Maintaining High-Technology Facilities

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Biography:

Larry Crossley is IDC's Director of Facilities Services Group for Asia Pacific. He is based in IDC's Shanghai office, and is experienced in other areas of China in which IDC has been active. He has more than 30 years of experience in industrial and commercial facility start-up, operations, maintenance and construction, including experience at many high-technology facilities. Mr. Crossley has served in various roles as a maintenance engineer, maintenance and operations supervisor, regional manager of maintenance services, contracts manager and director of facilities. He has worked with and managed various facility operations for such companies as IBM, Glaxo Wellcome, Takeda Chemical, Ajinomoto USA, McDonnell Douglas, Nissan, Novartis Agribusiness, Ciba Geigy, Philip Morris, TRW, Cisco Systems and the Ministry of Saudi Arabia.

Abstract:

Quality industrial facility maintenance is becoming an increasingly critical factor in improving the reliability and profitability of manufacturing facilities in China. Many Asian manufacturers have not traditionally implemented methodical industrial facility maintenance programs. The relatively low cost of labor to perform repairs has helped further reduce the importance of proactive maintenance approaches. Yet long-term maintenance costs can represent thirty times the original procurement cost of industrial manufacturing equipment and systems. Effective maintenance programs can significantly reduce repeated maintenance costs and improve a facility's long-term profitability.

While intensified industrial activity in China has increased awareness about the value of effective maintenance protocols, Western suppliers cannot assume that their approaches to facility maintenance will automatically work well in Asia. This presentation reviews approaches that can deliver high levels of maintenance program quality and reliability within Chinese manufacturing environments. It describes some of the specific ways that formalized industrial facility maintenance programs can bring short- and long-term benefits to Asian facility owners. The concepts presented are applicable to industrial manufacturing processes, as well as non-process elements of facilities such as the industrial utilities that support a manufacturing plant. The presentation reviews how maintenance protocols can offer additional value when begun early in the planning of industrial facilities. It also provides an approach for implementing Reliability Centered Maintenance (RCM) programs, which strategically assign levels of maintenance activity to individual systems based on the criticality of each system. Key objectives of this presentation are to help manufacturers reduce such negative consequences of deferred industrial maintenance as down time, product loss, recalls, impaired reputation with customers, and legal liability.

Data:

Methodical maintenance programs for industrial facilities are becoming more critical as costs increase for capital improvement and facility equipment, and increasing competition erodes margins. Figure 1 reflects the progression of industries that have actively integrated facilities maintenance services in recent years, as the quality of facility maintenance programs has evolved and improved.

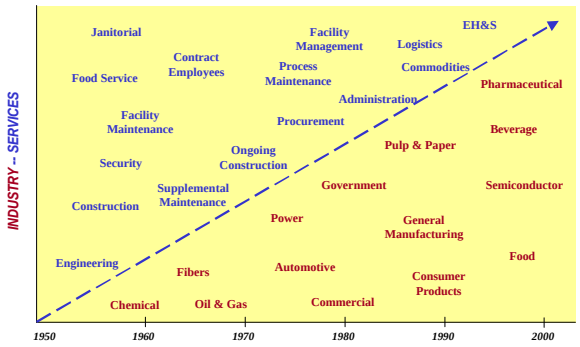

Figure 1. *The Steady Migration of Maintenance Services Into New Industries*

Industrial facility owners today are intent on finding ways to lower costs any way they can. An obvious way to economize is to reduce the initial costs of capital improvement projects, whether those projects involve new greenfield facilities or retrofits of existing plants. However, owners benefit from such savings only during the relatively brief period during which such projects are being performed.

The cost reduction strategy that continues to deliver owners savings year after year, indeed for the entire life cycle of an industrial facility, is the strategy that involves well-managed facilities maintenance programs. Studies indicate that the lifetime operations and maintenance costs for industrial facilities can represent up to thirty times the original capital costs for such facilities.

Maintenance considerations specific to Asia – There is a perception in some parts of the world that low industrial facility operation costs do not justify "world-class" facility maintenance programs. The belief is that because labor costs can be lower in Asia relative to other world markets, the payback potential of high-quality maintenance programs is poor.

