Performance benchmarking update: expectations and reality

Here’s how first-quartile companies optimize maintenance and improve reliability

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A presentation in June 1998, based on a maintenance practices benchmark study, contained much information of interest to the then HP readers. While certain numerical results are available only to study participants, our updated and expanded graphs are to scale. They obviously reveal trends that are of value to most of our readers.

**Expectations.** Benchmark studies continue to focus on a clearly definable business. As experienced personnel, the individuals performing the studies had certain expectations:

- Little variation in performance. After all, we live in the space age and everyone has access to modern technology.
- Similar results for the affiliates of world-renowned companies.
- Differences in performance due to such physical issues as size, age, location and unionization.

**Reality.** But what they found surprised even those seasoned individuals:

- Wide variations in performance in spite of access to modern technology. Profitability, expressed as return on investment (ROI) of pacesetter (best-of-class) companies was typically in the vicinity of 16% and vastly exceeded that of the low performers, some of which reached only 4%.
- No affiliation synergism. Top-quartile and bottom-quartile plants sometimes had the same owners.
- Weak correlation to physical factors; big plants at the top, big plants at the bottom, small plants at the top, small plants at the bottom, old plants at the top, old plants at the bottom, and the same with plants in this hemisphere or on that continent, unionized or nonunionized.

**How companies differ.** Both management practices and employee culture at leading companies differed from those that didn’t score well. Companies with high unreliability often also reported high maintenance costs. As illustrated in Fig. 1, for 2004, there is virtually no change in these observations. In other words, the same facts applied a decade ago. First-quartile (high) performers spend less money and yet enjoy fewer outages. (Note: In 1992 among the top companies, total annual refinery maintenance costs per unit of refinery capacity related to capacity and complexity amounted to $17/EDC (equivalent daily capacity). On the opposite side of the spectrum, low performers spent more than twice as much, $36/EDC in 1992.

As indicated in Fig. 2, rising reliability (reduced outage) trends were experienced in the 2000 to 2004 time frame. But with steady cost outlays, mechanical availability declined (outages increased) from 2004 to 2006 for all groups. Improved mechanical reliability is thus not related to the amount of maintenance effort.

In the refining industry, the pacesetters (best-of-class) companies enjoy an interesting and immensely valuable maintenance...
effectiveness index (MEI—maintenance cost plus outage loss) advantages (Figs. 3 and 4). Independent observations by one of the authors largely parallel those of Solomon Associates. We have seen that pacesetters share a number of values. These companies are reliability-focused, not repair-focused. In the mid-1990s, the highest (maintenance cost) quartile’s craftsmen inevitably worked for a repair-focused organization, whereas the lowest cost quartile craftsmen worked for a reliability-focused organization.

Workload and planning. Statistics show that the lowest (maintenance cost) quartile’s craftsmen had four times more pieces of rotating equipment per person than the highest cost quartile. Those in the highest cost quartile are kept busy repairing failures and have no opportunity to examine the causes of these failures. Thus, they cannot participate in formulating and implementing action plans to make permanent repairs or to devise preventive or predictive remedies.

It was further shown that the consistently high performers base management decisions on real data. They adhere to the plan and deal with all deviations. They always focus on economics, optimize revenue and expense, and take responsible risks. We know they record events and thoroughly investigate all causes.

These profitable plants follow through by revising their planning to avoid repeat events. Moreover, solid performers seek sustainable excellence and most decidedly engage their employees.

An analysis of the reliability and maintenance (RAM) benchmark study participants supports this feature. It has demonstrated the truth of the axiom, “To manage, it is necessary to measure.” Fig. 5 shows the demonstration.

Where organizational relationships mesh. In pacesetter companies, there is unconditional acceptance of the fact that facilities, maintenance and organization are an interdependent continuum. This implies that a commendable level of communication, cooperation and consideration among virtually all job functions in the plant exists. A good example would be a petrochemical company with not only a management committee, but also a steering committee that gives guidance and actively elicits feedback. This latter activity is structured to give visibility to the efforts of every competent worker.

Facilities with first-quartile capability are almost certain to engage in life cycle costing. They will view every maintenance event as an opportunity to upgrade and will base the decision on the findings of a rigorous root-cause failure analysis. Combined with life cycle costing of the various remedial options, these best-of-class companies have positioned themselves to capture financial credits from the chosen course of action.

Best-of-class, implying first-quartile companies, thus perform reliability-centered maintenance (RCM) in a thoughtful, results-oriented manner, quite unlike their fourth-quartile peers for whom RCM is often a laborious, costly and largely procedural effort. Many of the low performers have at one time tackled RCM simply because it had been viewed as the cure-all, or “magic bullet.” Seeing their efforts frustrated, they have since abandoned RCM and have gone back to their old and ineffective ways of doing things.
Who does what, and how. First and foremost, the engineering departments of better plants apply maintainability and reliability and life cycle cost optimization standards to all investment projects (Figs. 6 and 7).

