

SOLUTIONS

THE MAGAZINE BY PRACTITIONERS FOR PRACTITIONERS

VOLUME 13, ISSUE 4 2018



ADDRESSING THE SKILLS GAP

COURSE	WHO SHOULD ATTEND	YOU WILL LEARN HOW TO	DATES & LOCATION	DAYS/CEUs	COST
Maintenance Management Skills 	Maintenance Managers and Supervisors, as well as Supervisors from Operations, Warehouse or Housekeeping areas	Lead a world-class maintenance department using planning and scheduling best practices to drive work execution, improve productivity, motivate staff, increase output and reduce waste.	Sept 25-27, 2018 (KU) Dec 4-6, 2018 (CHS) Jan 29-31, 2019 (CU) April 16-18, 2019 (OSU)	3 consecutive days 2.1 CEUs	\$1,895
Maintenance Planning and Scheduling 	Planner/Schedulers, Maintenance Supervisors, Maintenance Managers, Operations Coordinators, Storeroom Managers and Purchasing Managers	Apply preventive and predictive maintenance practices. Calculate work measurement. Schedule and coordinate work. Handle common maintenance problems, delays and inefficiencies.	July 23-26, 2018 (CHS) Sept 24-27, 2018 (CU) Nov 5-8, 2018 (OSU) Jan 5-7, 2019 (CHS) May 7-9, 2019 (KU) Jun 18-20, 2019 (CHS) Jul 23-25, 2019 (CHS) Aug 27-29, 2019 (CHS)	4 consecutive days 2.8 CEUs	\$2,495
Materials Management 	Materials Managers, Storeroom Managers, Planner/Schedulers, Maintenance Managers and Operations Managers	Apply sound storeroom operations principles. Manage inventory to optimize investment. Understand the role of purchasing. Implement effective work control processes.	Oct 23-25, 2018 (CHS) Mar 5-7, 2019 (CHS) Jan 29-31, 2019 (CU) April 16-18, 2019 (OSU)	3 consecutive days 2.1 CEUs	\$1,895
Planning for Shutdowns, Turnarounds and Outages	Members of the shutdown or outage teams, Planners, Plant Engineers, Maintenance Engineers	Save time and money on your next shutdown by learning how to effectively plan for and manage such large projects. Learn processes and strategies for optimal resource allocation.	Aug 7-9, 2018 (CHS) August 6-8, 2019 (CHS)	3 consecutive days 2.1 CEUs	\$1,895
Predictive Maintenance Strategy 	Plant engineers and managers, Maintenance, Industrial and Manufacturing Engineers, Maintenance Supervisors and Managers	Collect and analyze data to assess the actual operating condition. Use vibration monitoring, thermography and tribology to optimize plant operations.	July 31-Aug 2, 2018 (CU) Nov 6-8, 2018 (KU) Apr 2-4, 2019 (CHS) May 21-23, 2019 (OSU) Jul 30-Aug 1, 2019 (CU)	3 consecutive days 2.1 CEUs	\$1,895
Reliability Engineering Excellence 	Reliability Engineers, Maintenance Managers, Reliability Technicians, Plant Managers and Reliability Personnel	Learn how to build and sustain a Reliability Engineering program, investigate reliability tools and problem-solving methods and ways to optimize your reliability program.	Oct 23-25, 2018 (OSU) Feb 26-28, 2019 (KU) Apr 30-May 2, 2019 (CU) Jun 18-20, 2019 (CHS)	3 consecutive days 2.1 CEUs	\$1,895
Reliability Excellence for Managers 	General Managers, Plant Managers, Design Managers, Operations Managers and Maintenance Managers	Build a business case for Reliability Excellence, learn how leadership and culture impact a change initiative and build a plan to strengthen and stabilize the change for reliability. CMRP exam following Session Four.	SESSION 1 DATES: Aug 28-30, 2018 (CHS) Mar 19-21, 2019 (CHS)	12 days total (4, 3-day sessions) 8.4 CEUs	\$7,495
Risk-Based Asset Management 	Project Engineers, Reliability Engineers, Maintenance Managers, Operations Managers, and Engineering Technicians	Learn to create a strategy for implementing a successful asset management program. Discover how to reduce risk and achieve the greatest asset utilization at the lowest total cost of ownership.	Oct 2-4, 2018 (CHS) Feb 12-14, 2019 (OSU) Mar 26-28, 2019 (CU) Jun 11-13, 2019 (KU)	3 consecutive days 2.1 CEUs	\$1,895
Root Cause Analysis 	Anyone responsible for problem solving and process improvement	Establish a culture of continuous improvement and create a proactive environment. Manage and be able to effectively use eight RCA tools to eliminate latent roots and stop recurring failures.	Aug 21-23, 2018 (KU) Oct 30-Nov 1, 2018 (CHS) Mar 19-21, 2019 (OSU) May 14-16, 2019 (CHS) Aug 20-22, 2019 (KU)	3 consecutive days 2.1 CEUs	\$1,895

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Workforce Development to Narrow the Skills Gap

The skills gap and resulting labor shortage are topics we are all too familiar with as maintenance, reliability and physical asset management professionals. Studies have long forecasted this shortage as a result of turnover from the Baby Boomer generation. A factor that is often overlooked in understanding the gap is the decrease in educational opportunities for skilled trades, preventing a new generation from filling the gap.

I have seen the shift in education first hand. In the early 2000s, my sons were a part of Project Lead the Way, a joint engineering and trades program in high schools that worked on significant projects, including a rebuild of a Revolutionary War-era submarine in partnership with the Naval Underwater Warfare Center. Most of the students involved moved on to engineering, science and skilled trades. However, this program was the exception rather than the norm. While trade schools and community colleges have recently started extension programs to provide skills training and trade certificates, these are carried out primarily with the support of local businesses and are not widespread enough to address the global shortage.

SMRP has long recognized the growing skills gap and is constantly working to narrow that gap through our committees, government relations (GR) program, continuing education efforts, scholarships and student membership. Our GR team has placed significant effort into the Workforce Development committee and regularly meets with government officials to express the need for career and technical education (CTE). At the same time, several of our Board directors including Nancy Frost, CMRP, and Christopher Mears, CMRP, are working with universities and trade schools to support workforce development and spread awareness

of SMRP's Student Advancement Opportunities as well as additional training and certification they can receive via the Certified Maintenance & Reliability Technician (CMRT) program. Individual chapters are also vital in this fight, conducting local outreach and support of training programs and technical schools in their area.