This perception is often inaccurate, but it is particularly questionable for the growing number of high-technology industries in Asia. These are manufacturers which must be capable of maintaining consistent quality for often highly complex products, such as microelectronics components, in an increasingly competitive global market. There have been periods in the past when Asian manufacturers were accused, often unfairly, of producing products of questionable quality. Asia has been successful in overcoming this stereotype by producing quality products in such markets as automotive, electronics, appliances and myriad other commodities. However, the quality standards that Asian manufacturers have achieved in recent years can be largely attributed to a more rigorous application of strong facility maintenance programs.

Asian manufacturing is now at a critical point in its evolution where high product quality is an expectation, not an "extra." Quality is a more critical requirement than ever before. No matter where in the world they operate, successful manufacturers are expected to offer products of consistent quality, or run the risk of being usurped by producers which have gained mastery of product quality through stringent facility maintenance.

It has been demonstrated in case after case that the investment in maintenance programs generates an excellent return on investment. It is only through strong corporate commitment to a well-designed and properly executed facility maintenance program that owners can achieve the "world class" level of quality that is a prerequisite for profitability, and corporate integrity, throughout the global marketplace.

Early involvement of maintenance expertise – Under ideal conditions, the establishment of a good maintenance program begins during the design and engineering stages of an industrial facility project. Figure 2 reviews a sampling of the services and areas of expertise provided by comprehensive facility maintenance programs.

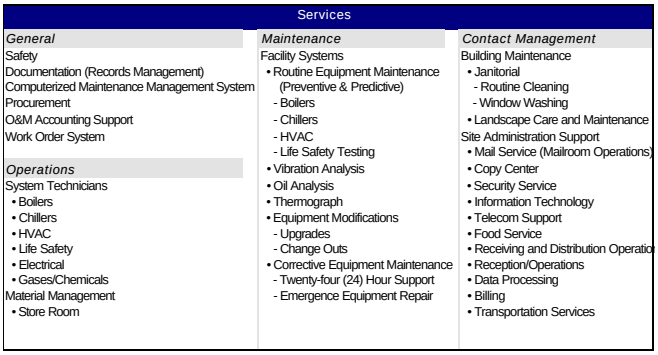

Figure 2. *Sampling of Services Provided by Quality Facility Maintenance Programs*

Input from maintenance professionals is valuable to help project teams make equipment selections based on consistency of performance, low maintainability costs, and longevity. Over the life of a facility, these desirable equipment characteristics can often pay dividends much greater than even the best discounts on first acquisition costs negotiated by procurement staff.

Maintenance specialists can also contribute strategic advice for the design of factory floors, and the strategic placement of equipment to help reduce long-term maintenance costs. Input from these specialists can improve the ability of facility designs to accommodate future expansions, and can facilitate accessibility to process equipment for ongoing maintenance efficiency. Industrial engineering expertise can provide additional insights to such design improvements.

Specialized maintenance software – Specialized software programs can be used to assist in the development of accurate long-term cost of ownership (COO) projections. These programs model the COO for various operations approaches. This allows owners to determine the best approaches for their facility using the accurate computer model, rather than having to resort to expensive and risky "trial and error" approaches on the factory floor.

Today there are advanced COO software products that can calculate materials consumption, maintenance scenarios, yield analyses for specific pieces of equipment, and overall facility throughput under real-world operating conditions. Figure 3 shows an example of an interactive facilities management software program, accessible through computer monitors placed either in management offices or on the factory floor, which serves as an effective cost and scheduling management tool that can be made readily available to owner managers as well as facilities services staff.

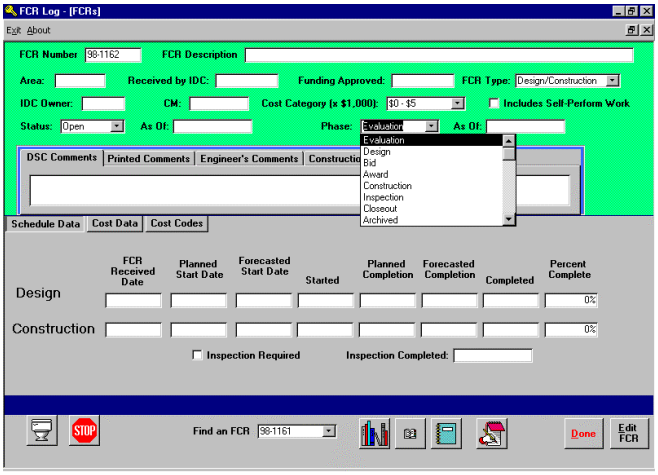

Figure 3. *User-Friendly Software Programs Provide Efficient Management of Facilities Services Activities*

Such software programs are flexible, and can improve the quality of decision-making related to major capital projects, modest upgrades, equipment purchases, raw material costs, optimizing tool set installation plans, eliminating production bottlenecks, reducing cycle time, and prioritizing engineering resources for long-term maintenance. Some of the leading tools of this kind have been developed jointly with SEMATECH, the consortium of major U.S. semiconductor manufacturers, so that their capabilities would be relevant to a wide sampling of cost issues encountered in industrial facilities of all kinds.

