Undergraduate Quality Management Project: Motorcycle Manufacturer Vendor Rating System

James Baker, Kansas State University, USA
Roger McHaney, Kansas State University, USA

ABSTRACT

A major motorcycle vendor, based in the U.S. Midwest, is the world's largest custom V-Twin motorcycle manufacturer and domestically the second largest motorcycle manufacturer behind Harley-Davidson. This project describes the process used used by a K-State undergraduate distance learning student to design and develop the initial version of a vendor rating system. Ideas for the project were derived in part from existing commercial systems and in part from interviews with different individuals in the organization. The project used concepts taught and discussed in a distance education version of a quality management course offered through Kansas State University but exceeded class expectations. The project was developed with Microsoft SQL, T-SQL, C# and Crystal Reports coding using Microsoft Visual Studio. The initial version of the program is now in use.

Keywords: Quality management, cause and effect diagram, vendor rating system, process model.

BACKGROUND

A large, Midwestern motorcycle manufacturer is the world's largest custom V-Twin motorcycle producer and domestically the second largest motorcycle manufacturer behind Harley-Davidson. For the sake of anonymity, the firm will be called Midwest Motorcycles in this paper. Established in 1994, the company began in a garage where Harley-Davidson motorcycles were given more flair and custom paint jobs. Eventually, Midwest Motorcycles began creating its own frame and designs and by the mid-2000's had turned out its 20,000th custom motorcycle at an average sales price of around $30,000.

Building this many motorcycles requires an established set of vendors for raw materials. Originally, parts were simply ordered from mail order catalogs, assembled, and then the motorcycles were shipped to customers. As time advanced and volume increased, this no longer sufficed. Suppliers for raw materials such as frame piping, tires, engines, paint, bolts and numerous other goods had to be procured competively. High quality standards had to be met in order to be considered and retained. Today, Midwest Motorcycles has approximately 130 vendors from which materials are purchased for manufacturing.

Prior to starting this project, managers found it difficult to determine which vendors met expected quality standards and which did not. In practice, bad vendors were disovered when problems arose and good vendors were simply those with whom problems had not surfaced. Midwest Motorcycles had no system to track which vendors were late or early on delivery, both of which can be costly either through delays on the assembly line, or through storage space costs in the warehouse and accounts payable costs on the books. Midwest Motorcycles had no way to track lagging trends with any particular vendor and did not know whether they were improving or slowly getting worse - and certainly had no way forecast vendor integrity for future orders. This situation indicated that Midwest Motorcycles had a problem and needed a way to better manage its vendor quality issues.

UNDERSTANDING THE ROOT CAUSE OF THE PROBLEM

A deeper investigation was conducted to ensure the correct problem was addressed. A cause and effect diagram (sometimes called a fishbone diagram) was developed to help identify root causes (Ishikawa, 1986). It was determined through observation and interviews that a portion of problem's root cause could be attributed to the corporate culture. Many in Midwest Motorcycle's management positions did not have traditional business education; however, this is common in many small enterprises and not necessarily bad. Many key Individuals were in their positions due to loyalty and seniority with the company. While this has changed somewhat as the company has grown, the movement to more formal organizational structures is not a fast process and 'old-school' thinking still permeates critical areas of the company such as engineering and purchasing. The company has a rather unique environment in which it is preferable to do things the old fashioned way – much of this can be attributed to the older generation of motorcycle enthusiasts that are employed with the company and are comfortable with the status quo. Change is not important even if it promises greater efficiency and higher profits. Although there is enormous talent within many areas of the organization, due to corporate culture, solution simplification will be critical along with automated data capture where practical.

The second sizable root cause is interdepartmental communication difficulties with regard to vendors and material issues. While the purchasing department may have a great relationship with a vendor, and engineering may have a fairly good relationship with its contact person, the warranty department may be receiving numerous service calls that include a particular vendor's part. Due to communication paths within Midwest Motorcycles, the warranty department's concerns may not reach either purchasing or engineering until a lengthy amount of time has elapsed or a significant incident has occurred that requires a service bulletin or a costly recall to be issued. Thus, problematic parts may reach the consumer causing downtime and dissatisfaction before the vendor is notified of problem materials. Figure 1 details the root causes of problems related to vendor quality and selection issues that were uncovered.