While this issue may seem domestic in nature, our growing international membership has also expressed issues with the skills gap in their regions, leading to the global expansion of SMRP's Approved Provider Education Program (APEP). This program was initiated to provide and recognize training that encompassed the five pillars and components of ISO 55000. There are currently over 40 companies and organizations recognized as Approved Providers by SMRP.

Another key issue in addressing the growing skills gap is promoting continuing education for established practitioners and professionals. SMRP supports this effort annually through our educational offerings and annual events. This year's Symposium featured a keynote from John Smith, the President and CEO Select of FedEx Freight. He spoke on 'Casting Your Leadership Shadow: Empowering Supervisors to Reinforce a Culture of Safety and Reliability.' This excellent presentation explored the history of leadership during periods of change, including rapid expansion, acquisition and constantly changing safety and regulatory requirements. Smith did discuss the application of Internet of Things (IoT) devices and automation, including concerns surrounding driverless vehicles. Following the keynote were multiple tracks of outstanding information and presentations which offered excellent opportunities for continuing education.

Now that this year's Symposium is

FROM THE CHAIR

finished, it's time to look ahead to the 26th SMRP Annual Conference, which will take place in Orlando, Florida from October 22-25, 2018 at the Rosen Centre Hotel. The Annual Conference is an excellent chance to network with fellow members and narrow your own skills gap with over 60 track sessions, 30 workshops and five facility tours, covering everything from the Industrial Internet of Things to leadership skills. This year's opening keynote will be delivered by our honored guest, Captain Mark Kelly, Commander of Space Shuttle Endeavour's Final Mission. Kelly will discuss lessons learned from his time in the Navy, outer space and working with NASA. Facility tours will include the Kennedy Space Center, Disney, SeaWorld, the University of Central Florida and Lockheed Martin. As always, the networking opportunities with over a thousand of your peers will be outstanding. Registration is now open online at smrp.org/conference.

We'll see you at the conference!



Howard W. Penrose, PhD,
CMRP, 2018
SMRP Chair
President,
MotorDoc® LLC,
a Veteran-Owned
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Emerging Asset Management Skills for Today's Leadership

Tracy T. Strawn, CMRP, President of Energy Services, Marshall Institute, Inc.

Thomas J. Furnival, CPLP, Director of Training Services, Marshall Institute, Inc.

The Perfect Storm

Change is occurring at an unprecedented rate in industries around North America and the world. Technology is emerging and growing in almost all segments of manufacturing and process industries. These new technologies present challenges and opportunities unseen in previous years. With the rise of the digitalized plant and the Industrial Internet of Things (IIoT), the new skills required by the workforce change as fast as the old ones disappear.

Along with new technologies, there are new government laws, regulations and standards. In addition, many businesses are making corporate decisions to comply with or conform to new standards adopted by industry such as, ISO 9000, ISO 14001, ISO 31000 and ISO 55000. Educating the workforce to operate within these standards can create another hurdle for companies to overcome.

Even with these challenges, the forecast for the United States' economy is healthy according to key economic indicators. The global domestic product (GDP) growth rate is expected to remain between two percent and three percent, and

unemployment to continue at its natural rate. This should be good news for industry; in fact, it is so good according to the U.S. Bureau of Labour Statistics that there were 6.6 million job openings reported at the end of March 2018. That has led some industries to claim there are more job openings than qualified applicants. You may be well aware of this trend with openings at your own company.

In the face of rapidly changing technical, business and economic requirements, it comes as no surprise that the new skill sets required for today's workers are outpacing the current workforce's competencies. To compound this, according to a study conducted by the Society of Human Resource Management in 2015, approximately 27 percent of the workers in manufacturing are 55 years of age or older. Retiring baby boomers will only deepen the looming skill crisis.

According to studies, more than three-quarters of U.S. manufacturing plants are more than 20 years old. Many of these plants are facing decisions on whether to repair or relocate. With the current economy in a growth mode, relocating existing plants will be the most likely choice. The decision to relocate

and build a plant from the ground up, using the latest technology and standards, will most likely be driven by the sentiment: how can we do this faster, smarter and cheaper?

That brings us to the current trifecta of perfect storms: technology outpacing the skills and competencies of the present workforce, baby boomers on the verge of retirement and aging plants relocating and building to 21st century standards and requirements. The engineering discipline that this will have the most significant impact on is that of physical asset management, including those that are responsible for repairing and maintaining plant machinery and infrastructure.

The technical skills deficit is prevalent across most industries, evident in millions of open jobs across nearly all sectors. One area that is often overlooked, but has a massive impact on physical asset management delivery and execution, is the tactical and strategic management and engineering practices associated with that discipline. This includes the knowledge and competencies required for effective management at the supervisor, manager and executive leader positions.

The Changing Role of Leadership

Peter Drucker, an American management consultant, educator and author, said it best “The productivity of work is not the responsibility of the worker but of the manager.” If we believe that is the role of the manager, then the manager must have knowledge and understanding of what the workers perform that adds value to the business so he can enable them to be productive. The manager may not need to be as technically proficient as the workers, but they should have an understanding of what the workers do and how they interact with the business systems.

The knowledge level may vary depending on the level of management. For example, a maintenance supervisor may need a higher level of technical skills than a mid-level manager as he interacts daily with technicians and tradesmen. As we get closer to the shop floor, the skills of the manager or supervisor will be more tactical than the mid-level manager – tactics could be defined as the means to achieve an objective. An executive leader at a senior level in the organization, such as a director, would require a high-level understanding of the business systems, but his necessary skill set required would be more strategic and less tactical. Strategic skills could be defined as goal setting, planning and decision making that directs tactical execution. The mid-level manager would have a blend of tactical and strategic skills, but lean more towards a strategic skill set.

Based on our own observations of industry management practices, specifically those in the field of physical asset management, it's apparent that there is a lack of tactical and strategic skills in many facilities. Many of the people promoted into positions of management have a background in production or engineering, and perhaps they have the requisite people

skills developed over time as they have progressed through the organization. Nevertheless, in many cases those production or engineering skills may not translate directly to managing plant maintenance and reliability.