Facility document control – In the initial stages of a facility's construction, organization of accumulating facility documents needs to be performed in a structured way to assure that maintenance staff will have complete and accurate documentation on the facility and its equipment. This documentation is the backbone of any effective maintenance program. It consists of facility drawings, specifications, meeting notes,

vendor operations and maintenance manuals, operations parameters, as-builts, vendor documentation, inventory documentation, and other documents that are pertinent to the operation of the facility and its future capital improvements.

Planning for facility startup – Additional critical activities related to maintenance that should occur prior to facility startup include:

- Development of a system for spare parts selection, acquisition and organization. Such a system can audit inventories, and better coordinate the use of local vendors for spare part and materials resupply activities.

- Determination of required staffing skills, and an execution approach for a training program to assure that project staff maintain the appropriate skills. This process will also add value and efficiency to the company's hiring activities if the data is properly shared with human resources personnel.

- Selection and implementation of software for a computerized maintenance management program. This effort should begin at least six months before facility startup. It will also be instrumental in setting analytical strategy for the control of facility data and staff training.

- Development of a Reliability Centered Maintenance (RCM) strategy (see discussion in following section).

- Establishment of a Preventive and Predictive program (see discussion in following section).

- Selection of vendors and contractors to support the maintenance program cost-effectively. This process may include strategies for the outsourcing of certain services to improve cost-effectiveness, such as crib operations and specialty contractor support.

- Planning for long-term modifications, overhauls and rebuild needs. This includes planning for prevention of production interruption, avoidance of obsolescence, and the budgeting necessary to meet anticipated facility improvement requirements.

- Development of maintenance quality, safety and environmental protocols specific to an individual industrial operation. These can include prescribed standards for Guaranteed Manufacturing Practices (GMP), ISO qualifications, environmental and permitting requirements, safety planning, and project management procedures.

There is broad consensus within industry that in order for all of these activities to be accomplished efficiently, the assistance of specialized consultants is often necessary. Such specialized assistance is especially valuable at the strategically critical point of maintenance program design.

Industrial operations are successful because they focus on applying manufacturing expertise specific to their individual products. It is not logical to expect these same operations to have in-house expertise on the wide range of issues that constitute a successful maintenance program. This is especially true in operations which have not previously regarded a methodical maintenance program as a priority. Maintenance program specialists can introduce many insights that are the result of real-world case histories, including data derived from similar manufacturing environments. The value of such expertise is typically worth many times the consulting fee required by maintenance program specialists.

Reliability Centered Maintenance (RCM) – The single most important success factor in a high-technology manufacturing facility is reliability, both in process up time and product quality. The most effective means of assuring reliability is a properly planned and executed Reliability Centered Maintenance (RCM) program. The RCM approach entails the methodical study of the most critical areas of the manufacturing process in order to identify the specific pieces of production equipment, and the specific components that support that equipment, which are most significant to a potential "failure scenario" within the plant. This is a process that requires

collaborative involvement by staff focused in both production and quality roles, since each of these roles involves often different dynamics. Those dynamics converge to complement each other in the level of quality achieved in the end product.

No two facilities have the same maintenance program approach, no matter how similar their end products may be. Every facility has its own unique characteristics. The advantage of the RCM process is that it develops a customized maintenance strategy that is highly specific to the circumstances prevailing in your plant. The strategy revolves around "points of potential failure" which are prioritized according to their individual level of criticality to the overall performance of your plant. By prioritizing the relative risk level of individual systems and pieces of equipment within your plant, RCM allows maintenance costs to be allocated as wisely as possible. Maintenance resources are deployed conservatively, only where and when they are needed the most, to create a maximum return on the maintenance investment.

Continuous review and adjustment is needed to maintain the RCM program's operating integrity. Operating parameters change constantly in a dynamically evolving plant, especially one involved in a high-technology enterprise. The RCM approach places heavy emphasis on applying preventative measures in critical areas, proportionate to the level of importance assigned to each area related to failure prevention.