Figure 1: Cause-and-Effect Diagram for Vendor Selection Issues
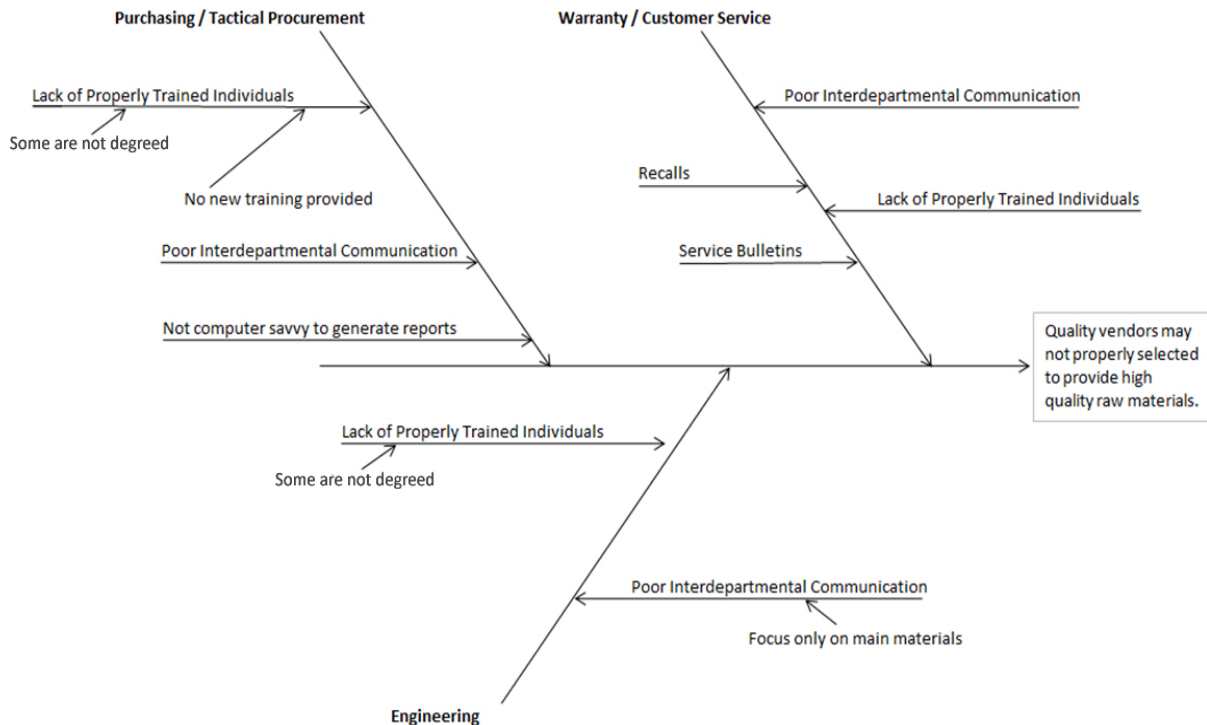
TOWARD A SOLUTION

Based on root-cause analysis, further interviews and observation, it was determined that development of a Vendor Rating System would help improve overall quality. The improvement would begin with the purchasing process, which would in turn flow through the value chain to production and ultimately the consumer. By purchasing quality products from quality vendors, Midwest Motorcycles will experience a reduction of warranty related issues and costs and provide a better experience for the ultimate rider. Since the internal users for the Vendor Rating System are well understood, it can be developed in manner where the average user will find it beneficial in their jobs regardless of background education or computer skill level. In addition, through proper training, Midwest Motorcycles should be able to begin reaping the benefits very quickly thus achieving a quick return on investment for development costs.

SYSTEM DEVELOPMENT

The development portion of the project began with the process of gathering ideas from different departmental staff members including those in procurement, purchasing, and engineering. Using these inputs a baseline vendor rating system was established. The envisioned system was constructed in several parts. First, quarterly qualitative inputs were received from select individuals in tactical procurement, strategic purchasing, engineering, and quality. These inputs were obtained in the form of graded opinion- and fact-based surveys related to each vendor and their relationship with Midwest Motorcycles. Purchasing and delivery information was obtained automatically from the existing organizational accounting system using T-SQL queries that populated tables in a new Microsoft SQL database developed as a data warehouse for the project. Procedures were run against data overnight to process raw data and weight it according to predetermined calculated scales based upon a normal distribution of important criteria. This created data silos from which information was drawn the following day. This information was displayed in Crystal Reports XI release 2, a web-based reporting package.

Once the data existed in Crystal Reports, users were able to select a vendor name from a drop down list which in turn filtered the data from the silos. After just a few seconds, a main grading page with links to several additional reports appeared for use. The more detailed reports consisted of quality and purchasing information as well as qualitative grading. In the end, the purchasing agent, engineer, or any other person with the need to review the information was able to tell within a matter of seconds if the vendor with which they are working has a solid quality rating or exhibits signs of being a quality risk. While purchasing can still procure materials without using the vendor rating system, the information it contains, if used prior to faxing a purchase order or making a phone call to a vendor, can save the company money through more knowledgeable purchasing.

VENDOR MEASUREMENT SCALE

Devising a vendor measurement scale was one of the project's more challenging aspects. The scale needed to make sense and be understandable but also scientific and objective. In addition, the measuring system needed to compare the vendors with each other, with a moving rubric based on overall performance of the group. Research into past methodologies used led to adoption of a five color grading scale based on Raytheon's scale (Raytheon, Inc., 2006). Although the color scheme came from Raytheon, calculations applied to fit vendors into each category was developed independantly and specifically for Midwest Motorcycle's needs (see Figure 2).

Figure 2: Vendor Measurement Scale

The five-color bar flows through the reporting system and while not all things are calculated in the same manner, they do all relate back to this bar where "Exceptional" would receive a score of a 5 and an "Unsatisfactory" would receive a 1. Most sections of the Vendor Rating System show a summary grading box for that particular area, and underneath each grade, report the effective score or range to achieve that grade. On line item grading in the details section, the grading is based on one to four standard deviations from "Exceptional".

Quality and delivery are based on calculated data, while the qualitative data is obviously opinion-based. The overall grade is determined through numerous calculations, including weighting when applicable, and is summerized on the main reporting page.   Fifty percent is based on the overall quality of the products received, thirty percent on delivery, and the remaining twenty percent tied to the qualitative portion of the system. Since those percentages also act as weights, the final overall score is calculated to give the best possible and most realistic score.