Asset Management – A Unique Role

The competencies and skills required to manage a plant's reliability and maintenance are somewhat different and may be more unique than other disciplines. They could be described as a blend of management or business processes and engineering practices. One skill that all levels of physical asset management can benefit from is an understanding of how all the processes and practices interact together. In other words, the manager should understand how parts work together to create value. The parts that make up this system are what those in industry call physical asset management.

One skill that all levels of physical asset management can benefit from is an understanding of how all the processes and practices interact together.

We have compiled a list of essential competencies and knowledge areas for asset management leaders. The focus is on the tactical and strategic skills required, beginning with supervisors up to executive leaders. The list is a representative sample of the critical, established and emerging competencies. Established competencies are those that are firmly entrenched in industry, while emerging competencies are those that will become more critical in the coming years.

There has been no attempt to define the level of skill required at each management level, but only to list the critical competencies required. The level of learning required by these competencies may vary based on the industry and the manager's responsibilities. It can be assumed, for example, that the supervisor, competent in condition monitoring, should be able to perform the task to a specific standard while his competence in budgeting would only require limited knowledge of a few specific terms and practices used by his company. Disciplined engineers and other specialized supporting professionals may require skills and competencies listed below but have not been included as they are outside of the scope of our focus. Although soft skills, such as communication and teamwork are equally important, the focus of this discussion is on the tactical and strategic areas required to be an effective manager in asset management.

Emerging Knowledge and Competencies

Emerging Asset Management Knowledge & Competencies	Supervisor	Mid-Level Manager	Executive Leader
Technology	<ul style="list-style-type: none"> • IIoT impact on the plant • Benefits and application of: <ul style="list-style-type: none"> ◦ Condition monitoring ◦ Sensors/Smart devices ◦ 3D printing ◦ Robotics/Automation • Application of management and change 	<ul style="list-style-type: none"> • The elements, benefits and challenges of IIoT • Benefits and challenges of condition monitoring • Data analytics • Data analysis • Decision making • Resourcing strategy and plans 	<ul style="list-style-type: none"> • The elements, benefits and challenges of IIoT • The digital asset management investment and expected return • Data analytics and analysis • Capital investment decision making
Regulations and Standards	<ul style="list-style-type: none"> • Understand the behaviours compliant with OSHA/or equivalent and company health and safety policies • Awareness of ISO 55000 • Supervise and coach teams' behaviours, where applicable, in alignment with: <ul style="list-style-type: none"> ◦ ISO 9000 ◦ ISO 14001 	<ul style="list-style-type: none"> • How to maintain compliance with OSHA/or equivalent regulations and standards • How to maintain compliance with company health and safety policies • The ability to re-design processes to support, where applicable: <ul style="list-style-type: none"> ◦ ISO 9000 ◦ ISO 14001 ◦ ISO 55000 ◦ ISO 31000 	<ul style="list-style-type: none"> • OSHA/or equivalent regulations and standards • Company health and safety policies • The business case for: <ul style="list-style-type: none"> ◦ ISO 9000 ◦ ISO 14001 ◦ ISO 31000 ◦ ISO 55000
Core Asset Management Skills	<ul style="list-style-type: none"> • Mastery of work management <ul style="list-style-type: none"> ◦ Planning ◦ Scheduling ◦ Execution • Application of reliability management: <ul style="list-style-type: none"> ◦ Conduct RCM analysis ◦ PM review • Understand the materials management spares strategy • Basic mechanical theory • Awareness of: <ul style="list-style-type: none"> ◦ Budgeting basics ◦ Scorecard review and decision making • Problem solving/Root cause failure analysis (RCFA) 	<ul style="list-style-type: none"> • Practical knowledge and application of: <ul style="list-style-type: none"> ◦ Work management ◦ Reliability management ◦ Materials management • Budget management: building, managing and optimizing • Scorecard review and decision making • Assessing asset management competency • Understand asset management plans 	<ul style="list-style-type: none"> • Understand the value of: <ul style="list-style-type: none"> ◦ Work management ◦ Reliability management ◦ Materials management • Strategic asset management planning (SAMP) • Policy development • Goals and objective setting and alignment with vision and mission • Scorecard review and decision making

A Roadmap for Upskilling

This is by no means a comprehensive list of knowledge areas and competencies; however, we believe these skills and competencies are critical to optimizing the value of physical asset management today. So the question remains: how you and your organization transition this list of competencies and knowledge areas into improved leadership performance and achievement of company goals? We suggest you consider the following areas:

Recruiting: While developing in-house expertise and promoting from within is ideal, there may be instances where it is appropriate to recruit from outside the company. Recruiting outside can bring in fresh talent with new ideas that will spur new ways of working, challenging the status quo. Once you've decided which competencies are vital for your asset management success over the next five years, partner with your human resources team to ensure that the competencies, knowledge areas and character qualities are added to job descriptions. Once this is achieved, you'll be more prepared to find talent to support successful execution of your physical asset management strategy. If you require outsourced support and guidance, help to attract and hire the best resources —there are resources available in the marketplace, just ask your favourite online search engine.

Assessing Competency: Training and development delivers the best return when it improves meaningful competencies and knowledge areas. A great way to ensure a return on your training investment is to close known and important competency and knowledge gaps. You can identify such gaps by conducting an asset management competency assessment. If you don't have an assessment tool, consider either developing one internally or with external guidance. A training and development team will no doubt be eager to support preparing for and conducting a competency assessment.

Training and Development

Once competency and knowledge gaps are known, you can credibly prioritize the gaps you will close first through education and training. To upskill your existing asset management talent, you should select, curate and provide the appropriate information, education and training resources. Again, in an ideal world this would be done in partnership with a training and development department. As we continue to experience incredible shifts in relevancy with regard to competencies, it is important to keep an up-to-the-minute library of education and training materials.

Succession Planning: Now that qualified leaders are hired and existing leaders have upskilled, you are in a strong position to enhance your succession planning tools and process. This is an ideal arena to engage many experienced and qualified soon-to-be retirees. Their knowledge and experience is priceless and should be passed down to the next generation of leaders. If you

aren't already actively engaged in such a process, consider the following tactics: conducting structured on the job training (SOJT), building job aids, document processes and procedures and building training programs for the initial content that will be built into training programs.

