



A Review of Existing Tools and their Applicability to Facility Maintenance Management

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A Review of Existing Tools and their Applicability to Facility Maintenance Management

Joseph Neelamkavil

Table of Contents

Summary	3
Failure Patterns and Preventions	3
Asset Maintenance	5
Predictive vs. Condition-based Maintenance.....	7
Condition-based Maintenance – A Strategy for Facility Maintenance	9
Facility Maintenance Management Software Tools	11
References:	40

Summary

Over the past fifty years, the concept of maintenance and the tools/support systems aiding maintenance have changed. The changes are due to a huge increase in the number and variety of assets (plant, equipment and buildings), which must be maintained. More complex designs, new maintenance techniques and changing views on maintenance organization have also contributed to these changes. Maintenance has also responded to changing expectations. It now includes a growing awareness of the extent to which equipment failure affects safety and the environment, a growing awareness of the connection between maintenance and quality, and is subjected to increasing pressure to have a positive effect on the smooth operation of the facility and to also contain costs.

The primary objective of this report is to provide a synopsis of the various computer-based maintenance management software (CMMS) tools that are available in the market today. It will help to facilitate greater understanding of the state of facility maintenance as a discipline, and will also help to conduct a gap analysis with respect to facility requirements vs. tool's capabilities. Various forms of maintenance management software (MMS) tools have been available for several years; these tools vary slightly from one developer to another, but the basic purpose and design are similar from one package to another. That is, the fundamental equipment information is stored; Information such as size, date of purchase, ratings, cost, maintenance cycle, and equipment-specific notes are all maintained. The MMS tool packages can print out work orders when calendar-based preventive maintenance schedules are in effect, and some packages can also store the maintenance results. Some of the modern packages also embed newer concepts of maintenance. But, prior to providing overview of these tool packages, it makes sense to provide brief descriptions on equipment/asset failure patterns, as well as the need for asset maintenance and maintenance management.

Failure Patterns and Preventions

Detailed investigation [refer 1] has revealed that all failures fit into one of six conditional probability (or likelihood of occurrence) failure curves, as shown in Figure 1, below. Such failure patterns were summarized based on aircraft maintenance history, as well as US Navy investigations. It was concluded that the majority of failures were not age-related

where the equipment failed because of length of time in use. This also means that time-based preventative maintenance is somewhat irrelevant in many of these cases. 'Age-related use' includes stress fatigue failures (e.g. shafts breaking), corrosion failures (e.g. metal corrosion), wear-out failures (e.g. car tire tread wear) and other such failures where the length of operating time contributes to the eventual failure.

It appears that only about 15% to 20% of maintenance occurs based on age-related factors. One can verify these based on company work orders for the same repair again and again over a period of time. Or one can also confirm this by asking long-serving maintenance planners and operators about what commonly fails on each piece of equipment. The time-based repetitive failures can be addressed by doing preventative maintenance and/or planned replacement maintenance. But non-time related failures cannot be addressed by the renewal-based maintenance strategies, as they require different solutions.

As just mentioned, the time in-service factor has no influence on 77% to 89% of the failures; in addition non-time related failures are somewhat unpredictable. This also means that, for the vast majority of equipment, maintenance needs to be based on non-age related factors, which further infers that repair requisitions can happen randomly. But it is possible to use the changed condition of the equipment to tell when a failure is likely to happen. For example, as a piece of equipment's operating life progresses, degradation is bound to occur. And it is immaterial what the reasons are for this degradation; the fact is that the item can no longer meets its original function requirements and/or its level of performance falls. By detecting the loss-in-condition of the item one will have advanced warning that degradation has begun. If this change in performance level is detected in advance, it provides a means to forecast a forthcoming failure.

One can identify a change in equipment condition in many ways. Commonly used procedures include detecting changes in vibration, changes in power usage, changes in operating performance, changes in temperatures, changes in noise levels, changes in chemical composition, and so on. The most important aspect is to detect the signs early enough so that one has time to plan and prepare an organized correction at the least cost. Bear in mind that once the equipment breaks down, one has to spend whatever time, money and resources it takes to get it back in operation.

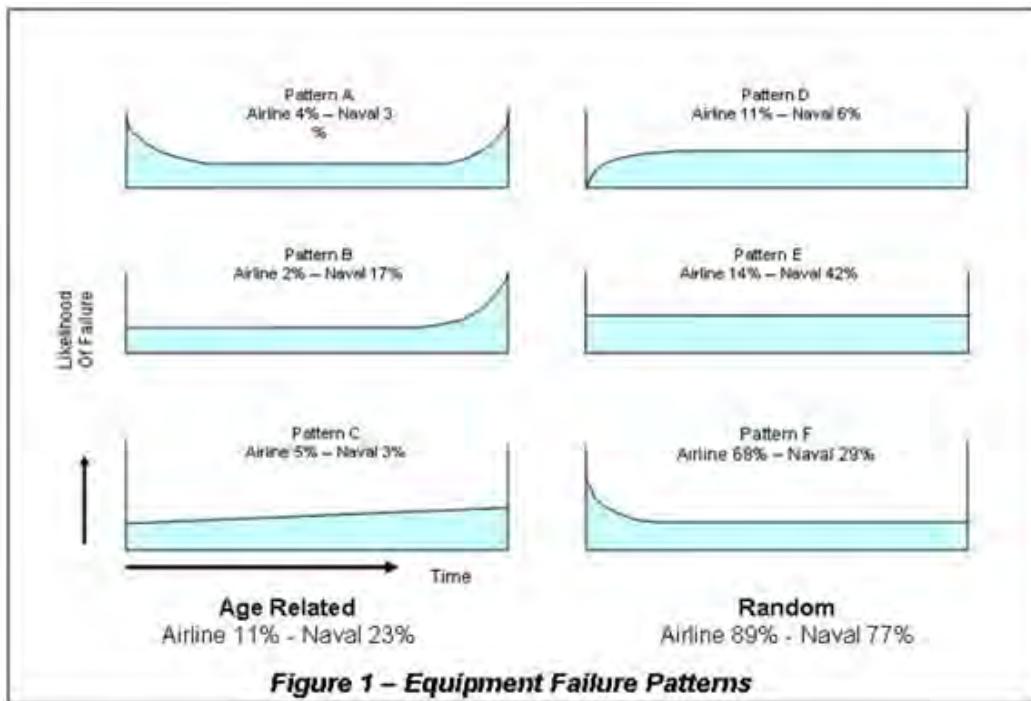


Figure 1 – Equipment Failure Patterns

Source: Mike Sondalini (reference 1)

Asset Maintenance

Organizations have now recognized the social and economic implications and impact of facility and asset management. Here, it is very much contextual to provide the evolution of maintenance which can easily be traced through at least three generations [2].

The First Generation spans over the period up to World War II. Prior to this time period, industry was not highly mechanized or automated, and downtime was of little consequence. This also meant that the prevention of equipment failure was not a high priority item. Most equipment was simple to operate and much of it was over-designed, which made it reliable and easy to repair. There was no need for systematic maintenance of any sort beyond simple cleaning and lubrication. The requirement of maintenance skills was not a major concern, either. Such failure-driven maintenance (FDM) was called corrective maintenance or run-to-failure maintenance. It is a reactive management strategy, where corrective maintenance is often dominated by unplanned events, and is carried out only after the occurrence of a function failure, malfunction, or breakdown of equipment. Corrective maintenance action can restore failed equipment by either repairing or replacing the failed component. If the equipment can be repaired easily or is somewhat non-critical, unplanned equipment stoppages will cause only minimal disruption, and the FDM likely will be an

acceptable maintenance strategy. But in today's economy, this would have a serious impact on production and/or quality of life; urgent corrective maintenance action becomes necessary to avoid the serious consequences of failure. Note that the impact of urgent and corrective maintenance can result in unpredictable performance in an organization, evidenced by very high equipment downtime, equipment restoring cost, repair time, penalties associated with the loss of production, and spare parts inventory.

