The Journey Toward Reliability

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Abstract

Kansas State University faculty members have partnered with industry to assist in the implementation of a reliability centered manufacturing (RCM) program. This paper highlights faculty members' experiences, benefits to industry of implementing a reliability centered manufacturing program, and faculty members' roles in the RCM program implementation. The paper includes lessons learned by faculty members, short-term extensions of the faculty-industry partnership, and a long-term vision for a RCM institute at the university level.

University Faculty-Industry Partnership

Faculty of the College of Technology and Aviation at Kansas State University –Salina (KSU) have partnered with local industry to explore the benefits of reliability-centered manufacturing and to assist a local manufacturing company in implementing a reliability centered manufacturing (RCM) program. The faculty members are responsible for creating the RCM training curriculum, directing the RCM training workshops, and assisting the manufacturer when obstacles to implementing and operating the RCM program occur.

Implementing a successful RCM Program creates multiple benefits for the company, including increased focus on the plant as a system, increased throughput, decreased down time, and decreased spare parts inventory. When properly implemented, the program allows maintenance employees to work *smarter*, not *harder*. It enables identification of *all* options and the selection of the *best* option, instead of quick, unorganized, and ineffective fixes to maintenance problems. In short, RCM improves the quality of work experiences for maintenance employees.

Implementing a RCM program, though, does not happen overnight; rather it is a process. Certainly the implementing company faces obstacles, but the successful company is one that finds solutions to the obstacles. A successful RCM program requires buy-in from all employees at all levels, from the line employee to the highest managerial level, from the maintenance employee to the production employee. It requires a real culture shift within the company, for RCM must be embraced by all and supported by management. In short, it is no easy task to implement an RCM program, but the benefits are rewarding.

With all this as a basis, faculty at Kansas State University set out to create a strong RCM training curriculum that focuses on all the requisite technical issues while addressing implementation issues. In order to create enriching, worthwhile workshops, KSU faculty were required to attend seminars on Reliability Centered Manufacturing and the RCM technologies, to network with other industry professionals who have RCM expertise, and to delve into self-study and research.

The Curriculum

Following is the KSU-created reliability-centered manufacturing curriculum with emphasis on the traditional predictive maintenance technologies: thermal imaging, oil analysis, vibration analysis, and ultra-sonic analysis. Introductory, intermediate and advanced level workshops were created and presented.

Introduction to RCM

- 4-hour course.
- Presented to entire maintenance staff, production managers and supervisors, and upper management.
- Topics addressed:
  - Introduction to the RCM process.
  - The need to move from a reactive to a preventive/ predictive maintenance program.
  - Cost justification of the RCM program.
  - Discussion of why previous "quality" programs failed and why RCM will succeed.
  - Introduction to some of the predictive maintenance technologies.

RCM Tools

- 8-hour course.
- Presented to entire maintenance staff.
- Topics addressed:
  - Predictive maintenance technologies – overview, applications, implementation, and documentation.
    - Thermal imaging
    - Introduction to oil analysis
    - Introduction to vibration analysis
    - Ultra-sonic analysis

Advanced Oil Analysis

- 24-hour course.
- Presented to select group of maintenance staff.
- Topics addressed:
  - Types, function, and application of lubricants.
  - Sampling techniques.
    - Equipment
    - Location
    - Frequency
  - Field tests.
  - Prevention of common contaminants.
  - Interpretation of analysis report.
  - Documentation procedure.

Advanced Vibration Analysis

- 24-hour course.
- Presented to select group of maintenance staff.
- Topics addressed:
  - What is vibration?
  - Sampling techniques.
    - Equipment
    - Location
    - Frequency
  - Interpretation of analysis report.
  - Documentation procedures.

One additional course, "Root Cause Analysis", was recommended by KSU to the manufacturing company. This course would provide a methodical process for maintenance staff to address new and existing problems. The manufacturer has not been enthusiastic about this course, thus it has been set aside for the current time.

Workshop Feedback

Course evaluations were conducted. Questions were posed utilizing a 1 (strongly agree) to 5 (strongly disagree) scale. Evaluations from the "Introduction to RCM" class included the following items.