In the face of rapidly changing technical, business and economic requirements, the list of skills and competencies required by physical asset management professionals will only continue to grow and progress.

Conclusion

As industry grows and evolves, the demand for skilled and competent physical asset management professionals will grow as well. Companies can no longer rely on managers whose competence is tied to the fire-fighting maintenance philosophy.

In the face of rapidly changing technical, business and economic requirements, the list of skills and competencies required by physical asset management professionals will only continue to grow and progress. Companies must train and develop their physical asset management leaders or risk being left behind or worse, out of business. Organizations that evolve, change and develop their physical asset management professionals and leaders are those that will prosper and grow in 2018 and on into the next decade.

Alexandria Renew Enterprises -

Building The Workforce of The Future

Steve Hill, CMRT, ENV, – Alexandria Renew Enterprises

Wendy Callahan, CBP, CCP, PHR, WLCP – Alexandria Renew Enterprises

David Brewster, MBA, CMRT, CMRP – Alexandria Renew Enterprises

Alexandria Renew Enterprises (AlexRenew) is a water resource recovery facility located in the heart of Alexandria, Virginia. AlexRenew is recognized as one of the most advanced water reclamation facilities in the nation. Implementing and sustaining cutting-edge technology, such as the systems and processes utilized at AlexRenew requires a dedicated and highly-skilled workforce.

As with any organization, hiring and cultivating skilled workers is a challenging proposition, but within the Washington D.C. area, it is even more difficult. This is due to a lack of heavy industry, few local trade schools and heavy regional competition. For these reasons, and the fact that 60 percent of AlexRenew's skilled labor force is nearing retirement, AlexRenew chose to implement their own apprenticeship training and development program.

This article discusses the initial work and coordination required to establish an apprenticeship-training program for three distinct trade groups: operators, mechanics and control systems technicians. It also covers the implementation process, development and certification of each trade group.



Building a Program

Under a citizen-appointed Board of Directors, AlexRenew's human resources (HR) department implemented an apprenticeship-training program through a partnership with the Virginia Department of Labor and the state's Registered Apprenticeship program.



Registering the apprenticeship program with the state agency ensured working apprentices, employers and the public would be able to gain a clear understanding of the training content and ongoing quality of the program. Another advantage included the availability of funding through program grants that support the cost of classroom instruction.

After establishing partnerships with state agencies, AlexRenew's worked with the trade teams and Human Resources department to develop a program manual that detailed the apprenticeship policies and procedures. The Commonwealth of Virginia approved the program manual and AlexRenew became a registered apprenticeship sponsor in 2013. Since then, AlexRenew has actively hired and developed five apprentice groups, also known as cadres.

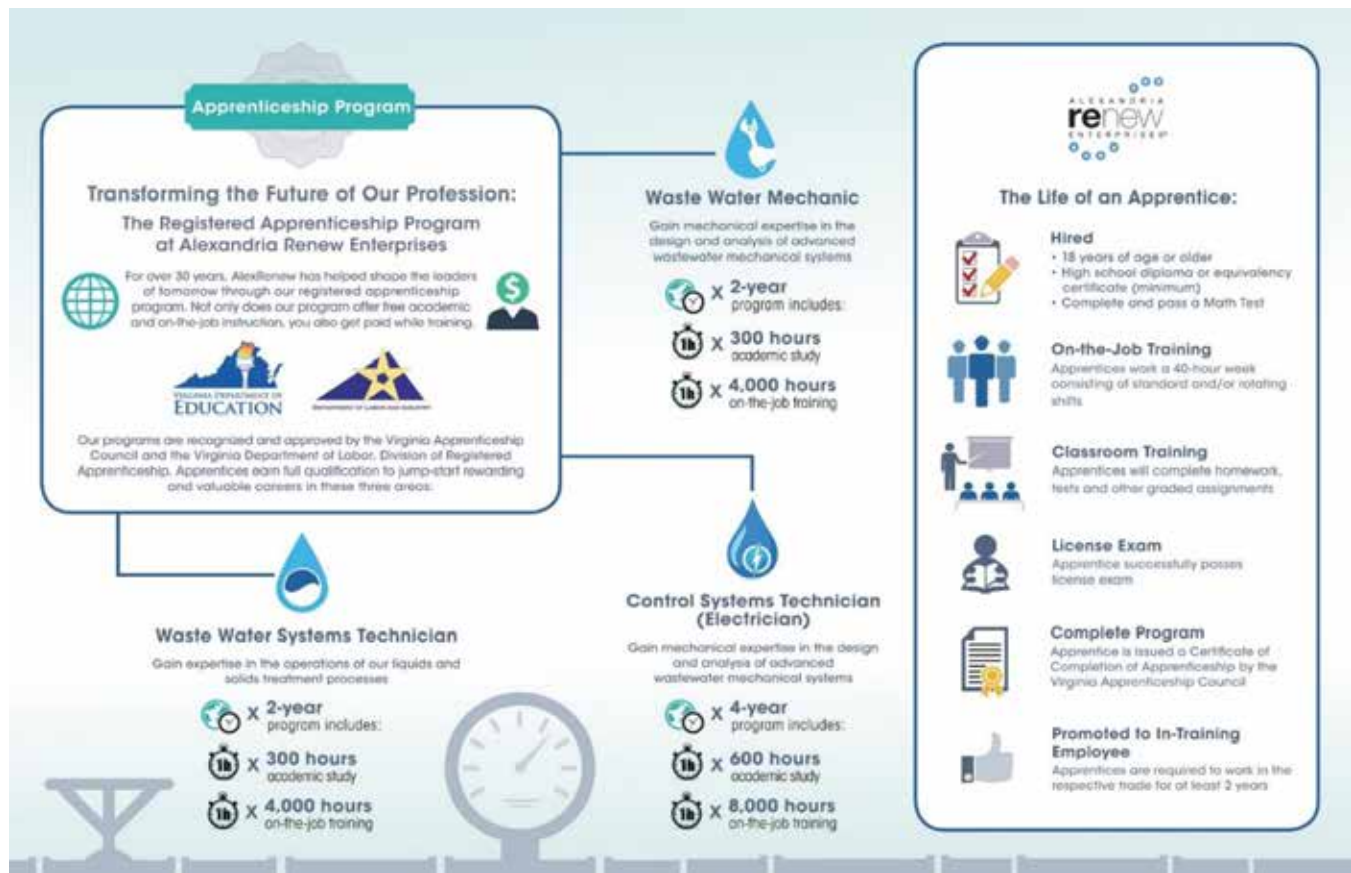
Once the program manual was completed and approved, AlexRenew developed curriculum in partnership with the Virginia Community College System (VCCS), electing to pursue three separate trade groups: operators, mechanics and control systems technicians. The curriculum for control system technicians followed the four-year electrical apprenticeship