Around World War II things changed. Wartime requirements increased the demand for assets of all kinds, while the supply of skilled labour dropped sharply, which led to increased automation and mechanization. By the 1950's, machines and equipment of all types became relatively complex, and industries depended on them. As this dependence grew, downtime came into close scrutiny. This led to the idea that failures should be prevented, which in turn led to the concept of preventive (or time-based) maintenance. In the 1950's, it consisted mainly of equipment overhauls that were done at fixed intervals. Around this time, the cost of maintenance started to rise sharply, which led to the growth of maintenance planning and control systems. It also led people to start seeking ways in which they could maximize the life of their assets. To slow down the asset deterioration processes leading to faults, such time-based maintenance (TBM) is carried out by lubricating, calibrating, refurbishing, and inspecting equipment on a regularly scheduled basis. TBM assumes that the estimated failure behaviour of the equipment (i.e. the mean time between functional failures) is statistically or experientially known for equipment/machinery degrading in normal usage. TBM also involves minor (sometimes even major) planned shutdowns of systems for overhaul or predetermined repair activities on still functioning equipment. It prevents functional failures by replacing critical components at regular intervals, just shorter than their expected useful lifetime. Although TBM can reduce the probability of system failure or the frequency of unplanned emergency repairs, it cannot eliminate the occurrence of random catastrophic failure. Further, most TBM decisions are made by experienced planners according to the original equipment manufacturer's recommendations, the reported breakdown history or failure data and the operating experience and judgement of the maintenance staff and/or technicians.

Since the mid-seventies, industry dynamics have gathered even greater momentum that forced even more changes in maintenance management. Downtime affected the productive and functional capability of physical assets, resulting in a reduction of output, increasing

operating costs and even interfering with customer service. By this time, automation had been widely accepted, the growth of which also meant that reliability and availability were key issues in all sectors, including the building construction and health care disciplines. Greater automation meant that frequent failures easily affected the ability to sustain quality of life; as well frequent failures had serious safety or environmental consequences. Dependence on physical assets grew significantly, and so too their cost to own and operate. To secure the maximum return on the investment that these equipments represented, they must be operating efficiently for as long as their owners want. At the same time, the cost of maintenance itself had been rising in absolute terms and as a proportion of total expenditure. In short, in less than half a century, maintenance as a discipline, became a cost control priority, and moved to the top of the board room agenda. This led to a third generation of maintenance concepts - to what is generally known as predictive and/or condition-based maintenance techniques.

Predictive vs. Condition-based Maintenance

It makes sense to further elaborate on the essence of third generation maintenance strategies, currently known as predictive and/or condition-based maintenance strategies. These have now found their way to computer-based maintenance management systems (CMMS). In a broad sense, both predictive and condition-based maintenance essentially stand for the same thing. Predictive maintenance comprises methods which attempt to "predict" or diagnose problems in a piece of equipment, based on test results. Predictions are usually based on the trending of results. An example [refer 3] can convey this aspect more clearly.

Assume that an insulation test is performed on a 15 kV substation bus. A minimum value of 5,000 Megohms is considered acceptable, and the standard one minute test result indicates a reading of 5,225 Megohms. Such a reading might prompt one to accept the reading and do nothing about it. Further review of Figure 2 can lead one to a totally different conclusion - one that clearly shows that the equipment is seriously deteriorating. The last two readings, taken six months apart, show a drop from approximately 10,500 Megohms to 5,225 Megohms. Assuming the trend will continue, the insulation resistance of this equipment will likely reach zero in a relatively short time. Based on this observation, one can easily

conclude that, while still in service, if the condition of the equipment is checked and action taken, significant savings will be realized.

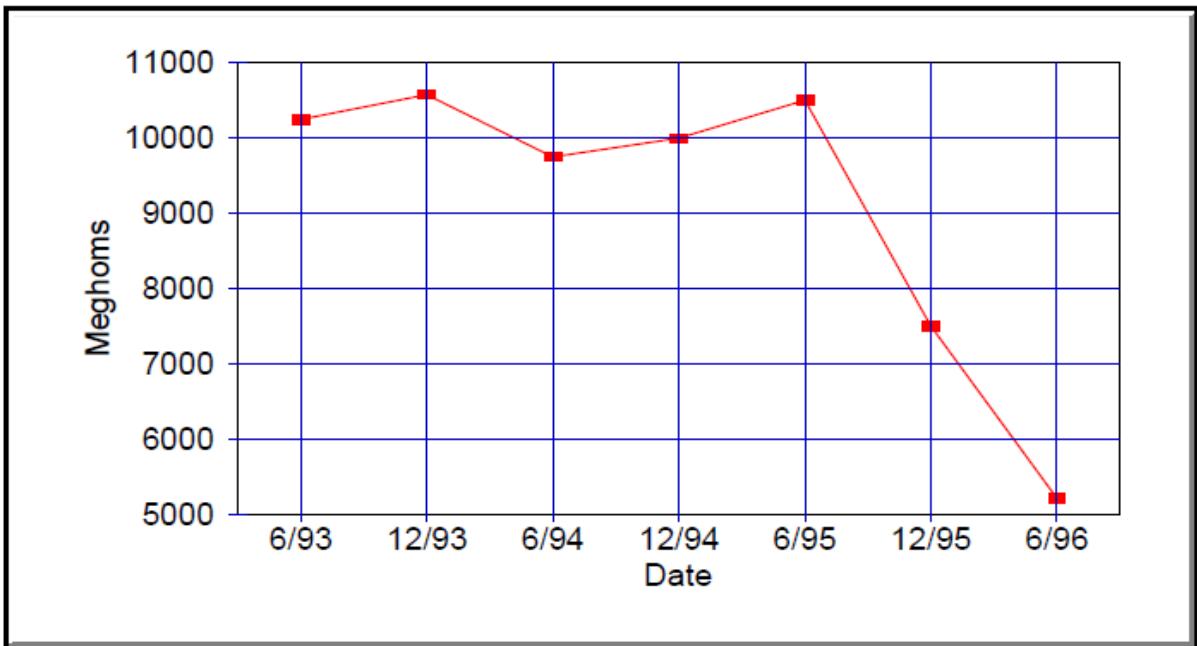


Figure 2- Insulation Resistance Trending Chart (Source: John Cadick reference 3)

Typically, condition-based maintenance (CBM) adds two factors to the predictive maintenance model (PDM). First, CBM deals with the entire system as an entity, since it realizes its greatest potential when applied evenly across the entire system. The second factor is the notion of shortening (or extending) maintenance intervals. In early PDM systems, trending techniques were used primarily to confirm maintenance decisions that were previously based on expert opinions. And in such instances, it had minimal effect in reducing the cost of maintenance efforts, whereas trending and statistical analysis are the building blocks of the CBM and as such, because of its systemic approach, CBM can contribute to the decrease of long term maintenance costs. Comparing data absolute values and more importantly, comparing data deviations via statistical analysis provide information never before available. For example, referring to Figure 3 [refer 3], and after entering the needed information into the CBM model as well as performing the required analysis, the results can determine whether the maintenance interval should be increased,

decreased or maintained. And, there is a good possibility that maintenance costs will go down, based on an increased time interval between equipment shutdowns.