THE VENDOR RATING SYSTEM

Prior to developing the vendor rating system, when a vendor was needed, Midwest Motorcycle's purchasing department would research the internet for candidates. After narrowing the search, candidates would be contacted and a phone interview conducted. Once the field had been narrowed to just a few contenders, an on-site visit of the vendors' facilities would be arranged. After the trip, a group would assemble, weigh the pros and cons based on the information gathered, and then make a decision as to the primary vendor and any alternates for a particular product after initial quality samples were received and evaluated. After being certified as a vendor, as long as those supplies are perceived as a quality product and not "too many" failures occur, the vendor is retained. The problem with this process was the lack of a formal method to gauge how a given vendor is performing. To make assessing the requirements easier, a Process Model for Requirements (Parsley & Corrigan, 1999; Crosby, 1989) was created (see Figure 3).

Figure 3: Crosby's Process Model for Requirements

1	Vendor Rating System
2	**Initial Activity:** Determine vendor required for raw materials.
	Final Activity: Make an educated purchase based on available scoring and reports in the Vendor Rating System.
3	Completed reports and scoring information.
4	VP of Engineering and Purchasing, Tactical Purchasing Department, Strategic Procurement Department, Quality, and Engineering.
5	A scientific summary as to how well a vendor is performing.
6	**Materials:** Vendor Rating System Grading Summary or other reports.
	Information: Vendor name selection from the drop down list in Crystal Reports.
7	**Materials:** IT Department.
	Information: VP of Engineering and Purchasing, Tactical Purchasing Department, Strategic Procurement Department, Quality, and Engineering having a need to access the system.
8	**Materials:** Current version of a web browser. *(IT department will require Microsoft Visual Studio, Microsoft SQL Server, and Crystal Reports XI r2, for system development.)*
	Information: An easy to use and understand scientific rating system that performs quickly and provides detailed insight into the historical quality and delivery information as well as qualitative information for any vendor.

Further development of the new system was conducted by flowcharting the existing system. It was determined that the new system should maintain the existing procurement steps; however, to eliminate identified problems, it adds two new processes. First, a qualitative meeting process was added. Once per quarter, or more often if desired, designated representatives (*and customers*) from Engineering, Quality, Tactical Procurement, and Strategic Purchasing, along with the Vice President of Purchasing & Engineering meet and assess the top 40 vendors based on the critical nature of their materials. Input is collected through a form tied directly to the SQL server to capture the opinions of the individuals. The information is then processed, weighed, and blended with other data to create several predetermined reports. The second new process is the actual Vendor Rating Reporting system. Figure 4 shows the flowchart developed.

Figure 4: Flow Chart of New Vendor Rating System
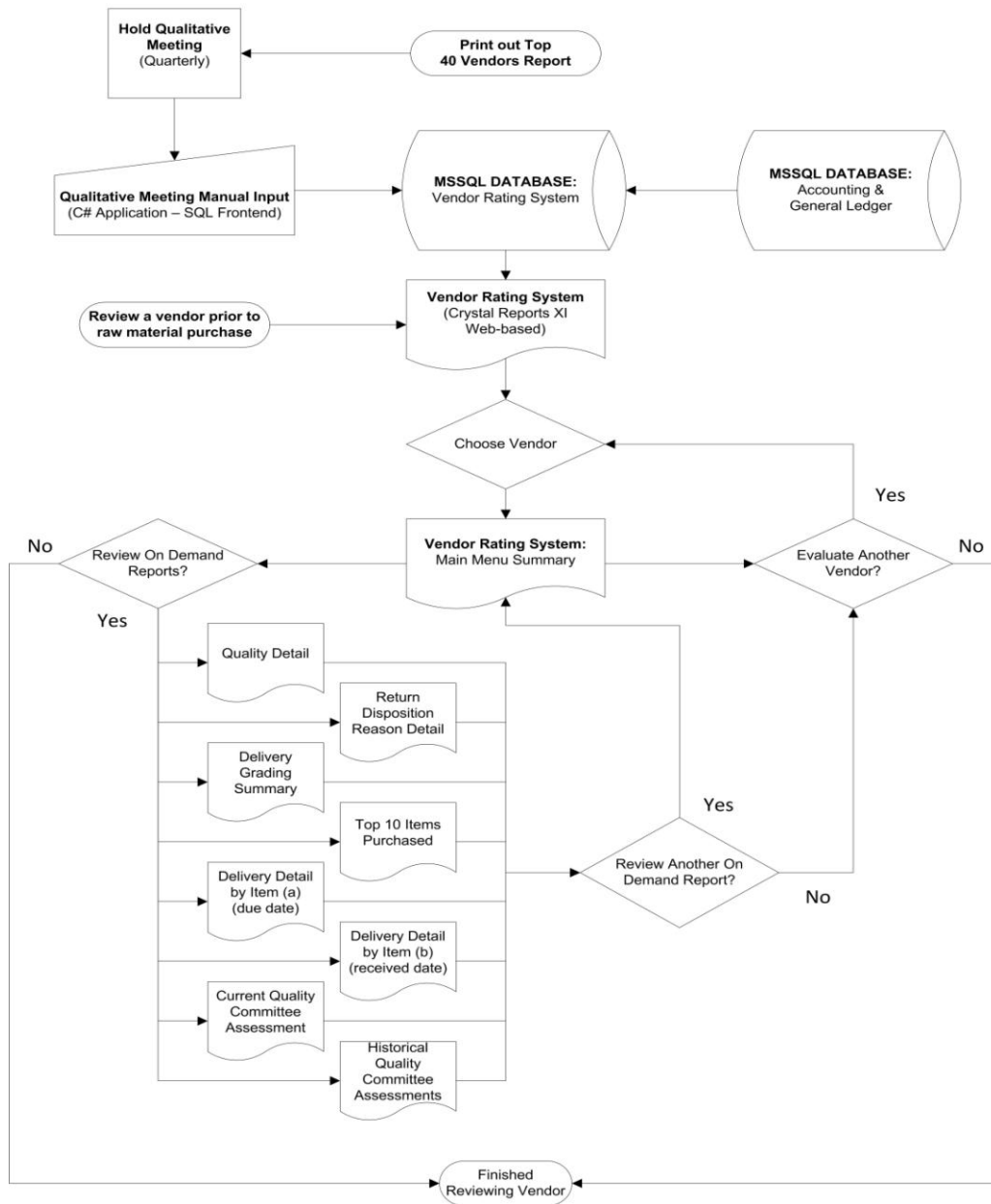
SAMPLE INTERFACES AND REPORTS

