134</td>
</tr>
</tbody>
</table>

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>2793604</td>
<td>2793604</td>
<td>3.51</td>
<td>0.134</td>
</tr>
<tr>
<td>Residual Error</td>
<td>4</td>
<td>3181794</td>
<td>795448</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>5975397</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

H₀: β = 0  H₁: β ≠ 0

Figure 15 Regression Analysis – Total Calls/Year

Regression Analysis
Total Calls/Year versus Year – Abridged Data

The regression equation is
(Calls/Week) = -893504 + 452 Year

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-893504</td>
<td>172486</td>
<td>-5.18</td>
<td>0.014</td>
</tr>
<tr>
<td>Fiscal Year</td>
<td>452.36</td>
<td>86.13</td>
<td>5.25</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>3519636</td>
<td>3519636</td>
<td>27.6</td>
<td>0.013</td>
</tr>
<tr>
<td>Residual Error</td>
<td>3</td>
<td>382795</td>
<td>127598</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>3902431</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

H₀: β = 0  H₁: β ≠ 0

Figure 16 Total Calls/Year – Data Distribution and Residuals
6.2. Analysis of Calls/Week Data Summarized by Year

Regression analysis to test for the statistical significance of the linear relationship between calls/week and fiscal year was performed. Based on the results of the calls/week data distribution (Section 3.2.2), analysis was performed using the transformed data – ln(calls/week). Initial analysis was performed on the entire dataset, but residual analysis showed a cluster of points in the upper tail (panel 1, Figure 19) that were affecting the normal distribution of the data. A discussion with the client revealed that four weeks in this cluster had unusually high calls due to problems encountered during the rollout of new hardware. When the four weeks were removed and regression analysis repeated the residuals demonstrated a more normal distribution (panel 2, Figure 19). The removal of these four weeks is justified since they represent atypical data.

Regression analysis (Figure 18) shows that the null hypothesis (H0: β = 0) is rejected at the 95% confidence level based on the p-value of 0.000 (p ≤ 0.05), indicating that regression is significant. Both the constant and fiscal year predictors are statistically significant (p ≤ 0.05). Several unusual observations were identified, but there is no basis
Driving Monro Muffler Brake with an IT Dashboard

for removing them from the analysis. Based on the regression analysis the average number of calls/year can be predicted based on year.

Analysis of the residuals (Figure 19) shows normally distributed residuals when the abridged data is analyzed. Residuals versus fitted values and residuals versus order are unremarkable.

<table>
<thead>
<tr>
<th>Wk</th>
<th>Year</th>
<th>ln(Calls/Week)</th>
<th>Fit SE</th>
<th>Fit</th>
<th>Residual</th>
<th>Std Res</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>2000</td>
<td>4.7622</td>
<td>0.023</td>
<td>-0.6058</td>
<td>-2.72R</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>2000</td>
<td>5.8464</td>
<td>0.023</td>
<td>0.4785</td>
<td>2.15R</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>2000</td>
<td>6.0568</td>
<td>0.023</td>
<td>0.6888</td>
<td>3.09R</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>2000</td>
<td>5.8972</td>
<td>0.023</td>
<td>0.5292</td>
<td>2.37R</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>2000</td>
<td>5.9054</td>
<td>0.023</td>
<td>0.5374</td>
<td>2.41R</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>2000</td>
<td>5.8141</td>
<td>0.023</td>
<td>0.4462</td>
<td>2.00R</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>2000</td>
<td>6.0088</td>
<td>0.023</td>
<td>0.6409</td>
<td>2.88R</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>2000</td>
<td>5.8435</td>
<td>0.023</td>
<td>0.4756</td>
<td>2.13R</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>2001</td>
<td>4.9488</td>
<td>0.017</td>
<td>-0.4634</td>
<td>-2.07R</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2002</td>
<td>5.9135</td>
<td>0.013</td>
<td>0.4571</td>
<td>2.04R</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>2002</td>
<td>4.9345</td>
<td>0.013</td>
<td>-0.5219</td>
<td>-2.33R</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>2002</td>
<td>5.948</td>
<td>0.013</td>
<td>0.4917</td>
<td>2.20R</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>2003</td>
<td>4.9628</td>
<td>0.013</td>
<td>-0.5378</td>
<td>-2.40R</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>2003</td>
<td>4.8598</td>
<td>0.013</td>
<td>-0.6408</td>
<td>-2.87R</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>2004</td>
<td>5.0626</td>
<td>0.017</td>
<td>-0.4822</td>
<td>-2.16R</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>2004</td>
<td>5.0626</td>
<td>0.017</td>
<td>-0.4822</td>
<td>-2.16R</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>2004</td>
<td>6.0684</td>
<td>0.017</td>
<td>0.5236</td>
<td>2.34R</td>
<td></td>
</tr>
</tbody>
</table>