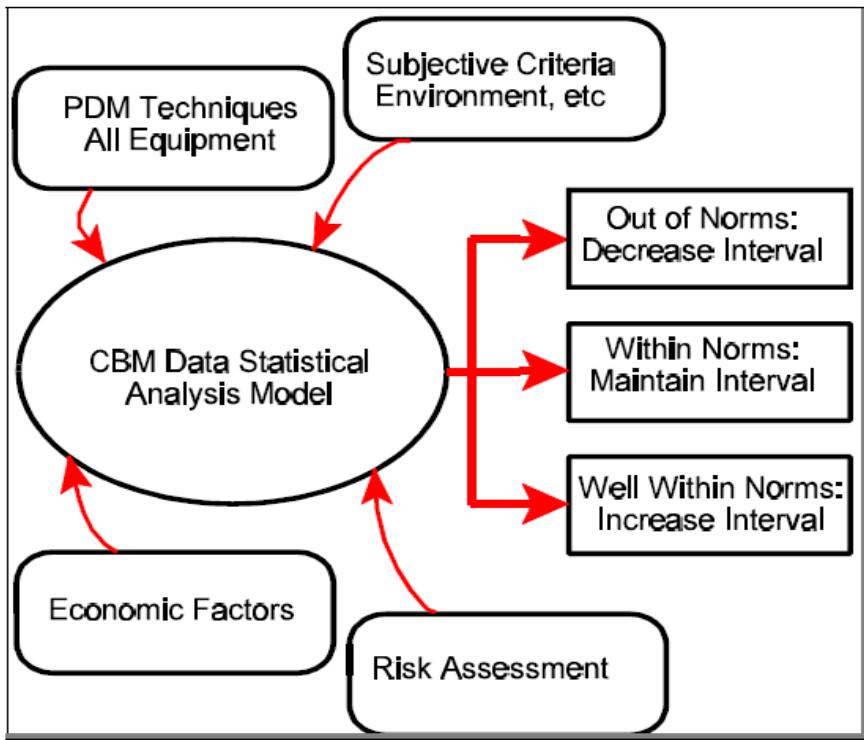


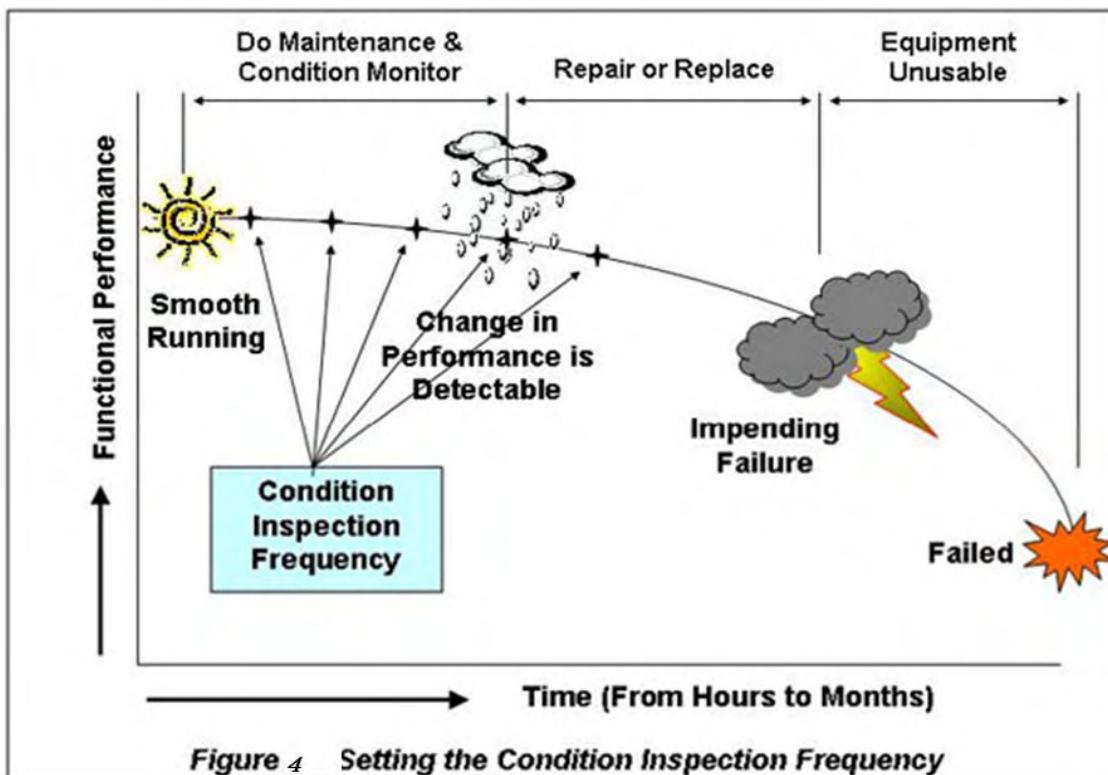
Figure 3 CBM Flowchart Model (Source: John Cadick reference 3)

Condition-based Maintenance – A Strategy for Facility Maintenance

Condition-based monitoring, as a maintenance philosophy, is being quickly embraced by facility managers across the industry, and hence it is worthwhile to elaborate more on this topic. CBM is aimed at immediate detection and diagnosis of off-normal asset operations and the identification of the root causes of this condition, so as to help trigger timely actions. CBM assumes that prognostic parameters, that are indicative of trouble, can be detected and used to quantify the possible failure of equipment before it actually occurs. It is understood that equipment conditions are useful metrics of possible faults and/or potential problems before catastrophic failure or damage to equipment occurs. The trend in deterioration of critical components can be identified through a trend analysis of the

equipment condition data, while the maintenance decisions depend very much on actual measured abnormalities, faults initiation, and the prediction of the trends in equipment deterioration.

Equipment Monitoring doesn't have to be expensive; it can be based on inspections, and in such cases, the time periods must be set at a frequency that will let one easily spot the change, well before the impending failure. For example, in Figure 4 [refer 1] it refers to a frequency inspection period that will detect the degrading performance well before the failure. Once the start of a failure is detected, one can prepare for its repair, and/or take necessary steps that make changes in its use, to extend the time before failure. After discovering the potential and cause of failure through condition monitoring, one can now try to remove it, or else it can occur randomly at anytime in future, even after it is repaired.



Source: Mike Sondalini (reference 1)

As already mentioned, careful control of operational parameters can result in extending the component life beyond what is normally expected. The idea is to arrive at a plan to deal with the 'actual versus intended' operational environment, with a goal to define strategies in

terms of life cycle and economic management of the facility's assets. The bottom line is to reduce the number of unplanned asset failures by monitoring the equipments' condition to predict failures and enabling remedial actions to be taken [refer 4]. It is to be noted that, though maintenance is done at the component level, the asset maintenance strategy should take a holistic approach to the entire system; note also that real-time data collection, data mining, systems integration, trending and statistical analysis are the building blocks of any modern CBM strategy.

Many factors need to be evaluated when trying to select and prioritize the various conditions to monitor - how often, for which components, and leading to what actions. To make the process simple, one may prioritize the assets for which CBM might make sense, based on what could happen when an asset (or component) fails. If the consequences of failure are catastrophic (large loss of production, major safety risk), then CBM might be appropriate. Such criticality assessments are procedures which aim to identify those assets that could have the greatest effect on an operation if they were to fail. Invariably, since the organization is bound to face the problems of certain deterioration and random failure of equipment, decisions based on condition-based fault diagnosis and the prediction of the trend of equipment deterioration will become critical for maintenance planning and control. In addition, increasing the percentage of planned maintenance actions will decrease the quantity and capital investment in spare parts on-hold for emergency repairs [refer 5].