This section provides additional detail regarding several key interfaces and reports available in the Vendor Rating System. The examples shown include the *Qualitative Meeting Input Interface, Vendor Rating System Interface, Main Menu Summary Screen, Quality Detail Report, Return Disposition Reason Detail Report, and Delivery Grading Summary Report*. For these examples, the vendor's identity has been removed. Although a variety of other reports and interfaces exist, these key items provide an operational view of the system.

Qualitative Meeting Input Interface: The qualitative interface, written in Microsoft C#.net, allows a simple yet effective way to collect qualitative information about a vendor. Each department has its own set of topics that need to be graded for each of the top 40 vendors for the past period. The multi-department section allows for topics where two to four departments are involved. When conflicting grades are collected for these topics, an average is calculated then rounded to the nearest whole number. Figure 5 illustrates.

Figure 5: Qualitative Meeting Input Interface
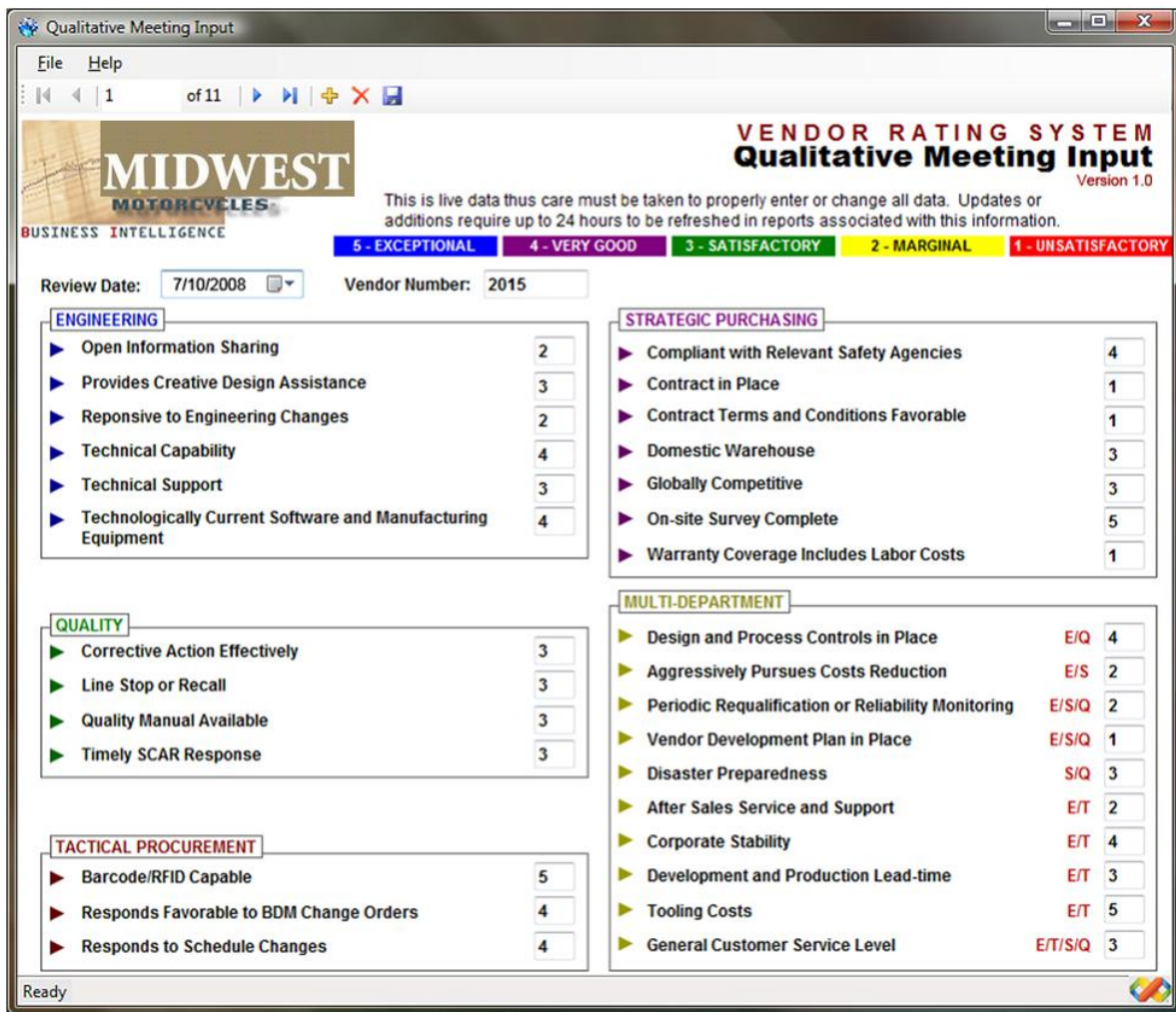
Vendor Rating System Interface: The interface is very straightforward. Upon opening the vendor rating system, a user selects a vendor from an alphabetically sorted dropdown list and then selects 'OK'. Approximately ten seconds