Research shows that this strategy, of correcting problems before they deteriorate to a point where they can result in a production interruption or quality defect, is more cost-effective than addressing maintenance issues when they have progressed to the point of breakdown. In a breakdown scenario, delays are compounded as owners scramble to locate and mobilize repair staff appropriate for a specific system or piece of equipment. In the meantime, the plant is suffering the economic damage of interrupted production, plus the added risk of jeopardized relationships with customers if committed product shipment dates are missed.

It is important to note that the RCM approach does not ignore the facility systems or equipment defined as "non-critical." All elements of a manufacturing facility's maintenance needs are accounted for in an RCM program, but the primary emphasis is applied to the facility's most vulnerable areas.

Preventive and Predictive programs – The functioning part of the RCM is the preventive and predictive programs. A carefully planned and well-executed preventive maintenance/predictive maintenance program will uncover equipment problems before failures occur, resulting in planned shutdown corrective action. Figure 4 reviews some of the key steps involved in the implementation of a reliability improvement process in a facility management program.

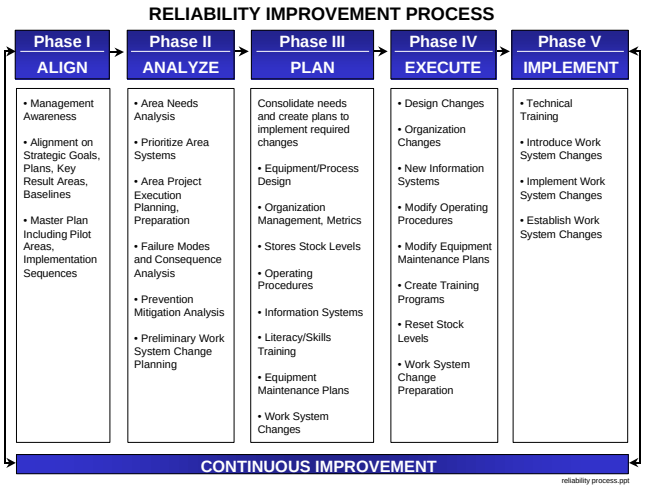

Figure 4. *Sequence of Events in a Reliability Improvement Process*

Another benefit of these programs can be the reduced repair costs that result when problems are detected in early failure stages. Timely repairs of failing components before they actually malfunction protects other process components from the "domino effect" that can result when one critical component breaks down. An example is the chain reaction that occurs when the bearing shaft on a motor fails, which can then trigger subsequent bearing problems, shaft damage, and other collateral damage to adjacent components.

A good preventive maintenance/predictive maintenance program must focus on failure points that can be detected through analytical

measurement, device observation, and a variety of analytical approaches.

Documentation for trend analysis is poorly performed in many of the preventive maintenance/predictive maintenance programs that we have studied. If a dynamic trend data study program is not used consistently, your preventive maintenance/predictive maintenance program will have limited success.

Proper training is a critical element to the success of any preventive maintenance/predictive maintenance program. Continuous review of training needs as they relate to preventive maintenance/predictive maintenance needs is a must to assure overall program success.

The philosophies and deliverables of a successful maintenance program – The following are some principles shared by successful "world-class" industrial maintenance programs.

- Work is executed according to a workable plan, rather than "fire fighting" problems as they arise. 85 percent of work orders should be planned. Problems shouldn't drive maintenance; planning should.
- Maintenance is a science and accepted as such, rather than being regarded as a "necessary evil."
- The individual talents of a maintenance team are sought, identified and optimized.
- Fully defined roles are assigned to all maintenance personnel, rather than assigning all accountability to a maintenance manager.
- There is a continuous upgrade of maintenance staff skills through specific and ongoing training efforts.
- Maintenance staff are strategically deployed to meet a target of full utilization for optimal cost-effectiveness.
- Maintenance activities are strategically prioritized based on the criticality of the maintenance needs involved (the RCM approach).
- The maintenance program is supported by quality audits of repairs and root cause analyses of failures.
- Dedicated RCM procedures are adhered to diligently.
- Operations staff work collaboratively with maintenance staff to support preventive maintenance and participate in cost decisions.
- Management fosters a team commitment to continuous improvement in maintenance performance quality.
- A complete history of individual equipment costs is maintained, as well as benchmarking of repair costs for long-term cost-efficiency tracking.
- Careful planning is performed to maintain a minimal stock of parts for routine repairs to reduce inventory costs.
- An on-line materials requisitioning capability is built into the maintenance systems.
- A system is developed to forecast mean time between equipment failures to improve strategic maintenance planning.
- Maintenance staff are supported with a corporate attitude regarding them as long-term, full-service business partners in the enterprise.
- Incentive-based contracts are arranged, with maintenance team compensation tied to measurable performance parameters.
- Plant performance is the focus, realistically balancing the costs of maintenance with the benefits of maintenance.