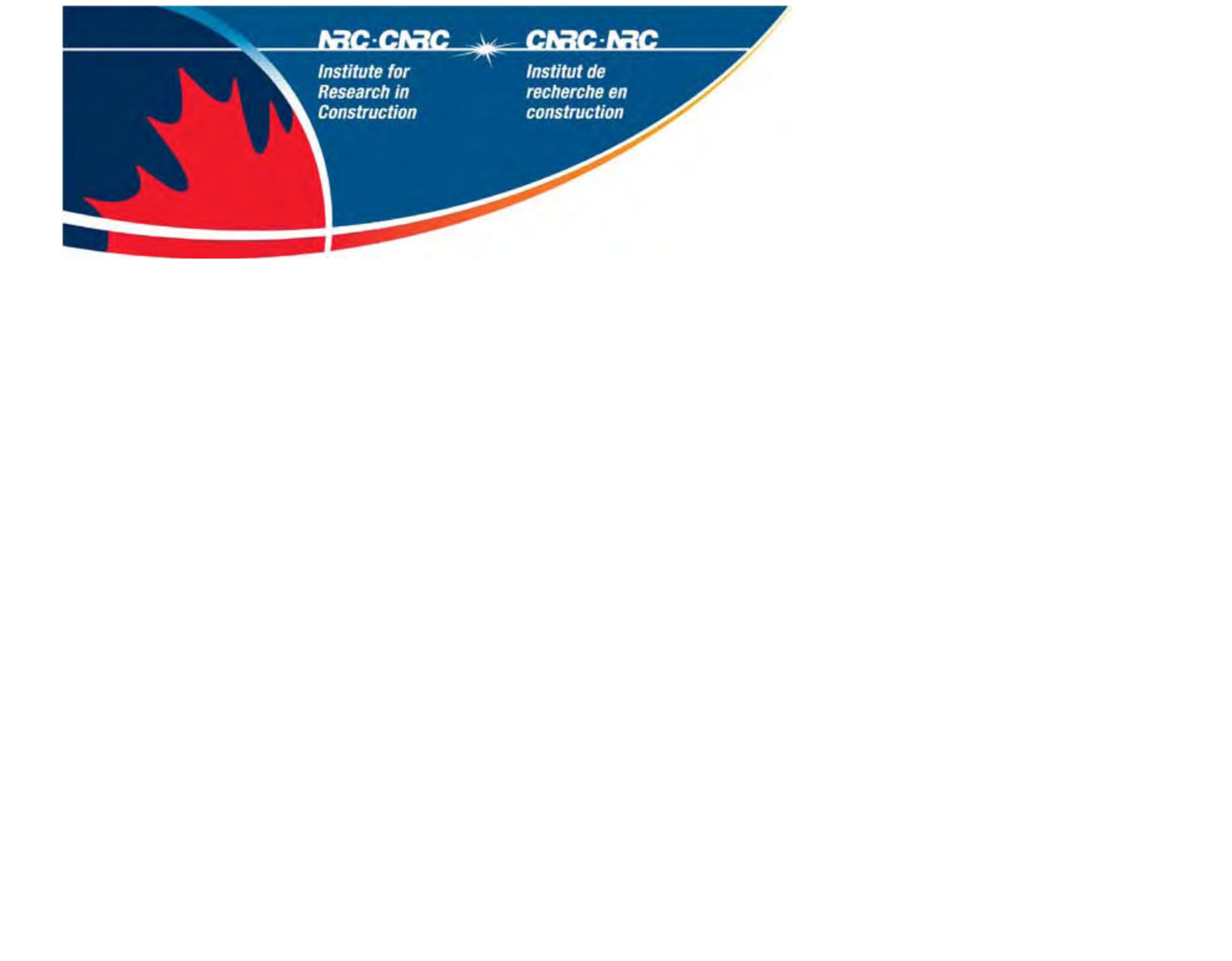
Facility Maintenance Management Software Tools

As mentioned earlier, the main purpose of this document is to report on facility maintenance management commercial tools. Yet it seemed appropriate to briefly mention some of the research tools that could evolve as commercial tools, at a later stage. Garcia et al [6] have developed an Intelligent System for Predictive Maintenance. It is a software application that takes into account the information in real-time coming from different sensors and other information sources and tries to detect possible anomalies in the normal behavior expected of the industrial components; this allows for an early diagnosis and the possibility to plan effective maintenance actions. Jay Lee et al [7] developed an E-maintenance system that addresses the needs of predictive intelligence tools to monitor degradation rather than

detecting faults in a networked environment and, ultimately to optimize asset utilization in the facility. Several case studies were introduced to validate these developed technologies and tools. Moore and Starr [8] have reported a system that automatically prioritizes jobs arising from condition-based maintenance using a strategy called Cost-Based Criticality (CBC) which draws together various types of information. CBC weights each incident flagged by condition monitoring alarms with cost information and risk factors, allowing for optimized prioritization of maintenance activities. Trappey et al [9] have tackled engineering asset management functions and processes in a collaborative environment integrated with a service centre with diagnosis and prognosis expertise. The collaborative maintenance chain jointly combines asset operation sites (i.e., maintenance demanders), a service centre (i.e., the system provider and maintenance coordinator), a first tier collaborator (i.e., maintenance providers), and maintenance part suppliers. And, to realize the automation of communication and negotiation among organizations, the multi-agent system (MAS) technique is applied. Ko [10] has presented a web-based RFID building maintenance system that embeds three modules - data management, statistics, and scheduling – in which the users implement maintenance work using tablet PCs attached with portable RFID devices.

Focusing strictly on commercial tools, currently, there are not very many maintenance management tools (MMS packages) that can perform the trending and/or statistical analysis, which is part and parcel of a full implementation of the modern condition-based maintenance program. Recently, some vendors have started incorporating CBM into their computer- based MMS offerings. The simplest packages allow for the manual input of data, such as condition readings for triggering preventive maintenance routines. The more sophisticated MMS software connects online to PLCs or other shop-floor devices for automated data collection. The software then analyzes incoming data to ensure that trends are on target and within user-defined control limits. It tracks the variance from the target, as well as the worst and best readings. When data deviates from the user-established limits, the software comes alive to initiate a work order and/or triggers some other actions.

The rest of this document is devoted to providing an overview of many of the commercial tools that are available in the market today. For more in-depth details of these tools, the reader needs to access the appropriate websites.



Organization	Tool	Main Functions	Special Features	Comments
XATA Corp - Burnsville, MN (USA) www.xata.com	Asset Management	Fleet Asset Management and optimize fuel consumption at delivery route		
Verian Technologies - Charlotte, NC (USA) www.verian.com	Asset Manager - Web-based and deployable via an intranet or extranet.	<p>Manage the asset life cycle, from acquisition to disposal. Determine cost of asset ownership as the system tracks acquisition costs, maintenance costs, depreciation and disposal costs</p> <p>Maintain asset audit trail of movement and ownership. Calculate depreciation using multiple methods. Procure and manage asset maintenance and repairs with built-in work orders. Record parts, labor and departments associated with asset maintenance.</p> <p>Integrate with Verian's Purchase Manager system to order parts for assets and share data with other systems like accounting or IT auto-discovery tools. Identify opportunities to redeploy assets instead of just buying new ones. Plan and budget using asset performance and cost data. Eliminate unused assets to give the balance sheet a boost</p>		

Ventyx - Indus, Mobile Data Solutions (MDSI) - Atlanta, GA (USA) www.ventyx.com	Asset management for power generation	<p>Ventyx provides asset management solutions for power generation, energy delivery and other asset-intensive organizations.</p> <p>Reduce generation plant operational costs; and improve plant workforce effectiveness, expertise and solution capability in the industry. The Ventyx Asset Management solution integrates with its field workforce management solution. More efficient operations improve ability to meet environmental goals. Meet regulatory and safety requirements. Streamline the supply chain.</p>	<p>Operations management information systems for the chemical, power, marine, petro-chemical, and pulp & paper industries.</p> <p>Ventyx has also developed the Shift Operations Management System (eSOMS).</p>	48 of the top 50 North American power generators use Ventyx solutions
USCS Equipment Technology- Brookfield, WI (USA) www.uscounseling.com	Asset Management Software	<p>They created the Thermo Scientific LIFECYCLE Enterprise Solutions portfolio and the Thermo Scientific 3D Model to help one manage assets throughout their lifecycle--from acquisition to disposition.</p> <p>The 3D Model, an integrated services solution, capitalizes on available service methods, such as managed maintenance, multi-vendor direct services, biomedical services and service contracts, to create a customized solution that helps clients improve productivity, reduce total cost of ownership and ensure compliance.</p>		
UNIK Associates-	CMMS	PEAK Industrial Solutions, provides		