after the selection is made, Crystal Reports lets the user know that his/her report is finished and presents the Main Menu Summary Screen.

Main Menu Summary Screen: The opening screen acts as both the overall summary report for the vendor as well as a detailed report menu. Upon quickly glancing at the screen (see Figure 6), the purchasing agent can tell if this is a reliable vendor. If more detail is desired, the user can click on one of the links under the on-demand reports. The contact information is clearly displayed in the upper left-hand corner of the page followed by the grading grid in the upper right-hand corner. The products supplied are in the middle. This uncluttered interface will help those who are not as computer savvy navigate quickly to the information that they need.

Figure 6: Main Menu Summary Screen

Quality Detail Report: The quality detail report shows a measurement of how often the vendor's materials are rejected in quality assurance. The information is based on a 24 month rolling time period so as to give an accurate appraisal of data in the recent past. As shown in Figure 7, the user can see the Midwest Motorcycle's (BDM) part number tied to the corresponding vendor part number, a description, the received amount, rejected amount, a calculated acceptance ratio for that particular part number and then an acceptance grade. In the grid in the upper right-hand corner is a grade along with the overall acceptance ratio of all of the parts that are received from this vendor.

Return Disposition Reason Detail Report: The Return Disposition Reason Detail provides an itemized detail as to why an item is being returned. It shows if it is a current production part (CPP), non-production part (NPP), or a support part for serviceable items. Along with a description, cost, status of the return, and if it was scrapped or returned, it also shows whether or not it was the fault of the supplier or another reason. Depending on the extended part costs and the source of the fault, the severity is weighted and calculated into the quality score on the summary page. See Figure 8.
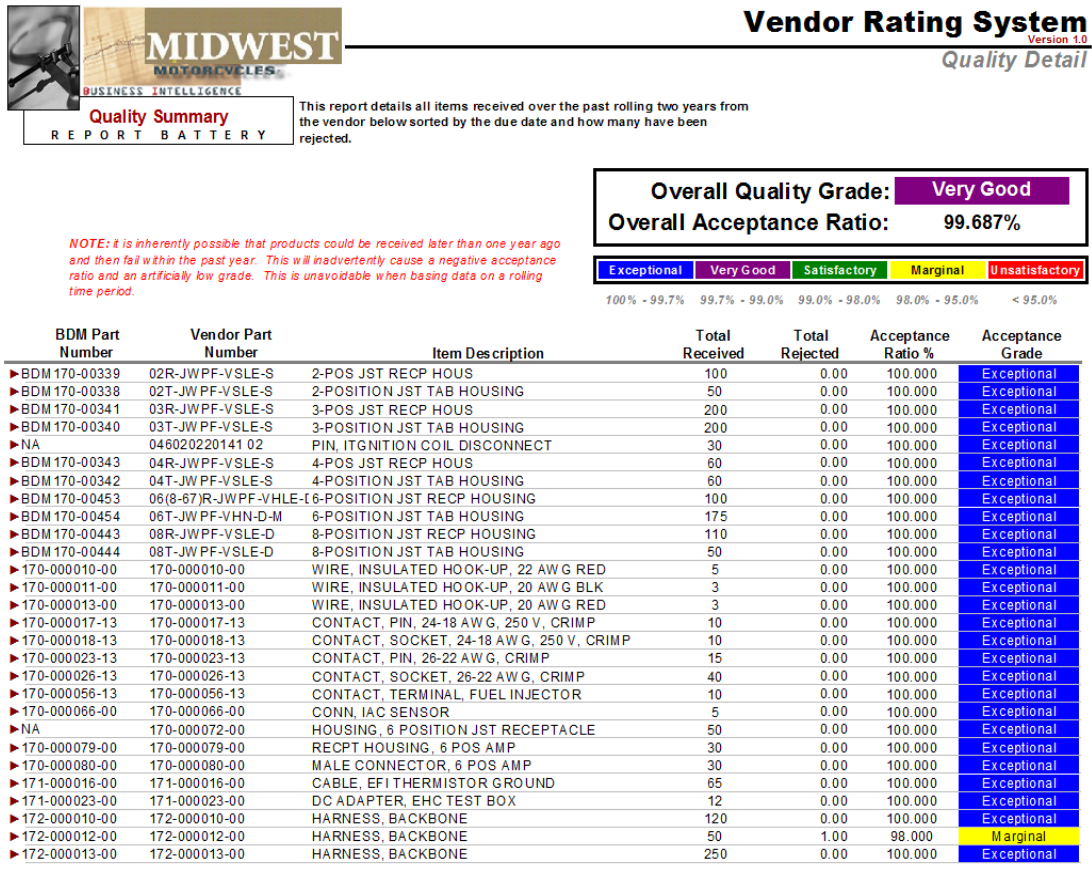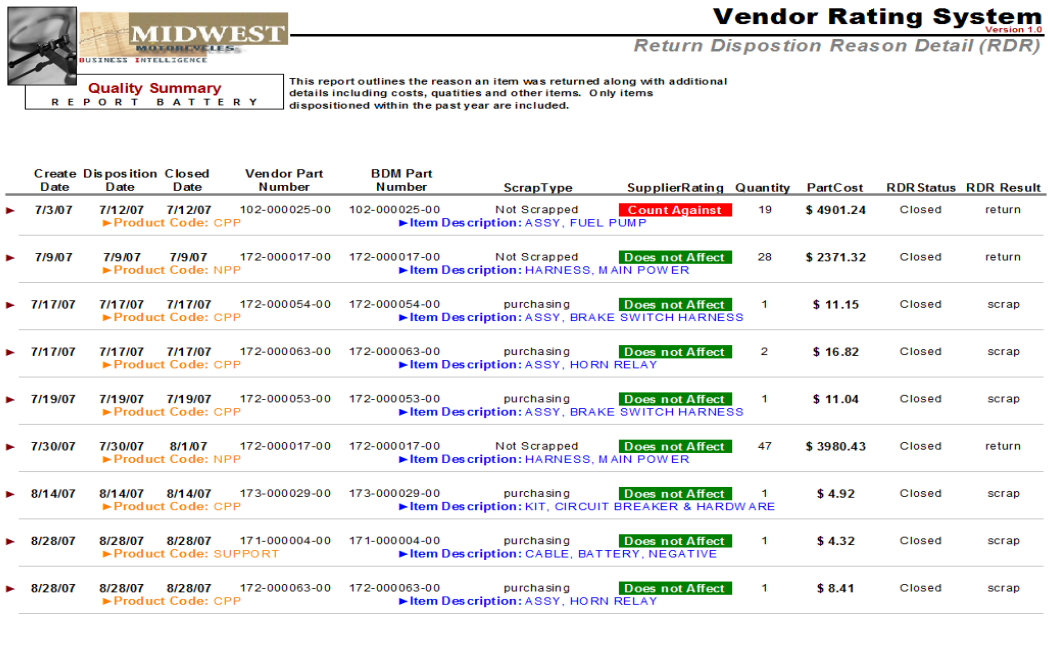
Figure 7: Quality Detail Report

Vendor Rating System
Version 1.0
Quality Detail

This report details all items received over the past rolling two years from the vendor below sorted by the due date and how many have been rejected.

Overall Quality Grade:	**Very Good**
Overall Acceptance Ratio:	99.687%

NOTE: *it is inherently possible that products could be received later than one year ago and then fail within the past year. This will inadvertently cause a negative acceptance ratio and an artificially low grade. This is unavoidable when basing data on a rolling time period.*

Exceptional	Very Good	Satisfactory	Marginal	Unsatisfactory
100% - 99.7%	99.7% - 99.0%	99.0% - 98.0%	98.0% - 95.0%	< 95.0%