training requirements from Fairfax Adult and Community Education Centers (ACE); the wastewater mechanic curriculum was developed as a hybrid-training program, combining the curriculum provided at Fairfax ACE with onsite training; and the wastewater operator curriculum was with the Maryland Center for Environmental Training. Each program requires a minimum of 150 hours of annual classroom instruction.

Developing on-the-job training (OJT) requirements was the last step to finalize the program structure. AlexRenew utilized its own subject matter experts (SMEs) to develop an OJT model. The SMEs included licensed operators, industrial electricians, instrumentation technicians and senior mechanics/mechanic supervisors. The program currently requires each operator and mechanic apprentice to complete 2,000 hours of OJT, and each control systems technician to complete 4,000 hours of OJT. The hours spent in training are sub-divided into several categories. Front line supervisors or department managers verify hours that are logged daily. The apprenticeship coordinator (a department-designated supervisor) maintains records as part of the verification process and documentation of program completion.





Program Implementation, Management and Certification

At this point, AlexRenew had an approved apprenticeship training program with the state of Virginia, defined program manual, schedule outline for classroom activity through local community colleges and an OJT structure for documenting work activity. Before implementation, program coordinators also recommended identifying leaders within each of the trade groups to serve as mentors for new apprentices. Mentors are paired with apprentices, and staff focuses on identifying OJT activities – preventative maintenance (PM), predictive maintenance (PdM), and corrective maintenance tasks – that are aligned with program objectives.

The diagram above provides an overview of the apprenticeship training programs offered at AlexRenew.

Certification

The goal of these apprenticeship-training programs is to achieve complete licensing or certification. Licensing programs already existed in the state of Virginia for the operator and control systems technician programs, while the maintenance mechanic program required additional research to identify a nationally-recognized program aligned with AlexRenew's expectations.

The following breaks down the licensing and certification requirements for each trade group:

Operators Technicians: The wastewater operator apprenticeship program includes state licensing through the Department of Professional and Occupational Regulation (DPOR), which identifies specific training requirements for the licensing in Virginia. The AlexRenew program requires level progression and licensing to Level 1 before being considered fully qualified. With the exception of employees in the apprenticeship program, all operator technicians must meet Level 1 qualification requirement.



Control Systems Technician: Upon completion of the state-sponsored program, control system technicians are automatically eligible to sit for the Virginia Journeymen Electrical (JE) license exam. The JE license is also the AlexRenew certification requirement for the control systems technician role. With the exception of apprentices, all control systems technicians at AlexRenew are licensed JE licensed.



Maintenance Mechanic: AlexRenew selected SMRP's certification program – Certified Maintenance & Reliability Technician (CMRT) – as the primary qualification requirement for all mechanic apprentices. The CMRT “assesses the knowledge and skills of those responsible for preventative, predictive and corrective maintenance.” The CMRT aligns with AlexRenew's strategic vision and goals identified within the wastewater mechanic apprenticeship-training program.



AlexRenew implemented CMRT certification as a requirement for all maintenance mechanics, first testing the certification process with current mechanics as a means of setting an example for apprentices. The first round of testing resulted in a 50 percent pass rate. The goal was to achieve 100 percent certification, so AlexRenew established study groups led by CMRT-certified mechanics to better prepare our mechanic team members for the next series of tests. After each round of testing, the success rate climbed and AlexRenew soon achieved its goal of 100 percent certification by all mechanics and apprentices.

AlexRenew believes in building and retaining talent, and is committed to building the workforce of the future today. The apprenticeship-training program at AlexRenew is a great

example of how an innovative organization can develop the workforce it needs today while ensuring that it creates the workforce of the future.

References:

“About Certification: CMRT Certification,” Society of Maintenance and Reliability Professionals, accessed May 10, 2018, <https://www.smrp.org/certification/cmrt-certification>.

“About Funding through Program Grants,” “The Virginia Registered Apprenticeship Program, accessed, May 9, 2018, <https://www.doli.virginia.gov/apprenticeship/registered-apprenticeship.html>.



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A background image of a blue industrial robotic arm in a factory setting. Overlaid on the image are semi-transparent circular graphics containing icons: a gear, a wrench and screwdriver, and a laptop with a wrench icon.

Maintenance Training, A Holistic Approach

Lee McClish, CPM, CMRP, Reliability Engineer, RagingWire

Investing in people should be the mantra of every maintenance department that wishes to be effective. Human capital must be invested in and treated with high priority. So why do some organizations choose not to make this investment? Typical reasons may include a limited budget, not enough time to invest in mentoring, or the fear that once technicians are trained they will leave for higher wages and greener pastures. Whatever the reason, a maintenance department cannot be effective without highly-trained technicians with the right skill sets.

How to get started

The first hurdle is obtaining management support. The case must be made using examples of equipment downtime that could have been avoided or reduced by having the proper skills in-house. Hiring outside assistance takes time and is usually very costly on an unplanned basis. Next, a training program needs to be created, written and circulated among

the technicians for input and approval. The following are key aspects of an effective training program:

- 1. Survey equipment and required skills needs** This includes the mechanical maintenance required, as well as electrical maintenance-related areas like power distribution, controls, electrical drives and programmable logic controller (PLC) programs. The decision needs to be made regarding which tasks will be done internally versus externally. A spreadsheet should be filled out listing each drive and PLC manufacturer with which each program is running.
- 2. Survey internal skills** One method is using a matrix that includes required skills such as welding, hydraulics, pneumatics, bearings, gears, couplings, reading schematics, electrical fundamentals and troubleshooting. Any skill required internally should be listed. A scale should be used to document the desired level from a trainee to a master level.