Butler, WI (USA) <a href="http://www.cmmsm
adeeasy.com/">http://www.cmmsm adeeasy.com/	Maintenance Software	<p>Computerized Maintenance Management Systems (CMMS)/Enterprise Asset Management (EAM) software solutions, and consulting.</p> <p>Includes:</p> <ul style="list-style-type: none"> Equipment Management Preventive Maintenance Work Request System Work Order System Labor Management Inventory control Requisition/Purchasing Budgeting Mobile, Bar Code, Interface 		
TMA Systems- Tulsa, OK (USA) www.tmasystems.com	CMMS Asset Management Software	<p>TMA Solutions combines the functionality of Asset Management Software with Computerized Maintenance Management System (CMMS) providing the ability to manage an organization's work-flow process.</p> <p>These features include:</p> <ul style="list-style-type: none"> Work Order Management; Preventive Maintenance Management; Materials/Inventory Management; Project Management; Contract Management; Asset Management; Space Management (CAFM); Fleet Management; Custodial Management; Room Inspections; Utility Management; Mobile Solutions <p>TMA's scalable product set includes: TMA desktop solutions, TMA eXpress, TMA WorkGroup, TMA Enterprise, and TMA's web-</p>		

		based solution, WebTMA .		
TGX Medical Systems - Carmel, IN (USA) www.terraphix.net	Asset Management Software	<p>TGX Medical Systems designs, develops and markets software solutions for medical asset management and tracking. These web-based systems work with specialized hardware supplied by major integrators. They are sold to small, medium and large-sized hospitals and medical facilities.</p> <p>Provides a baseline for infection control, track instrument usage throughout their lifecycle, and report on employee productivity in a healthcare facility. It ensures proper sterilization methods are being used while maintaining biological records electronically.</p>	Hospital systems	
Symx Corp - Miami, FL (USA) www.symxcorp.com	Hospital Healthcare Capital Equipment Life Cycle Asset Management	<p>SYMX Corporation provides equipment life cycle management services to hospitals, integrated healthcare systems and group purchasing organizations as well as government entities.</p> <p>It utilizes the SYMX ATLAS (Asset Tracking Location Accountability System) to enable RFID data access, management and integration. The SYMX ATLAS uses active RFID to deliver real-time location and process automation for healthcare organizations and its patients, clinicians, staff and equipment. In employing Microsoft BizTalk Server 2006 R2, ATLAS delivers the "Connected Enterprise," so customers can connect real-time business processes and command intelligent RFID data, giving hospitals a competitive business advantage in terms of asset tracking, equipment management, patient safety and increasingly effective staff performance.</p>	Hospitals	RFID is used for real-time location info.

Symology Ltd - Caddington, Bedfordshire (UK) www.symology.co.uk	Infrastructure Asset Management	Infrastructure Asset Management Solutions: Symology develops and supplies a range of integrated solutions for the management of infrastructure assets, including highways, land and property, bridges and structures, public lighting, and distribution networks.	Street-works and highway asset management	
St Croix Systems Inc - Watertown, MA (USA) www.stcroixsystems.com	Asset Management Software	<p>CMMS application in healthcare and is the core of St. Croix's asset management solution. Computerized facility and equipment management software and services designed to integrate functions of asset management, asset logistics, safety management, and capital planning for healthcare providers.</p> <p>Automate the core functions of Work Order Management, Workforce Management, Preventive Maintenance, Inventory Management, Contract Management, Regulatory Compliance and Reporting;</p> <p>Track and manage the condition and performance of facilities and equipment, including preventive maintenance according to manufacturer, JCAHO and other regulatory standards;</p> <p>Real-time data driven reporting;</p> <p>Manage the intake of service requests via a web-enabled request and dispatch solution that auto-creates work orders and escalates until requests processed and closed;</p> <p>Drive workforce efficiencies with Mobile Asset</p>	Healthcare	

		Manager designed for portable PCs and PDAs.		
Source Atlantic- Cambridge Massachusetts www.sourceatlantic.com	Healthcare Equipment Software	Source Atlantic software medical equipment management, new facility construction planning. Atlantic software coordinates capital planning, forecasting, budgeting, purchasing. Source Atlantic software asset maintenance medical equipment, furniture.	Healthcare	
SoftSols Group Ltd - Wrenthorpe, Wakefield (UK) www.impactxp.com	Facilities Maintenance Software	Supplier for Computerized Maintenance Management Systems (CMMS) and facilities management software. Claims: <ul style="list-style-type: none"> - Extended Asset Life through improved maintenance and reliability - Increased production from improved equipment availability and better planning - Lower maintenance costs from better planning and control of external costs - Increased quality by reducing scrap rates and breakdowns - Quick, low cost implementation 	Focuses on many industries including healthcare, oil & gas, manufacturing, etc.	
SMGlobal Inc- Cary, NC (USA) www.smglobal.com	CMMS Maintenance Software	CMMS Software for Windows: Plant maintenance; facility & building maintenance; utility maintenance (e.g. water/ sewage/ power); aircraft or vehicle fleet maintenance; enterprise asset management; hotel & restaurant maintenance; general equipment maintenance	Multiple industries	
Seltek Solutions - Stockwood, Worcestershire (UK) www.maintenance-software.co.uk	Preventive Maintenance Software	Provides with the information to control resources by prioritizing and allocating planned maintenance work, tracking machine and/or tool repairs and maintaining inventory	Manufacturing	

		<p>levels. It allows one to:</p> <p>Track machines and other equipment; Track tools, e.g. mould tools, foundry patterns, press tools; Schedule machine planned maintenance based on dates or hours run; Schedule tool planned maintenance based on dates or cycles run; Flag planned maintenance work due for machines and tools; Prioritize planned maintenance work load; Issue a task and kit list for each due planned maintenance; Track internal and external repairs; Flag open machine or tool repairs; Record machine and tool cost histories; Control machine and/or tool parts inventory.</p>		
RDMI Maintenance Solutions - North York, ON (Canada) www.rdmi.com	CMMS Software	<p>Offers Computerized Maintenance Management System (CMMS) solutions to manufacturing, service and government agencies.</p> <p>Maintenance of Critical Assets (MoCA for Windows) is complete Critical Asset Maintenance System (CAMS) designed for small, medium and enterprise level organizations. It is the only CMMS which allows Facility, Building, Equipment, Fleet and Asset maintenance with multiple service categories and multiple work order numbers in one package.</p>	Primarily manufacturing	Canadian – Toronto based
Preco Electronics - Boise, ID (USA) www.preco.com	Vehicle Communication Tracking Systems	<p>Rugged pulsed radar collision avoidance systems enabling heavy equipment operators to navigate blind spots around their vehicles (PreView™).</p> <p>Wireless information collection, transmission, and analysis system for tracking fleet and</p>	Heavy equipment industry	

		<p>equipment accessory activity (PreCise™).</p> <p>Safety Alert System (SAS™) combining active blind spot detection sensors with passive backup alarms and safety lighting.</p>		
PMXpert Software - Saskatoon, (Canada) www.pmxpert.com	Preventive Maintenance Software	<p>Preventive Maintenance Software.</p> <p>Generates scheduled emergency and work orders, view cost entries and reviews, and track the service history on equipment.</p>	General equipment	Canadian-Saskatoon based
PMS Systems Corp - Santa Monica, CA (USA) www.assetsmart.com	Asset Optimization Management Tracking Software	<p>Provider of integrated, enterprise-wide asset management software, which addresses various phases of asset management and handles all categories of equipment.</p> <p>SMART/PEMS (Property and Equipment Management System) delivers asset management across the enterprise. The application offers comprehensive tracking and management of the company and government property, to reduce asset downtime, maintenance and management costs and increase asset utilization and redeployment.</p> <p>SMART/MMS (Maintenance Management System) is a generalized maintenance and repair management system for plant maintenance, computers and manufacturing equipment.</p> <p>Optimize equipment resources by planning, scheduling and tracking service requests and equipment maintenance across the organization</p> <p>Standardize maintenance processes across</p>	Multiple industries and Government	