BDM Part Number	Vendor Part Number	Item Description	Total Received	Total Rejected	Acceptance Ratio %	Acceptance Grade
►BDM170-00339	02R-JWPF-VSLE-S	2-POS JST RECP HOUS	100	0.00	100.000	Exceptional
►BDM170-00338	02T-JWPF-VSLE-S	2-POSITION JST TAB HOUSING	50	0.00	100.000	Exceptional
►BDM170-00341	03R-JWPF-VSLE-S	3-POS JST RECP HOUS	200	0.00	100.000	Exceptional
►BDM170-00340	03T-JWPF-VSLE-S	3-POSITION JST TAB HOUSING	200	0.00	100.000	Exceptional
►NA	04602022014102	PIN, ITGNITION COIL DISCONNECT	30	0.00	100.000	Exceptional
►BDM170-00343	04R-JWPF-VSLE-S	4-POS JST RECP HOUS	60	0.00	100.000	Exceptional
►BDM170-00342	04T-JWPF-VSLE-S	4-POSITION JST TAB HOUSING	60	0.00	100.000	Exceptional
►BDM170-00453	06(8-67)R-JWPF-VHLE-[	6-POSITION JST RECP HOUSING	100	0.00	100.000	Exceptional
►BDM170-00454	06T-JWPF-VHN-D-M	6-POSITION JST TAB HOUSING	175	0.00	100.000	Exceptional
►BDM170-00443	08R-JWPF-VSLE-D	8-POSITION JST RECP HOUSING	110	0.00	100.000	Exceptional
►BDM170-00444	08T-JWPF-VSLE-D	8-POSITION JST TAB HOUSING	50	0.00	100.000	Exceptional
►170-000010-00	170-000010-00	WIRE, INSULATED HOOK-UP, 22 AWG RED	5	0.00	100.000	Exceptional
►170-000011-00	170-000011-00	WIRE, INSULATED HOOK-UP, 20 AWG BLK	3	0.00	100.000	Exceptional
►170-000013-00	170-000013-00	WIRE, INSULATED HOOK-UP, 20 AWG RED	3	0.00	100.000	Exceptional
►170-000017-13	170-000017-13	CONTACT, PIN, 24-18 AWG, 250 V, CRIMP	10	0.00	100.000	Exceptional
►170-000018-13	170-000018-13	CONTACT, SOCKET, 24-18 AWG, 250 V, CRIMP	10	0.00	100.000	Exceptional
►170-000023-13	170-000023-13	CONTACT, PIN, 26-22 AWG, CRIMP	15	0.00	100.000	Exceptional
►170-000026-13	170-000026-13	CONTACT, SOCKET, 26-22 AWG, CRIMP	40	0.00	100.000	Exceptional
►170-000056-13	170-000056-13	CONTACT, TERMINAL, FUEL INJECTOR	10	0.00	100.000	Exceptional
►170-000066-00	170-000066-00	CONN, IAC SENSOR	5	0.00	100.000	Exceptional
►NA	170-000072-00	HOUSING, 6 POSITION JST RECEPTACLE	50	0.00	100.000	Exceptional
►170-000079-00	170-000079-00	RECPT HOUSING, 6 POS AMP	30	0.00	100.000	Exceptional
►170-000080-00	170-000080-00	MALE CONNECTOR, 6 POS AMP	30	0.00	100.000	Exceptional
►171-000016-00	171-000016-00	CABLE, EFI THERMISTOR GROUND	65	0.00	100.000	Exceptional
►171-000023-00	171-000023-00	DC ADAPTER, EHC TEST BOX	12	0.00	100.000	Exceptional
►172-000010-00	172-000010-00	HARNESS, BACKBONE	120	0.00	100.000	Exceptional
►172-000012-00	172-000012-00	HARNESS, BACKBONE	50	1.00	98.000	Marginal
►172-000013-00	172-000013-00	HARNESS, BACKBONE	250	0.00	100.000	Exceptional

Figure 8: Return Disposition Reason Detail Report

Vendor Rating System
Version 1.0
Return Disposition Reason Detail (RDR)

This report outlines the reason an item was returned along with additional details including costs, quatities and other items. Only items dispositioned within the past year are included.

Create Date	Disposition Date	Closed Date	Vendor Part Number	BDM Part Number	ScrapType	SupplierRating	Quantity	PartCost	RDRStatus	RDR Result
► 7/3/07	7/12/07 ►Product Code: CPP	7/12/07	102-000025-00	102-000025-00 ►Item Description: ASSY, FUEL PUMP	Not Scrapped	Count Against	19	$ 4901.24	Closed	return
► 7/9/07	7/9/07 ►Product Code: NPP	7/9/07	172-000017-00	172-000017-00 ►Item Description: HARNESS, MAIN POWER	Not Scrapped	Does not Affect	28	$ 2371.32	Closed	return
► 7/17/07	7/17/07 ►Product Code: CPP	7/17/07	172-000054-00	172-000054-00 ►Item Description: ASSY, BRAKE SWITCH HARNESS	purchasing	Does not Affect	1	$ 11.15	Closed	scrap
► 7/17/07	7/17/07 ►Product Code: CPP	7/17/07	172-000063-00	172-000063-00 ►Item Description: ASSY, HORN RELAY	purchasing	Does not Affect	2	$ 16.82	Closed	scrap
► 7/19/07	7/19/07 ►Product Code: CPP	7/19/07	172-000053-00	172-000053-00 ►Item Description: ASSY, BRAKE SWITCH HARNESS	purchasing	Does not Affect	1	$ 11.04	Closed	scrap
► 7/30/07	7/30/07 ►Product Code: NPP	8/1/07	172-000017-00	172-000017-00 ►Item Description: HARNESS, MAIN POWER	Not Scrapped	Does not Affect	47	$ 3980.43	Closed	return
► 8/14/07	8/14/07 ►Product Code: CPP	8/14/07	173-000029-00	173-000029-00 ►Item Description: KIT, CIRCUIT BREAKER & HARDWARE	purchasing	Does not Affect	1	$ 4.92	Closed	scrap
► 8/28/07	8/28/07 ►Product Code: SUPPORT	8/28/07	171-000004-00	171-000004-00 ►Item Description: CABLE, BATTERY, NEGATIVE	purchasing	Does not Affect	1	$ 4.32	Closed	scrap
► 8/28/07	8/28/07 ►Product Code: CPP	8/28/07	172-000063-00	172-000063-00 ►Item Description: ASSY, HORN RELAY	purchasing	Does not Affect	1	$ 8.41	Closed	scrap

Delivery Grading Summary Report: The Delivery Grading Summary report is visually simple. The historical monthly delivery performance summary graph shows the number of shipments received. The grading is based on a line item average of how many parts were early, on-time, or late. Detailed views of this data are provided in additional reports. The grading summary box at a quick glance reveals delivery history for a vendor. It is broken down by the past 45 days, 90 days, six months, and a year. Figure 9 provides an example.