Regression Analysis

ln(Calls/Week) versus Year – Abridged Data

The regression equation is

\( \text{(Calls/Week)} = -83.1 + 0.0442 \times \text{Year} \)

Analysis of Variance

Source | DF | SS    | MS    | F     | P   |
Regression | 1  | 1.7617 | 1.7617 | 35.1  | 0.00 |
Residual Error | 306 | 15.3583 | 0.0502 |
Total | 307 | 17.1199 |

\( H_0: \beta = 0 \) \( H_1: \beta \neq 0 \)

Figure 18 Regression Analysis – Calls/Week Data Summarized by Year
6.3. Analysis of Calls/Week Data by Quarter

ANOVA was used to test to see if the mean of the calls/week differed by quarter. Based on the results of the calls/week data distribution (Section 3.2.2), analysis was performed using the transformed data – ln(calls/week). The abridged set of the transformed data (ln(calls/week)) was used based on the atypical data described in section 6.1.

ANOVA results (Figure 20) shows that the null hypothesis (H₀: there is no difference between the µ) cannot be rejected at the 95% confidence level based on the p-value of 0.663 (p ≤ 0.05). Based on this result a residual analysis was not necessary.

![Residual Analysis - Call/Week Data Summarized by Year](image)

**Figure 19 Residual Analysis – Call/Week Data Summarized by Year**

![ANOVA Table](table)

**Table 1: One-way ANOVA
ln(Calls/Week) versus Quarter – Abridged Data**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calls/Week</td>
<td>3</td>
<td>0.1007</td>
<td>0.0336</td>
<td>0.53</td>
<td>0.663</td>
</tr>
<tr>
<td>Error</td>
<td>308</td>
<td>19.5601</td>
<td>0.0635</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>311</td>
<td>19.6608</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

H₀: no difference between µ  
H₁: at least one µ is different

![ANOVA Chart](chart)

**Figure 20 ANOVA – Calls/Week vs. Quarter**
6.4. Analysis of Calls/Week Data by Week of the Year

ANOVA was used to test to see if the mean of the calls/week differed by week of the year. Based on the results of the calls/week data distribution (Section 3.2.2), analysis was performed using the transformed data – ln(calls/week). The abridged set of the transformed data (ln(calls/week)) was used based on the atypical data described in section 6.1.

ANOVA results (Figure 20) shows that the null hypothesis ($H_0$: there is no difference between the $\mu$) is rejected at the 95% confidence level based on the p-value of 0.011 ($p \leq 0.05$). This indicates that at least one week has a different mean than the other weeks. The residuals are normally distributed and the residual plots are unremarkable (Figure 22).

A review of the means by week and their confidence intervals (Figure 23) seems to show that weeks 39 and 40 have a mean that is different than the at least some of the other weeks. Tukey comparisons (Figure 24) show that there are six week combinations that have different means, and weeks 39 and 40 are the weeks that differ.

While these results are statistically significant, they have no practical application. Viewing Calls/Week based on week of year offers no practical way of predicting calls.

<table>
<thead>
<tr>
<th>One-way ANOVA</th>
<th>ln(Calls/Week) versus Week of Year – Abridged Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>DF</td>
</tr>
<tr>
<td>wt</td>
<td>51</td>
</tr>
<tr>
<td>Error</td>
<td>260</td>
</tr>
<tr>
<td>Total</td>
<td>311</td>
</tr>
</tbody>
</table>

$H_0$: no difference between $\mu$  $H_1$: at least one $\mu$ is different

Figure 21 Regression Analysis – Calls/Week Data by Week of the Year
Figure 22 Residual Analysis – Calls/Week vs Week of Year
Individual 95% CIs For Mean Based on Pooled StDev