		<p>organization; Improve speed and access to information for maintenance planning and service requests via the SMART/WEB interface;</p> <p>Provide real-time maintenance information from a single application interface; Increase visibility and availability of real-time maintenance information by integrating all maintenance and work-in-progress data into a single data repository.</p>		
OPS Systems Inc- Rio Rancho, NM (USA) www.opssys.com	Maintenance Data Software	Computerized maintenance management program that assists in maintenance operations. The Calendar displays all the scheduled work, completed work, overdue work, and skipped work for a 52-week period.	Water and wastewater industry	
Nexant Inc – Utility - San Francisco, CA (USA) www.nexant.com	Petrochemical Software	<p>Assess the value of energy assets by enabling companies to make informed decisions with speed and reliability. Nexant provides a proven suite of software products, ranging from network congestion analysis and unit commitment to generation asset valuation and portfolio analysis.</p> <p>Software is installed both as advanced energy management system (EMS) applications and as standalone packages.</p>	Power generation and energy conservation	150 utilities worldwide
NetSimplicity – Austin, TX (USA) www.netsimplicity.com	Asset Management Software	<p>Provides a visual floor-plan of your company's assets showing you what your company owns, where it is and what it is worth.</p> <p>Categorize and inventory assets; Check resources in and out; Track usage and depreciation; Replace tracking with Excel® spreadsheets; Meet industry compliance regulations.</p>		

MPulse Eugene, OR (USA) www.mpulsecmms.com	Maintenance Software	<p>Desktop Maintenance Tools – used to manage the entire MPulse System: MPulse Gold, WorkFlow R, WorkFlow M, or WorkFlow W.</p> <p>MPulse Gold: Integrated asset maintenance management suite. CMMS system includes advanced user interface, browser-based requesting system, asset management, work order generation & management, extensive preventive maintenance (PM) scheduling & management, inventory ordering, control & management, management tracking & reporting, etc.</p> <p>Online Maintenance Tools – used by drop in users to get information such as work history, pickup work assignments, complete work orders, submit request for work, check status of work that is in the queue.</p> <p>Handheld Maintenance Tools - used to create a paperless environment.</p>	production, education, and government industries	Markets several software products
Micronics GPS Perth (Australia) www.micronicsgps.com	Field Asset Management Software, GPS Mobile Mapping, Wearable Long Range DGPS	<p>Global Positioning System and the Free to Air Differential Beacon located at Cape Shanke Victoria, to achieve sub-metre accuracy in the capture of road defect locality data.</p> <p>Linked to the Geographical Information System stored in a lap-top computer, loaded with an asset management software package, which also enables the assignment of attributes to each unique point recorded.</p>		GPS and GIS systems to identify defect locations

<p>Micromain Corp Austin, TX (USA) www.micromain.com</p>	<p>CMMS Preventive Maintenance Asset Software, Facility Management, Capital Planning</p>	<p>Maintenance and Facility Management Software:</p> <p><u>MicroMain Maintenance Management</u> software for automated work orders, preventive maintenance scheduling, asset histories, inventory and budget control, fleet management, purchase orders, and more. It includes risk assessment for biomed/clinical engineering departments in hospitals and other healthcare settings. Plant asset management, MRO, and equipment maintenance are also simplified with MicroMain maintenance management software. Its Facility Management software includes basic functionality such as:</p> <p>Linking data to facility drawings; using data-enabled drawings to search for assets; tracking employee & occupancy data; tracking building and property information; ensuring continuity &safety; using mark-up tools for FM project collaboration; viewing inspection and maintenance histories</p>	<p>Multiple industries including hospitals, production, education. etc.</p>	<p>Facility management and asset management included</p>
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Maintsmart Lodi, CA (USA) www.maintsmart.com	CMMS Maintenance Software	Reliability Analysis, Decision Support and Maintenance Program Optimization. Chance of Failure of An Equipment Item During a Specified Time Period? Work Orders Management and Analysis. Equipment Down Time Management and Analysis. Inventory and Purchasing Management and Analysis. Preventive Maintenance Management and Analysis. Inventory Tree View - Drag and Drop Parts Requisitions. Determine the "Cost to Own" a Equipment.. Security and Access Control. Match Personnel Skills to Tasks.	Multiple industries	
Maintenance Experts (MEX) Annerley, Brisbane (Australia) www.mex.com.au	CMMS Software	Computerised Maintenance Management System Comprehensive work order, preventative maintenance, asset management and inventory control system. Products include FleetMEX , MEX Ops , FuelMEX and MEX Mobile	Multiple industries	4,500 users worldwide
Kakari Systems Ltd Edmonton, Alberta (Canada) www.kakari.com	CMMS Software	Kakari offers a variety of software applications, including IGOR®, the computerized maintenance management software (CMMS), ESTIMATOR, estimating software for both general and pipe construction, and Task Tracker, a janitorial management system.	Multiple industries	Canadian – Alberta based.
ITHEC Lissieu (France) www.ithec.com	Maintenance Management Software	ITHEC International specializes in maintenance management systems and in software for the transport industry	transport industry	
IntelliTrack Hunt Valley, MD (USA) www.intellitrack.net	Warehouse Management Asset Tracking, Order Fufillment, Barcode, RFID	IntelliTrack provides inventory management software . With innovative barcode and RFID technology, one not only eliminate the manual processes that are wasting precious man hours, one can also reduce accounting errors and improve customer service.	Manufacturing, hospitals, education, hospitals, etc.	RFID, etc
Integrys – Assetpoint	CMMS and	AssetPoint's primary maintenance	Multiple	Critical plant

Greenville, SC (USA) www.assetpoint.com	EAM Asset Management	improvement tools are: TabWare EFx is an Enterprise Asset Management /computerized Maintenance Management System (EAM/CMMS) application accessed users to manage \$ in critical plant and facility assets worldwide. AssetPoint is recognized by industry analysts as one of the top suppliers of EAM solutions. Maintenance consulting, technology, support and training operation that focuses on improving maintenance programs, systems and procedures to reduce maintenance cost and improve production uptime. AssetPoint's roots are in maintenance management, beginning at Fluor Corporation in the late 1970's.	industries	and facility assets
Grand Ravine Software – Maintscape Ottawa, ON (Canada) www.maintscape.com	CMMS Maintenance Software	General purpose Computerized Maintenance Management System (CMMS) for plant and facility maintenance.		Canadian – Ottawa based.
GP Solutions Baltimore, MD (USA) www.gpsonline.com	CMMS Maintenance Software	Give users web browser-based access. Support remote users with portable bar code readers or PDA devices. Add problem reporting capabilities to company or customer web site. Generate remote monitoring reporting to management via web delivered content	Multiple industries	
FSC Thunder Bay, Ontario www.4site.com	CMMS Maintenance Software	Asset maintenance, inventory management, maintenance management	Power, manufacturing, healthcare	Canadian – Thunder bay based
Four Rivers Software Systems Inc Pittsburgh, PA (USA)	CMMS	Four Rivers Software Systems, Inc. delivers maintenance management software (EAM/CMMS) solutions to the healthcare industry.	healthcare	over 1,300 healthcare facilities nationwide

www.frsoft.com				
FKW Oklahoma City, OK (USA) www.fkw.com	Maintenance Management Software	<p>The Recurring Work Program (RWP) module encompasses Preventive Maintenance (time-based) and Predictive Maintenance (condition-based) requirements. RWP provides managers with an automated scheduling and tracking program for all recurring activities. Preventive Maintenance refers to periodic activities. Predictive Maintenance manages equipment maintenance based upon conditions rather than time.</p> <p>TM2 Facilities can include such diverse facilities as architectural displays, tennis courts, roads, sidewalks, curbs, flag poles, antenna systems, traffic lights, etc. Create Facility records for buildings, infrastructure components, or any physical entity. Identify tenants or owners for each Facility record and track space allocation and utilization. Show utility usage and utility reimbursement factors down to the tenant and room level. Maintain organization codes and mailing lists. Maintain construction data down to the "room" level; i.e., what ceilings or walls in what rooms contain asbestos. Maintain critical real property data, including: Map Codes, Work Zones, Condition Codes, Disposal Data, Area Availability/Usage, Track lease dates, etc.</p>		
FDS Advanced Systems Ltd Knaphill Woking, Surrey (UK) www.fds ltd.co.uk uses Qube Global software:	Facilities Management Software	<p>Qube Global Software is one of the most significant suppliers of property and facilities management software.</p> <p>Provide a responsive facilities help desk. Manage planned and reactive maintenance. Keep control of contractors. Optimize use of space. Provide web-based facilities information</p>	Most industries are covered	With over 800 customers in 52 countries