Figure 9: Delivery Grading Summary Report
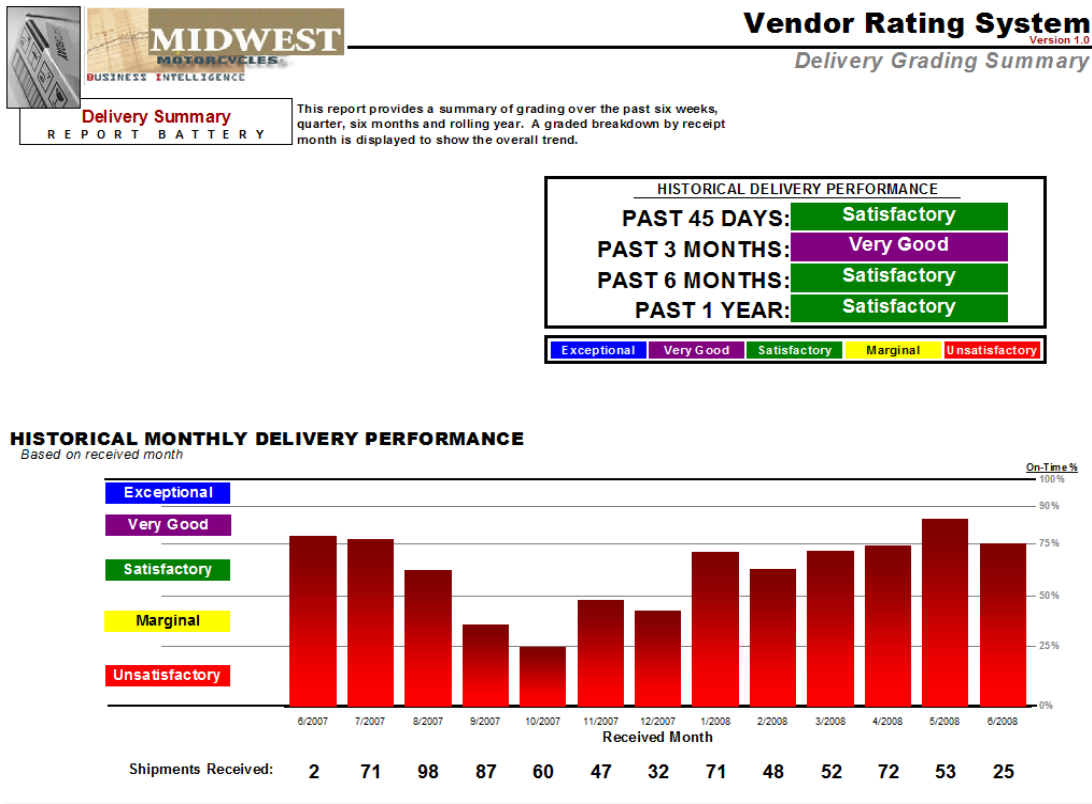
CONCLUSIONS

The Vendor Rating System, version 1, is the starting point of a long term project. Since nothing similar previously existed for Midwest Motorcycles, there was nothing with which to compare the system. Thus, through use over the next few months, insight as to whether additional reports should be written, existing reports altered, and some even eliminated will be gathered. To accomplish this, face to face feedback from different departments using the system and the qualitative committee will be gathered. While the main reporting system probably will survive long term in its current state, it is important to look at re-engineering the Qualitative Input Interface to make it more user friendly and discover better methods in order to grade vendors more quickly.

Currently, three dry runs for test data took approximately 5 to 7 minutes each. Thus, at best, the group could only get through 12 reviews an hour, requiring approximately three-and-a-half hours to go through 40 vendors each quarter. It may be determined that too many aspects are being graded and a more generalized approach would provide just as useful information regarding each vendor. Speed, too, is expected to improve as the group becomes acclimated to the program.

Initial reviews of the capabilities of the new software from procurement and purchasing as well as engineers and quality personnel, indicate they are very pleased, yet a bit overwhelmed. A future possibility is to make this information available to Midwest Motorcycle's vendors through a secured website. As part of sharing information to improve the system, Midwest Motorcycle's vendors should know how they are perceived regarding their quality and delivery performance. Allowing them to review their own information could help them become better partners.

AUTHOR INFORMATION

James Baker graduated from Kansas State University in 2009 with a bachelor's degree in Business Administration. Most recently, he was employed by Big Dog Motorcycles, LLC. in Wichita, Kansas, as the Operations Analyst. His focus was on gathering report and application requirements; developing solutions and applications in MSSQL, Crystal Reports, VB.net, and Excel; as well as implementing the end product and training users.

Roger McHaney is a University Distinguished Teaching Scholar and professor of management information systems in K-State's College of Business Administration. A K-State faculty member since 1995, McHaney teaches courses in enterprise systems, quality management and business computing. His areas of research include discrete event simulation, education technology, service simulations, and organizational computing. McHaney has a doctorate in computer information systems and quantitative analysis from the University of Arkansas. He has lectured in a variety of countries including New Zealand, Australia, China, the UK, and Italy. McHaney has published in numerous journals, written textbooks, and developed various instructional material.

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