Evaluation item:	Evaluation Score
The content was relevant to me for my job.	3.77
The content was relevant to me for my career path.	3.85

The course evaluations also solicited comments from workshop attendees. Selected comments from the "Introduction to RCM class" evaluations follow.

"How is this new system to be implemented?"
"What is success under this system?"
"This program will work with team work only."
"Don't think it will work."
"Will work only if all upper management goes for it too."
"Works well on paper…will it work in practice?"
"Concept of program is great but management won't let it happen."

Measuring Program Success

At the writing of this paper, training is still ongoing. Once training is completed and the RCM program and related technologies are fully implemented, key parameters will be tracked to measure program progress and success. Two key parameters that will be tracked are (1) change

in product throughput and (2) maintenance expenditures as a percentage of facility replacement cost.

Lessons Learned

Faculty members have recognized several weaknesses in the curriculum during the presentation of the material to the manufacturer. The first weakness was that not enough attention was given to changing the culture of the company. Certain comments from the introductory workshop evaluations, as noted above, anecdotally confirm this. The faculty had recognized the need to change the culture but had not considered that *telling* them the culture had to change would be inadequate. The challenge now is how to teach the company personnel to change their culture. The second weakness in the curriculum was implementation and documentation. The faculty underestimated the ability of the company staff to "run" with the information and tools provided. The courses yet to be presented will be modified to address this weakness, and an additional capstone course is being discussed to bring together these tools and techniques and to document the results in a format whereby they can be retrieved and used for improving reliability.

Obstacles to RCM Implementation

Because the RCM program affected the very nature of the maintenance employees' job duties and because KSU faculty members knew it was critical to the success of the RCM initiative to have employee buy in, the entire staff of the manufacturing company's maintenance department attended the general (introductory) training workshops. Additionally, key production and supervisory employees attended the general workshops to provide visible evidence of their support of this new initiative.

To emphasize the importance of the team in implementing this wide-sweeping change, introductory workshop attendees were asked to share with the faculty any barriers they saw to the implementation of the RCM initiative and ways they felt these barriers might be overcome. This was an effective way to discover and ultimately minimize obstacles prior to costly implementation, because line employees would be at the most appropriate level for such analysis. Workshop discussion was summarized and forwarded to the appropriate supervisory level. This activity provided valuable insight and allowed plant administration to minimize potential stumbling blocks prior to implementation, thereby saving time and money.

Managing RCM Initiative Outcomes

At the writing of this paper, much of the training is complete, but specialized training still remains to be delivered. To assist the manufacturing company in the next level of RCM implementation, Kansas State University faculty members will serve as interns at the manufacturing company during the fall 2005 semester. Goals of the internship will be to assist company employees in implementing the reliability-centered manufacturing technologies (thermal imaging, oil analysis, vibration analysis, and ultra-sonic analysis) and to assist employees in creating a reporting system that documents *finds* and *trends* and also serves as a mechanism through which to capture cost savings.

Additional internship activities will include providing application-oriented training on the use of RCM technologies to small groups of employees. This training will occur in the manufacturing facility, an ideal site from which to enhance employee learning. The small-group training sessions will allow hands-on activities tailored to each specific group. With the manufacturing facility as the training site, instruction will be job-specific for the employees.

The remainder of faculty time will be utilized in creating an efficient reporting system. Faculty will learn the current tracking system and will survey employees about their documentation and reporting needs. Based on findings and training in RCM technologies, the faculty will assist company employees in creating a system that will allow them to easily document findings from the use of RCM technologies. The comprehensive reporting system will organize the findings chronologically so trends can easily be discerned and acted upon. The overarching purpose of the system will be to capture the cost savings created by the use of RCM technologies. The reporting system will be flexible enough to encompass finds from multiple sources. This cost savings will substantiate the value of the RCM technologies, justify the use of these technologies at the manufacturing company, and support the quest for new applications of these technologies.