3. Prioritize formal training This ensures a solid foundation of fundamentals are established, supporting the required skill levels desired. Check with local community colleges and find out what certificate and degree programs are available. There are national maintenance skills exams that the college can proctor to provide insight on any gaps. This input will help choose which courses are needed.

4. Create individual training plans These plans must be created by sitting down with each person, understanding their goals and interests, and balancing those with the department's goal to improve the overall skill base. There can be incentives such as pay increases after achieving a certificate, earning a degree or demonstrating a competency. These will most likely need to be negotiated in union plants.

5. Create an external school schedule This should be created to ensure each desired skill is planned. Original equipment manufacturers (OEMs) often have specific equipment

classes on various aspects of maintaining their equipment. These need to be factored in with PLC, drive schools and local community college courses.

6. Establish an internal training plan This includes on-the-job training (OJT) done by the Train the Trainer model, or a senior technician willing to share his or her knowledge with future generations. There are many fundamental maintenance training programs available on digital media, as well as web-based programs that can be used for junior technicians or anyone wanting to learn more in a specific area. This plan should include how many hours will be allotted every week per person to upgrade skills.

7. EXECUTE, EXECUTE, EXECUTE Your genuine excitement is the key to this venture being successful. It is not a "program of the month." It has to become a culture and on-going expectation at all levels.



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Once a training program has been established, ensure that it targets all ages and styles of learning to be effective. Hands-on is often the best maintenance training, but some theory is necessary for conceptual understanding. Ensure internal personnel conducting the training not only impart the knowledge of the correct techniques, but also verify trainee comprehension, otherwise negative training can occur. Consider meeting with each technician on a recurring basis to check how they feel their training is building their skill base.

The following are best practices I've found to solidify a training program:

- **Create skills checklists for each skill listed in the matrix.**

Each skill should reflect a progression of mastering that skill. Skills checklists take a lot of work to create, but they remove the guess work in acquired-skills assessment. This method serves as solid evidence that the skill has been mastered, rather than a feeling, and can be tied to a promotion. An effective assessment evaluates theoretical knowledge as well as practical demonstrations of competency. Consider using work orders to document completion of practical factors. The following is an example in regards to bearings:

a. Level 1 – What is the purpose of a bearing? What are the types of bearings we use in this plant?

b. Level 2 – Show how to utilize a bearing cross-reference manual. Describe the application for various types of bearings.

c. Level 3 – Describe the common bearing to shaft fits. Demonstrate proper bearing replacement techniques. Replace common bearings in the plant, including an interference fit.

d. Level 4 – Specify a suitable replacement bearing based on expected loading.

- **Schedule the electrician group to receive machine-specific training weekly.** Start in the classroom, going over schematics to ensure understanding of symbols, purpose of the logic and sections of the machine. Then take the schematics machine side and identify the various electrical components, control boxes, limit switches, etc. Lastly, schedule a session where a trouble is inserted and each person troubleshoots the problem. For more technical skills, create a training board using a spare PLC, drive or hydraulic system to allow off-line learning or troubleshooting.
- **Set up on-site OEM training on vital equipment.** This will most likely save money with less traveling expenses and ensures specific equipment training in regards to field changes, model specifications, etc. is taught. This method also allows direct interaction with specific machine components that are covered in the classroom. Consider

inviting a sister plant with similar equipment; you may be able to charge them a small fee to offset the cost of training. The best aspect of this is the synergy of sharing common problems between plants and learning from each other.

Once a training program has been established, ensure that it targets all ages and styles of learning to be effective.

- **Research availability of state or local grants.** These are often available for employees learning a craft. I was personally able to capitalize on \$27,000 over two years to upgrade our technicians' fundamentals.
- **Explore vendor-provided training opportunities.** Vendors such as Motion, Grainger, Fastenal and others often cover fundamental industry topics for low or no cost. Typical topics include fasteners, roller chains, belts, slings, bearings, hydraulics, Loctite and fuses. Everyone will learn something. I had a 40 year veteran tell me he learned something after a roller chain discussion. Don't forget the donuts!
- **Review the gaps.** Look for training that your contractors can provide for a minimal cost. Some examples include steam boiler contractors, boiler chemistry representatives, air compressors, welding by local machine shops, pipefitting or electrical contractors on National Electrical Code (NEC).
- **Investigate organization-developed tools.** The packaging industry has the Packaging Machinery Manufacturers Institute (PMMI) from The Association for Packaging and Processing Technologies. They provide certificates in packaging-oriented mechatronics as a resource.

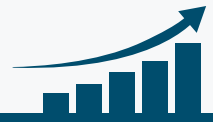
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- **Get it in writing.** Before sending someone to external training, ensure you have a written agreement of what they plan on learning and how it will be applied at the plant. It is incumbent upon the supervisor to allow time and create opportunities to reinforce that knowledge gained or it will decay quickly.
- **Provide detailed-written materials to new hires.** Create a list of industry terms, including types of machines with the purpose of associated assemblies, to use for on-boarding of hired employees new to the industry. This should supplement any established new hire training.
- **Establish local cooperative education partnerships.** A great pool of talent can be hired through cooperative education partnerships with local community colleges. It gives you a chance to evaluate them as they evaluate you. After graduation, they can step right in, ready to contribute versus hiring someone from the outside.
- **Consider reliability programs.** Reliability programs such as root cause analysis, trusted platform module (TPM), predictive maintenance (PdM), lubrication, mean time between failures (MTBF) and failure mode and effects analysis (FMEA) may be beneficial. There are many great resources from organizations like SMRP.