http://www.qubeglobal.com/		to customers. Ensure a safe working environment. Quote and invoice clients. Provide workforce with mobile data tools.		
Express Technology Inc Fairhope, AL (USA) http://www.expresstechnology.com/	Maintenance Software	ExpressMaintenance is a maintenance (PM) software designed for rugged multi-user environments.	manufacturers, schools, fleets, institutions, plants, utilities, transporters, etc.	many large and small companies in 30 different countries
EQ2 Burlington, VT (USA) www.eq2.com	Hospital Equipment Management Software	<p>EQ2 Software for hospital equipment management of capital assets. CMMS maintenance software for clinical instruments, beds, HVAC, gas and electrical systems, elevator maintenance. EQ2 CMMS Software for scheduled and routine maintenance.</p> <p>For each patient admitted to a healthcare institution, there are hundreds of equipment items required to successfully deliver efficient, high quality care to the patient. These equipment assets comprise or support the delivery of both critical and non-critical patient care in the modern environment of care. EQ2 supports the equipment management professionals who maintain these critical equipment assets with software and service solutions.</p>	Hospitals	
Engineered Software Inc Belleville, MI (USA) http://www.engineeredsoftware.com/	Maintenance Optimization	<p>Reliability & Maintenance Analyst:</p> <p>The software consists of two modules; a life data analysis module and a maintenance optimization module. Data is entered with the specialized data entry grid which allows billions of data points. This entry grid is linked to a Microsoft® Access™ database. All graphics can be customized with easy to use dialog tabs. Life</p>	Manufacturing	

		data analysis module is capable of estimating the distribution parameters for the Weibull distribution, normal distribution, lognormal distribution, and exponential distribution.		
eMaint Medford, NJ (USA) www.emaint.com	Enterprises - Asset Management Software	Established in 1986 , eMaint was among the first providers of CMMS (Computerized Maintenance Management) systems to embrace the power of the Internet	Multiple industries	Appears to be a good tool
EDL Systems Witham, Essex (UK) www.easy-fm.co.uk	Facilities Management Software (CMMS)	Planned maintenance asset survey Planned maintenance scheduling and optimisation Data loading Measured Building Surveys for Asset Maintenance Plan Topographical surveying/GIS interface Checking existing site and building plans for accuracy/content Amending/developing AutoCAD drawings Linking drawings with Asset Management databases		
Eagle Technology Inc Mequon, WI (USA) www.eaglemmms.com	CMMS Maintenance Management Software	ProTeus is a full-featured facility maintenance software solution. ProTeus can seamlessly interface with intelligent Building Automation System. Link continuous commissioning and the LEED process. Master PM Scheduler (Multi-Cycle) ; Building Automation Alarm System Interface; Automated Work Order Generation; PM Implementation Library; Tenant Service Request; Mobile Capabilities; Barcode System; Over 120 Reports and Graphs. ProTeus has capabilities for airport maintenance management solution.	Multiple industries. Airport and Healthcare – main focus	3,000 customers

		<ul style="list-style-type: none"> • Scheduling and tracking of work to authorized contractors • Track maintenance activities by individual asset and location • Track costs associated with all activities • Building Automation System (BAS) Interface. 		
DPSI Greensboro, NC (USA) www.dpsi-cmms.com	Maintenance Management Software (CMMS)	iMaint is an enterprise asset management (EAM) system that control and monitor all maintenance activities, from an individual site to a global enterprise. Maintenance tracking; cost-effective inventory control; in-depth reporting and analysis; Windows or Web-based client interface; choice of database, and choice of host	industrial plants, facilities, vehicle fleets	DPSI has 3200 facilities in 80% of Fortune 500
Delinea - HCI Systems Portland, ME (USA) www.hcisystems.com	CMMS Software	<p>4tell™ Solutions, LLC (formerly HCI Solutions, LLC) develops information technology and software products for sustainable governance of facilities, infrastructure and buildings. Optimize their capital and operating lifecycle budgets</p> <p>Manage their facility governance processes ; Keep their environmental commitments; Comply with regulations and reporting requirements; Inform stakeholders through sustainability reporting</p>	Government, schools, hospitals, etc.	
DataTrak Inc Friendswood, TX (USA) http://www.data-trak.com/	CMMS - Maintenance Management Software	Data-Trak, Inc. develops and supports software for asset maintenance and management for small to mid-sized maintenance organizations with emphasis on low entry cost and ease of use.	Multiple industries	
CyberMetrics Corp Scottsdale, AZ (USA)	Maintenance Management	Founded in 1988, CyberMetrics Corporation is a developer and supplier of supply chain, and	Multiple industries	Fortune 1000 customers

www.cybermetrics.com	Software	<p>facilities maintenance management software solutions.</p> <p>Create Work Orders & PM's; Receive Service Requests and Email Notifications; Establish and Require Maintenance Procedures and Compliance; Predict Preventative Maintenance Labor Requirements; Track Maintenance History & Costs; Customizable Program Messages, Field Labels and Reports; PDA Compatible; Facility-wide Service Request Issuance via the Internet with Web Service Request Module.</p>		
COGZ Software Woodbury, CT (USA) www.cogz.com	CMMS Maintenance Management	<p>COGZ preventive maintenance program scheduling is automation for the maintenance management operation. COGZ CMMS can be used in computerized maintenance environment that requires preventive maintenance programs. COGZ CMMS Software can be utilized as maintenance software, including: building maintenance software, facility maintenance software, fleet maintenance software, plant maintenance software, vehicle maintenance software, educational facility maintenance software, heavy equipment maintenance software, electrical preventive maintenance software, hospital CMMS software, hotel maintenance software, etc.</p>	Multiple industries	

Chase Software Systems Omaha, NE (USA)	CMMS Maintenance	<p>Chase is a Computerized Maintenance Management System (CMMS) that links material and labor costs to Equipment (Assets), and includes a Preventative Maintenance (PM) module. The Chase System helps the facility to track costs as well as budget.</p> <ul style="list-style-type: none"> • Asset Management • Inventory Management • MSDS Management • Work Order Processing • Preventative Maintenance • Warranty Tracking 		
Champs Software Inc Crystal River, FL (USA) www.champsinc.com	Web CMMS Maintenance	<p>CHAMPS software solutions help optimize aspect of maintenance, improve equipment reliability, personnel productivity and ensure material availability. CHAMPS <u>CMMS / EAM</u> modules include:</p> <p><u>Maintenance</u>, <u>Inventory</u>, <u>Purchasing</u>, <u>A/P Lockout/Tagout</u>, <u>Corrective Action</u>, <u>Scheduling</u>, <u>Calibration</u>, <u>Project Tracking</u></p>		
CAE Consultants Inc Yonkers, NY (USA) www.municipalnets.com	Enterprise Facilities Plant Web Maintenance Software Preventative Maintenance	<p>Preventive maintenance, facility maintenance, municipal infrastructure, etc.</p> <p>Calendar allows schedule work ahead of time; Inventory feature and parts management; ISO compliance built in. Take procedures, photos and video anywhere without loading the</p>		Low cost tools

		database. Open your laptop and click and the server will send all you need to do the repair over the Internet. Maintenance index and flagging helps the personnel spot trouble when they fill out each work request.		
Bender Engineering Los Alamitos, CA (USA) www.maintstar.com	CMMS Maintenance Software	Asset Repair History; Preventive Maintenance (PM); Work Request and Work Order Creation; Asset Tracking and Replacement; Screen and Report Customization; Work Cost History including Labor, Equipment and Materials; Activity Based Planning Maintenance and Productivity Costs; Labor Resource and Scheduling; Interface with Microsoft Project; Inventory Control linked with Work Orders; Purchasing Control linked with Inventory; Bar Code and Palm Pilot capability; Web and E-mail Work Request and Approval Process; GIS, Auto Cad, and Digital Imaging Integration; Depreciation Tracking Replacement Cost Analysis; Replacement Cost; Projection methods; Budgeting; Custom Report Writer.	Multiple industries	Very comprehensive
BDR Systems Inc Downington, PA (USA) www.bdrsystems.com	CMMS Maintenance Software	Includes the CPRO 2000 and CPRO 2000 PLUS ISO Professional Calibration systems, the MPRO 2000 and MPRO 2000 PLUS Preventive Maintenance systems, PURCHASING PRO 2000 Procurement, Vendor Rating/Management system, FLEET 2000 Vehicle Maintenance system, and the PROPERTY 2000 Asset Management system.	Primarily manufacturing and fleet maintenance	
Ashcom Technologies Ann Arbor, MI (USA) www.ashcomtech.com	CMMS Maintenance Software	Provides an array of industrial products in the areas of a <u>computerized maintenance management system (CMMS)</u> , <u>document</u> management software, and <u>automated invoice</u>	Multiple industries	Many installations