Extensions of the Industry Partnership

The benefits resulting from the university / local industry partnership will not cease with the conclusion of the initial training / consulting engagement. There are potential ways to expand and build on the faculty experience. One possibility is to provide the same RCM training and consulting to other industry clients. Local industry would be a small outlet for these faculty services. A bigger extension of faculty activities would be to convert the RCM curriculum created for the initial industrial partner into a portable format. Once the curriculum is put into a portable format, faculty members would no longer be geographically bound and could reach out to new industry clients located across the mid-west geographic region. By extending the training beyond the initial client, faculty members could continue to utilize their RCM training and self-study and could build on their learning experiences while reaching a much larger industrial audience.

Though a majority of the RCM curriculum would be appropriate for a distance education format, some parts of the curriculum would be effective only when offered in a face-to-face lab format. For these portions of the training engagement, faculty members would still be required to be at the manufacturing site. Additionally, faculty members would need to travel to the client's site *pre-training* to assess client needs and *post-training* to assist the client in the RCM implementation. Because the faculty members involved in the RCM training and implementation have other teaching, research, and service duties at the university, the travel factor would limit the number of clients whom the faculty members could serve.

Long-range Vision

After documented successes locally and regionally, a long-term concept of the original university / local industry partnership would be to create a nationally recognized "Reliability Institute" located on the Kansas State University – Salina campus. The "stand-alone" entity would focus on serving clients in the midwest geographic region. As a separate entity from the college, its

staff would be solely dedicated to carrying out the institute's mission, which would be: *"Improve the profitability of regional companies by improving the reliability of the manufacturing operation"*.

The proposed Institute would provide a wide range of services to the region under the reliability umbrella, including *training*, *consulting*, and *research*.

Training – Complete turnkey training packages could be provided to industry. This turnkey approach would allow companies to focus on production, not on learning how to train employees. The training at the Institute would be unique in approach and content. The approach would be a hands-on style of learning; and the content would not only include the mechanics of implementation but would also address how to change the culture of the organization and how to capture the dollar savings. Training could be done on the KSU-Salina campus or at the client's facility. In addition to corporate training, the Institute could partner with KSU to provide valuable internships for students, providing these students with "real-world" experience. During internships, assignments could be completed through Company / Institute on-site work experience. This endeavor would enhance and produce new entries into the work-force that are "technology ready".

Consulting – The Institute would have the ability to provide consulting to companies in implementing the techniques taught in the training sessions. Consulting would also address specific problems that may be beyond the scope of the material covered in the standard training, such as design for reliability. Additionally, the Institute could be contracted to provide support in ongoing activities such as analysis of oil samples and periodic thermal imaging sweeps.

Research – The faculty and staff at the Institute would be involved in research projects that would significantly impact reliability in the future. These research resources could be made available to address industrial problems that regional companies experience.

Summary

Implementing a successful Reliability-Centered Manufacturing Program requires a clear, precise execution strategy. Short- and long-term goals must be defined and constantly monitored. Obstacles and challenges must be faced directly. Most importantly, though, *all employees should be included in the process*, and *even small victories must be celebrated*. These small victories mark progress on the journey toward reliability.

Biographical Information

GREG SPAULDING, P.E., Associate Professor
Mr. Spaulding brings a wealth of business and entrepreneurial expertise to the Kansas State University-Salina team. He holds two degrees from Kansas State University, having earned a Bachelor of Science Degree in Mechanical Engineering (1980) and a Master of Science Degree in Mechanical Engineering (1984). He received the 1997 *Faculty of the Year Award* from KSU-Salina. He serves as faculty advisor for the KSU-Salina Cat Cannon Club.

KATHY VRATIL BROCKWAY, CPA (inactive), Assistant Professor
Ms. Brockway is a graduate of Kansas State University, having earned her Bachelor of Science Degree in Business Administration (1990) and her Master of Accountancy Degree (1991). She has received awards including the Commerce Bank Outstanding Teaching Award; the Baird, Kurtz, and Dobson Outstanding Teacher Award; the Commerce Bank Outstanding Advisor Award; and the Marchbanks Memorial Award for Teaching Excellence.