Sustaining a training program

The following are best practices I've found to sustain a training program:

- **Hiring the right skills from the beginning is key.** Ensuring all jobs have detailed job descriptions can promote hiring the right personnel, determine gaps and provide input for individual training programs. Consider using the same national maintenance skills exam to assess possible new hires. This is a great way to validate what people tell you during an interview.
- **Don't forget to stress the fundamentals.** Use plant examples where the result weren't what you had hoped for and brief the department on where there are opportunities to improve. These can include proper rigging, aerial boom lift usage, correct bearing pulling techniques, resources for applying PdM technologies and evaluating PM tasks for value adding. Annually, include computerized maintenance management system (CMMS) training for maintenance and production.
- **Create subject matter experts (SMEs).** SMEs provide their expertise on various maintenance practices and equipment maintenance. This creates ownership and develops pride within the department. It also creates a Train the Trainer program for technicians to gain higher level skills and extend that knowledge to others, increasing the knowledge and effectiveness of the department.
- **Be watchful for current trends on the best training techniques.** There are numerous webinars and online videos on most maintenance activities. Additionally, push OEMs to provide effective training resources.
- **Start the New Year with a gap analysis.** Before each year starts, a gap analysis should be conducted for new equipment, identifying gaps not fully closed the year before. Each individual training plan should be reviewed and updated to raise the skill level of every maintenance person. Then, the department training plan should be updated to start the New Year on the right foot.
- **Fill holes with a tuition assistance program.** If skills don't exist internally, push management to adopt a tuition assistance program for those who desire to pursue a degree and enhance their career opportunities. Also ensure the training or school time is paid time for motivation.
- **Be a proponent of STEM programs.** Work within the community to educate young people on how necessary technology is for creating goods. Reach out to local high schools and joint vocational schools to provide education and leadership.
- **Create meaningful Key Performance Indicators (KPIs).** As with any worthwhile program, create one or two meaningful KPIs to show the impact training has on continuous improvement towards a world class operation. This should ensure continued management and technician support.



Learning is a life-long adventure. Enjoy it!



Knowledge Management

Under The Asset Management Framework

Manuel Lombardero, MBA, CMRP, Maintenance Manager, AES Corp

As companies are focusing strongly on asset management, the question arises as to what are the limits of the asset management program and if it will work to go beyond the management of physical assets. Let's explore the management of one of those non-physical assets – knowledge.

Knowledge as an asset

The ISO 55000 Asset Management Standard is intended primarily for managing physical assets; however, it has opened a door that didn't exist with its predecessor, PAS 55 – the British Asset Management Standard that fueled the asset management revolution. The PAS 55 limited its scope to the management of physical assets and only refers to other asset types as long as they interact with the management of physical assets. The ISO 55000, on the other hand, states that its principles can be applied to other asset types, leaving room for the exploration of applying well established asset management principles to things beyond our grasp, the intangible assets.

Assets are defined by the ISO 55000 as those things that have “potential or actual value to an organization,” dividing assets into tangible and intangible. Under that definition, it is easy to argue that knowledge is an asset and as such, asset managers need to control it so that the organization can realize value from it.

Knowledge is an asset and as such, asset managers need to control it so that the organization can realize value from it.

The knowledge lifecycle

If knowledge is an asset, then it is valid to manage it using an asset lifecycle management approach to realize its full value. This is in fact part of the premise of the draft ISO 30401 International Standard for Knowledge Management Systems Requirements which is currently under development. According to both the ISO 55000 and the draft ISO 30401 standards, there are four different stages of the asset lifecycle that should be taken into account: acquisition, utilization, retention and disposal. Without this lifecycle approach, it becomes all too common for organizations to concentrate on only the first stage of the lifecycle by identifying a knowledge gap and acquiring new knowledge to close it. This does little to assure that true value is obtained from newly acquired knowledge.

Let's further explore the four stages of the knowledge lifecycle:

Stage 1: Acquiring New Knowledge

In this stage, a company identifies what knowledge needs to be acquired. Companies will hire consultants and trainers, develop personnel qualification standards and send employees to different schools and seminars. Just like when you acquire a new piece of equipment, this is the stage where the biggest expenditure is made. Upper management will tend to see this not as an investment but rather as an expense, and that makes sense because from an accounting perspective, it is an expenditure.

Justifying the training expenditure is sometimes challenging for supervisors. While there are several approaches for identifying knowledge needs, a key component for successful training is

to ensure that it is aligned with organizational objectives. I will focus on one technique I have found particularly effective, as it lines up with my company's mission and heavily involved the human resourced department: Job Description versus Current Individual Employee Skills. This is a form of gap analysis for assessing and justifying training needs. For it to be effective, it is critical to have accurate, relevant and detailed job descriptions that are based on the company's needs. At the beginning of this process, the company identifies the functions required to be able to attain its mission and objective. A list of functions is then derived from those needs and assigned to current job descriptions, or to a new set of job descriptions altogether. Employee assessments can be made to determine where the gaps are.

Here is a practical example. The corporation decides that part of its operating strategy is to pursue ISO 55001 certification. This will have an impact throughout the organization that affects many different job roles. Your maintenance department may decide to support the asset management strategy by implementing condition based maintenance (CBM); this in turn will lead to the implementation of a vibration monitoring program, which will lead to the modification of select job requirements, illustrated in the following chart:

When job descriptions are aligned with company objectives, all related training will also be aligned with the company's mission and will be easier to justify.



Stage 2: Utilization of the Knowledge

For the recently acquired knowledge to generate value for the organization, it must be applied and put into practice. This means some things in the organization should change after the training is conducted. Besides helping to utilize newly acquired knowledge, these changes will also lead to new learning. This stage will inevitably tie in with the last phase of the knowledge lifecycle, which is retiring obsolete knowledge.

Depending on the knowledge that was acquired, utilization will be reflected in modification to procedures and manuals, creation of new programs, purchase of new equipment and better use of existing equipment. It is important to keep track of what changes are applied after the training is complete so that the benefits can be measured. There is a very useful SMRP metric related to this area – the Maintenance Training Return on Investment. To calculate this metric, you will need to translate the changes that occur after the training into cost benefits. Determining this metric is worth the effort as it will prove that training in maintenance is indeed an investment.

Stage 3: Retaining Current Knowledge

There are two aspects to knowledge retention, one is retaining the person with the knowledge and another is retaining the knowledge itself. While employee retention is fundamental for and organization's success, it is never a guaranteed strategy. The best insurance to prevent knowledge leaving with employees is to have a solid knowledge retention plan. Here are some knowledge retention techniques:

- **Codify the knowledge:** document all relevant information, equipment history, failure analysis and solutions. Develop solid operations, maintenance procedures and manuals. Review them periodically.
- **Create a “see one, do one, teach one” culture:** this saying comes from the medical profession and it's the notion under which doctors and nurses have been transferring knowledge for a long time. Encourage your employees to share knowledge and learn from each other.
- **Implement knowledge exchange programs:** this includes programs such as mentoring and job rotation.