		processing software.		
API Maintenance Systems A/S Albertslund (Denmark) DK www.apipro.com	Maintenance management	API Maintenance Systems develops, markets and supports maintenance management software.	multiple	Over 600 installations world-wide
American Quality Systems (AQS) Monticello, IN (USA)	Calibration, Maintenance Management Software CMMS	CyberMetrics Corporation is a developer and supplier of supply chain, and facilities maintenance management software solutions. Reduce Maintenance Costs, Optimize Inventory & Purchasing, Implement Standards & Compliance, Store & Retrieve Records, Improve Maintenance Management Program Reliability, Scalable to meet future needs.	multiple	
American Biomedical Group Inc (ABGI) Oklahoma City, OK (USA) www.abgi.net	Hospital Maintenance Management Cost Containment Software	American Biomedical Group, Inc. specializes in asset integration and management.	Healthcare	
AM Products Inc Boca Raton, FL (USA) www.attr.com	MMS Maintenance Software	MMS allows maintenance engineers to ensure QA compliance by providing a traceable history of all maintenance work. Comply with domestic and international standards. Allows asset management. Data base accepts unlimited number of equipment or parts.		
Aims - Phoenix Data Systems Inc Southfield, MI (USA) www.goaims.com	Maintenance Management Software (MMS)	Medical Equipment Maintenance Management Software (MMS) for Hospitals and Healthcare clinical engineering.	Healthcare	
Net Facilities, Inc. Long Beach, CA 90803 http://netfacilities.com/	Facility Maintenance Management Software	Total Work Order Management; Service Autopilot Work Orders; Total Asset Tracking; Preventive Maintenance Autopilot; Work Flow Distribution; Vendor Collaboration; Dashboard View; Work Order Pooling Assignments; Report	multiple	Facility mgnt, school mgnt, property mgnt. over 300

		Center; Inventory Management System; Budget Tracking; Role Based Users (unlimited); Custom Permission Levels; Guided Set-up		facilities and many system users.
PropertyTrak LLC Overland Park, KS 66210 http://www.propertytrak.com/	facilities management software	PropertyTrak implements web-based Computerized Maintenance Management System (CMMS) solutions that deliver facilities management automation. Adding preventive maintenance feature to PropertyTrak increases its practical usability by enabling facility managers to schedule regular maintenance activities on expensive and mission critical assets. It allows facility managers to record in advance and in detail all materials, tools and activities associated with specific preventive maintenance tasks. Also, PropertyTrak Equipment tracking lays the ground work for enterprise asset management.		
eWorkOrders http://www.eworkorders.com/	CMMS	eWorkOrders is a web based CMMS that allows individuals from different organizations – municipalities, real estate owners, property managers, building engineers, tenants, service providers, IT support and vendors – to work together in real-time while requesting and delivering services. Schedules preventative maintenance or recurring tasks. Tracking assets		

		such as vehicles, equipment, buildings, computers, and infrastructure. Tracks time and materials. Provides standardized reports and queries.		
Smartgroup. Meredith, NH 03253 Smartware Group	Facility Maintenance Software	For maintenance operations. Bigfoot software is about scheduling, managing, analyzing, and reporting on all aspects of maintenance, including preventive maintenance, work orders, maintenance requests, inventory, and predictive maintenance. EquipmentAsset Management, Preventive Maint. Management; Work Orders Management; Predictive Maintenance Analysis and Reporting;	Multiple	6,000 users - large and small, multi-site and single-site
Mainstream Software Twinsburg, OH 44087 http://www.mainstream.com/	Enterprise facility and maintenance management	Facility management, asset management, work order management, etc.	Multiple	more than 10,000 end users
Sprocket Layton, UT 84041 http://www.sprocketcmms.com/	CMMS	Sprocket CMMS is a web-based, facility and asset management software application. Sprocket GPS provides fleet and asset management software to construction industries. It enhances the ability to track, monitor and evaluate asset effectiveness with mapping and custom notifications for maintenance alerts. Benefits: Obtain information regarding runtime hours of equipment; Notify maintenance personnel of equipment that requires servicing; Knowledge of asset location and history; Accountability by members using remote assets; Up to the minutes status of driver; Email notifications on enter and exit of defined locations for time stamping; Billing for customers receiving service.	multiple	

AdventNet, Inc. Pleasanton, CA 94588, USA http://manageengine.adventnet.com/		Facilities Desk is a computer aided facilities and maintenance management software. It facilitates in managing and maintaining the property, space, people and asset of an organization effectively. This facilities and maintenance management application provides all that you need to have for integrated workplace management and general service administration. This CMMS tool offers seamless maintenance and workorder management, real-time data sharing of all the maintenance & facilities' activities and reduction in facilities cost run.	multiple	Large variety of software
Permanent Solution Industries, Inc Alexandria VA, 22314 http://www.psiwebware.com/	Facility maintenance and janitorial services	Facility Asset Management Software (FAMS®) helps you document important work throughout the day - from Preventive Maintenance, to Project Work, to Employee Management, to Service Requests or Complaints, and provides the structure and organization that helps achieve your tasks.		

AxisPointe Lehi, UT 84043 http://www.axispointe.com/	Facility Asset Management	AxisFM is a Facility Asset Management solution that takes the guesswork out of capital planning, provides clear process and procedure for work and space management, and lets you consolidate and report on the data from each.		
Thinkage Ltd Kitchener, ON N2R 1H6, Canada http://www.mainboss.com/english/index.shtml	CMMS	<u>MainBoss Maintenance Software</u> is the flagship of Thinkage's CMMS division. MainBoss enables maintenance management professionals to plan maintenance functions, improve productivity, lower overall maintenance costs and record and store valuable information about maintenance operations		Canadian - Waterloo based
ARCHIBUS, Inc. Boston, MA 02108 USA http://www.archibus.com/	CAFM	ARCHIBUS is a provider of real estate, infrastructure and facilities management solutions, with annual expenditures for ARCHIBUS-related products and services exceeding \$1.7 Billion (US). 4,000,000 ARCHIBUS users collectively manage over 5,000,000 properties around the globe. Available in over 130 countries and more than two dozen languages, ARCHIBUS is supported through a global network of over 1,600 Business Partners.	Multiple - 4,000,000 ARCHIBUS users	Huge
VFA Canada Corp. Mississauga, ON L4W 5K4 http://www.vfa.com/index.htm	Software and services for facilities asset management and capital planning	<u>VFA.facility®</u> software enables organizations to both manage information about facility assets and leverage that information in the creation of capital projects, plans and budgets. <u>AssetFusion®</u> enables the integration of data from VFA.facility with a variety of Computerized Maintenance Management Systems (CMMS), including Maximo from MRO Software, providing a facility management and capital planning solution that integrates work order, inventory, procurement and service management.	Multiple-especially healthcare	Over 350 installations; strong Canadian presence

		<p><u>VFA.auditor®</u> helps organizations quickly and cost-effectively audit their facility portfolio by guiding facility managers, maintenance personnel and others who may lack expertise in facility assessment to gather information about facility conditions.</p> <p><u>VFA.spendManager®</u> enables organizations to manage the entire capital spending process, streamlining capital budget creation, requisition processing, purchasing and reconciliation of expenditures.</p>		

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