Extensive use of predictive tools and monitoring instruments is found in companies ranging from top to bottom. However, where best-of-class performers use the operator to determine if a deviation exists and to then report this deviation to the highly qualified condition-monitoring technician for detailed analysis and follow-up, the low performers waste the trained professional's time by compelling him or her to collect reams of data on equipment exhibiting no deviation. In essence, the high performers execute maintenance as a mutual effort involving operations and maintenance as equal partners. Just as in modern aircraft, this maintenance approach will inevitably include both preventive (time-based) and predictive (condition-based) methods. Subscribing to either one to the exclusion of the other has shown to be flawed.

In any event, all maintenance decisions taken by high performers are based on real data and not on tradition or hear say. Craftsmen constitute the primary point of control and there is individual accountability. Self-directed work teams are not only empowered, but enabled. Enabling through proper and truly relevant training is viewed as a prerequisite to empowering. It follows that, at first-quartile facilities, supervisors and technical personnel are less involved in low-rung decision-making than elsewhere. Instead, they are used as a value-adding resource by craftsmen and operators. Their time and talent are optimized by allowing them to focus on longer-range plans. At these pacesetter companies, there are fewer management levels. The primary function of these managers is to enforce standards and, as stated earlier, to actively sponsor all cost-justified reliability improvement targets. The steering committee is asking technician-workers to discuss methods and accomplishments, thus giving visibility to the grassroots efforts.

Fourteen common attributes examined. Best-of-class companies share a large number of sound work practices, reliability engineering implementation concepts and organizational alignments. Some of these have been highlighted earlier, whereas others are implicit and follow a logical pattern of progression. While simply going into greater detail could easily expand their numbers, we are limiting our listing and examination to 14 of the attributes shared by best-of-class companies:

1. They have on their bidders’ lists only top-notch vendors and manufacturers. They recognize that reliability comes at a price, and that competent suppliers are entitled to a reasonable profit.
2. They specify and procure equipment and components based on life cycle cost studies, having built reliability and low maintenance into the equipment specification.
3. They engage in pre-award (pre-procurement) reviews, design audits and selective, systematic, pre-delivery engineering quality control. First-quartile companies know that this effort, while requiring an up-front investment, will always result in substantial payback.
4. They pay attention to detail, work toward perfection and understand that “business as usual” and “hurry up, we want it running again this afternoon” attitudes are intolerable impediments to achieving reliability improvement in any plant.
5. They are obsessed with doing every job right the first time. To that end, they develop, acquire, use and consistently invoke written checklists and procedures across all job functions.
6. They treat every maintenance event as an opportunity to upgrade, with a view toward run-length extension. The decision on how to proceed is again based on life cycle cost considerations.
7. They use major elements of predictive maintenance to determine when and how to perform preventive maintenance. They are aware that optimized, bottom-line, cost-justified maintenance is a composite of both.
8. They will not tolerate employing highly trained machinery condition analysts (vibration monitoring technicians) to periodically acquire data from 1,000 equipment bearings, only to find out that 970 of these bearings show no signs of distress. Instead, they train their operators to perform equipment surveillance. Operators report deviations from normal equipment behavior to the condition analyst for follow-up and definition of remedial action, component upgrading, etc.
9. Cross-functional teams perform true root-cause failure analysis and monitor their overall progress by maintaining accurate failure statistics. Top performers have a reasonably good idea as to what improvements are feasible and, in fact, achieved elsewhere. Their repeat failure events show significant downward trends.
10. They recognize the virtual impossibility of acquiring exper-
tise in all fields of major equipment component design, application engineering and component optimization. This realization prompts best-of-class companies to teach and actively pursue resourcefulness by maximizing all aspects of vendor/manufacturer experience. Vendor and manufacturer statistics are extensively consulted and design reviews performed whenever applicable and cost-justified. Electronic or conventional reference libraries are maintained and consulted by reliability professionals.

11. They have implemented an extremely close working relationship between the production (operations), maintenance and technical (reliability/project engineering) functions. The “services” concept with its wait-until-called-upon connotation has been abandoned in favor of a support and partnership concept that demands self-activation, contribution and participation at all levels and across all functions. More than mere lip service is paid to this critically important issue!

12. They take results-oriented training seriously. Reliability professionals are given guidance and direction through employee-devised and company-endorsed training plans, progress reviews and easy access to mentors.

13. They ensure that operating superintendents and contact engineers are thoroughly familiar with all operational and maintenance aspects of their assigned process units. Their presence and vigilance would make it difficult for operators to disable surveillance instruments or subvert operating procedures. These supervisory personnel could run the unit, if required.

14. They regularly participate in benchmarking analysis studies to update their priority RAM performance improvement opportunities. They also periodically review their plant profile and RAM practices to understand and evaluate differences with their better peers.

As mentioned, many subsets exist beneath these principal attributes shared by best-of-class companies. However, a process plant striving to excel in a highly competitive world economy would do well to give priority to our 14-point listing. And, while it is reasonable to proceed one step at a time, all of these items will ultimately have to be implemented if a company wants to measure up to the challenge. HP

LITERATURE CITED

1 Solomon, L. H., “Pacesetter Performance and the Role of Reliability.”