<table>
<thead>
<tr>
<th>Wk</th>
<th>Mean</th>
<th>StDev</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.52</td>
<td>0.1420</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5.51</td>
<td>0.2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5.43</td>
<td>0.1779</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5.50</td>
<td>0.2351</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5.43</td>
<td>0.1520</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5.51</td>
<td>0.2138</td>
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<td></td>
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<td>7</td>
<td>5.54</td>
<td>0.2004</td>
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<td>0.2909</td>
<td></td>
<td></td>
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<tr>
<td>9</td>
<td>5.29</td>
<td>0.2109</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>5.43</td>
<td>0.1455</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>5.48</td>
<td>0.2016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>5.51</td>
<td>0.1518</td>
<td></td>
<td></td>
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<tr>
<td>13</td>
<td>5.36</td>
<td>0.3699</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>5.52</td>
<td>0.2376</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>5.49</td>
<td>0.1975</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>5.51</td>
<td>0.1967</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>5.56</td>
<td>0.2207</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>5.52</td>
<td>0.1405</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>5.54</td>
<td>0.2322</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>5.45</td>
<td>0.2223</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>5.34</td>
<td>0.1962</td>
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<td>22</td>
<td>5.38</td>
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<td></td>
</tr>
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<td>23</td>
<td>5.30</td>
<td>0.2908</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>5.50</td>
<td>0.1420</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Figure 23 Means by Week and 95% Confidence Intervals

Tukey 95% Simultaneous Confidence Intervals

All Pairwise Comparisons Between Weeks

Individual confidence level = 99.99%

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Lower</th>
<th>Center</th>
<th>Upper</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 39</td>
<td>-1.1151</td>
<td>-0.5593</td>
<td>-0.0034</td>
<td>(------*-----)</td>
</tr>
<tr>
<td>26 39</td>
<td>-1.1676</td>
<td>-0.6117</td>
<td>-0.0559</td>
<td>(------*-----)</td>
</tr>
<tr>
<td>39 45</td>
<td>0.0960</td>
<td>0.6519</td>
<td>1.2077</td>
<td>(------*-----)</td>
</tr>
<tr>
<td>39 49</td>
<td>0.0302</td>
<td>0.5861</td>
<td>1.1419</td>
<td>(------*-----)</td>
</tr>
<tr>
<td>39 50</td>
<td>0.0076</td>
<td>0.5634</td>
<td>1.1193</td>
<td>(------*-----)</td>
</tr>
<tr>
<td>40 45</td>
<td>0.0239</td>
<td>0.5798</td>
<td>1.1356</td>
<td>(------*-----)</td>
</tr>
</tbody>
</table>

---

Figure 24 Tukey Comparison of Means by Week
7. Appendix B IT Dashboard Mock-up

Figure 25 IT Dashboard Mock-up
8. Appendix C References

The following is an annotated list of reference articles that are related to the Capstone Project.


Discussion of a statistical dashboard that utilizes automatic analysis to improve processes relating to defects.

Dashboards, enterprise resource planning (ERP) systems, web browser technology, and company intranets, which make the delivery of that information to users a simple task.

Discussion of off-the-shelf dashboard applications.

Example of a web-based dashboard.

Implications of the effect dashboards can have when they provide visibility of daily status to executives.

Includes discussion on types of dashboards and monitoring thresholds from a business-driven development and management point of view.
9. **Appendix D Contents of CD-ROM**

This Capstone Report and supporting documents have been saved to a CD-ROM which contains the following files:

- Spring 2006 Miller Capstone Project Monro IT Dashboard CD Insert.doc
- Spring 2006 Miller Capstone Project Monro IT Dashboard CD Insert.pdf
- Spring 2006 Miller Capstone Project Monro IT Dashboard Evaluations.doc
- Spring 2006 Miller Capstone Project Monro IT Dashboard Evaluations.pdf
- Spring 2006 Miller Capstone Project Monro IT Dashboard Mock-Up.xls
- Spring 2006 Miller Capstone Project Monro IT Dashboard Report.doc
- Spring 2006 Miller Capstone Project Monro IT Dashboard Report.pdf
- Spring 2006 Miller Capstone Project Proposal.doc
- Spring 2006 Miller Capstone Project Proposal.pdf