Figure 5 reviews some of the advantages that owners can realize from well-executed facility management programs.

Service	Feature	Advantages	Benefits
Documentation	Develop, maintain system drawings, P&ID's	Up-to-date drawings help trouble shoot system; allow system isolation;	Minimize down time, increase production
	Standard specifications	Standardize site equipment	Reduce required stores, improves maintenance efficiency and familiarity with equipment
	Catalog O&M manuals		
CMMS	Tool for collection of equipment and maintenance information	Makes equipment data collection faster and easier. Always easy analysis of data	Provides usable data to make equipment management systems
	PM's	Issues PM's in a timely way, tracks preventative maintenance	Extends life of equipment and reduces down time
	WO system	Issues and tracks maintenance work orders	Clearly identify's maintenance costs
Procurement	Purchasing of replacement parts and equipment	Centralized and ability to volume purchase items	Reduced cost for parts and equipment
Trained Technicians	Operators that are familiar with the systems they are operating	Know the system and can identify problems before they happen	Reduces down time, increases production
Maintenance PM Pools - Oil Analysis - Thermograph - Infrared Troubleshoot	Proactive maintenance tools used to identify potential problems	Identify equipment problems and allows for scheduled maintenance during shut downs	Reduces down time, increases production

Figure 5. *Advantages to Owners From Well-Executed Facility Maintenance Programs*

Factors to consider when outsourcing facility maintenance – Many industrial owners have determined that it is more cost-effective for them to outsource facility maintenance services than it is to maintain maintenance programs using internal staff. At a minimum, companies which attempt to implement their maintenance programs solely with internal staff often find themselves struggling to solve maintenance-related issues for which they lack appropriate expertise. These struggles are invariably a distraction from the core corporate mission of a manufacturing facility.

Below are some specific factors to take into account when considering using outside resources to assist with maintenance programs.

- Outsourcing of non-mission critical operations allows owner managers to concentrate on "core business" needs.

- The owner's challenges relative to workforce management and utilization are reduced and the responsibility is shifted to the outsourced firm.

- Support staff that are no longer the responsibility of the owner reduce the owner's overall operating costs associated with recruitment, supervision, training, benefits, insurance, equipment obsolescence, payroll, and purchasing.

- The varied experience base of the outsource firm, which has gained knowledge providing similar support to other companies, helps introduce new ideas derived from "lessons learned" at other facilities.

- Services that appear to be "free" when handled internally become a budgetary charge item when outsourced, forcing the owner's employees to clearly understand the costs of their requests (i.e., be more cost conscious), thereby requesting additional services only when absolutely necessary.

- In many facilities, the operations and maintenance staff are viewed as overhead. Consequently, career opportunities in maintenance areas may be limited, and the resources needed to develop and enhance these skills are often not approved. In an outsource firm, these staff positions are viewed as revenue and profit generators, making the advancement and growth of maintenance employee skills important.

Conclusion:

There are several misperceptions about maintenance programs for industrial facilities that need to be dispelled. These are:

- That low labor costs can justify the deferral of maintenance. This premise is the result of a false belief that it is less expensive to remedy failures in low labor cost environments than it is to maintain a prudent and consistent maintenance program.

- That maintenance programs are something to develop in response to facility problems, rather than making them part of the early planning process for a new facility or facility improvement project.

- That in-house performance of industrial maintenance responsibilities is typically more cost-effective than outsourcing of these tasks, when often the reverse is true.

Thorough, well-planned, and consistently executed industrial facility maintenance programs will be successful when the following ingredients are present:

- Long-term commitment from management.
- Adequate funding to maintain the program.
- Properly skilled staff, whether internal or outsourced.
- Good program design, using the experience of experts with proven competence in cost-effective industrial facility management.
- Dedicated staff who are motivated and incentivized to perform high-quality work.