Stage 4: Managing Invalid Knowledge

Just like other assets, knowledge will age and become obsolete. In reality, there are very few cases where knowledge is simply retired and not replaced with anything else. Most of the time, knowledge is either updated or replaced with new knowledge. This makes the managing of invalid knowledge very closely related to other phases of the knowledge lifecycle. It is important to highlight that for most real-life cases, the retirement of invalid knowledge does not begin with the acquisition of new knowledge but rather with the utilization of the new knowledge.

Knowledge that is codified in your procedures and manuals should be periodically reviewed and validated as it is easy to delete invalid knowledge that is codified. Having employees unlearn invalid knowledge is rather challenging because our human nature doesn't allow us to forget at will. The best path is to help them replace that knowledge with new information and relearn rather than unlearn.

In Conclusion

Actively managing knowledge should be an important part of the asset management strategy. The lifecycle approach is gathering strength as a technique to ensure that knowledge is properly selected, utilized, retained and retired so that maximum value can be realized from it.

References:

ISO/DIS 30401:2017 Draft - Knowledge management systems — Requirements

ISO 55000:2014 - Asset management — Overview, principles and terminology.

SMRP Maintenance and Reliability Metrics 4.2.3 – Maintenance Training Return on Investment (ROI)



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CHAPTER NEWS

April 17, 2018 – In the early morning of Tuesday, April 17th, the Strategic Air Command and Aerospace Museum (SACAM) held still in the early daylight. The museum was temporarily quiet, but in just a few hours, the museum would be bustling with activity. Fast forward to 7:30 a.m., as guests were about to arrive. Board members and volunteers of the Nebraska-Iowa (NE/IA) SMRP Chapter were arriving and preparing for the day's festivities. Banners were hung by vendors, nametags were handed out and other miscellaneous business was cared for. By 9:00 a.m., over 100 people had arrived at the museum and the chapter event was officially underway.

The 4th Annual NE/IA Chapter Event was highlighted by presentations, vendors and comradery. The day started with chapter chair, Dennis Uhl, giving a brief overview on the work that the chapter has been doing, including partnering with local colleges in the Nebraska and Iowa areas. Larry Hoing, the chair of the Board of the Directors, also addressed the benefits of becoming an SMRP member.

After the opening addresses, the attendees could choose between two tracks of sessions to attend. Between the two tracks, there were four sessions in the morning and four sessions in the afternoon. The sessions covered the following topics:

- **Operations Deflection Shape (ODS) Overview and Case Studies:** the use of ODS to perform advanced diagnostics of vibration and noise using the animation of vibrational patterns
- **Developing Quality Key Performance Indicators:** the process of finding key performance indicators (KPI) that add value and drive improvement
- **Proper Electrical Grounding:** the proper way to ground instrumentation to reduce noise while adhering to and improving upon the National Electrical Code (NEC) standards
- **Developing a Business Case for Management:** how to properly develop a vision and lay out the benefits of potential project
- **Alignment/Thermal Growth:** how to align a shaft and how thermal growth affects the accuracy of alignment
- **Doing Good Planning and Scheduling:** best practices for affective planning and scheduling
- **Internet of Things (IoT) and Data Science:** how IoT and data science are driving improvement and how they are used

- **What Community Colleges Can Offer for Skills Development:** how community colleges prepare their students to be successful for technical careers

In between sessions and at lunch, attendees were also given the opportunity to interact with vendors and explore the SACAM. The vendors setup booths in the main room and were available for hands on demos, best practices and general industry discussion.

After the sessions completed, the day ended with members of the NE/IA SMRP Chapter gathering to have a chapter meeting. The day's events were discussed and board elections were held. Overall, the event was a success and the chapter is planning on hosting the event at the Strategic Air Command and Aerospace Museum again next year.



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We look forward to working with you in 2018!



GOVERNMENT RELATIONS *UPDATE*

Career and Technical Education is Key to Closing Skills Gap

Career and Technical Education (CTE) is important to ensuring that tomorrow's workforce has the skills and training needed to succeed in an ever changing global economy.

According to the Association of Career and Technical Education (ACTE), half of all STEM jobs call for workers with less than a bachelor's degree. Jobs that require more than a high school diploma but less than a four-year degree account for 54 percent of U.S. labor market, but only 44 percent of the country's workers are trained at that level, according to the National Skills Coalition (NSC).

While more than half of employers are reporting a talent shortage, CTE programs are preparing a pipeline of workers that possess the technical competencies and workplace skills to succeed in the most in-demand areas, including information technology and skilled trades.

SMRP is supportive of policies and legislation that increase access to high-quality CTE. For example, the Carl D. Perkins Career and Technical Education Act Perkins is the primary federal investment in our nation's CTE system that recognizes the importance of aligning training with the demands of today's business and industry. SMRP is working to ensure that the Perkins CTE Act continues to be supported to sustain the next generation of maintenance, reliability and physical asset management professionals.

In June, SMRP signed onto a coalition letter along with 400 businesses and educational communities to advocate for the Senate to take swift, bipartisan action to reauthorize the Senate's Strengthening Career and Technical Education for the

21st Century Act, a bill to reauthorize the Perkins CTE Act. By July, U.S Senate Health, Education, Labor and Pensions (HELP) Committee approved the draft bill to reauthorize the Carl D. Perkins Career and Technical where it will move forward in the legislative process to the full Senate.

SMRP is dedicated to fostering the next generation of practitioners and professionals through CTE. We encourage you to get involved and collaborate with educational institutions in your local communities, and even at the state and federal level, to make a tremendous, lasting impact on the workforce available to you.

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SMRP is dedicated to fostering the next generation of practitioners and professionals through CTE.

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SYMPOSIUM *RECAP*

Memphis Plays Host to the 2018 SMRP Symposium

This past June, SMRP held a memorable SMRP Symposium in Memphis, Tennessee. Tennessee's second largest city, Memphis is home to many companies from the manufacturing and transportation industries, which made it a perfect choice to hold an event for maintenance, reliability and physical asset management practitioners and professionals. This event hosted more than 130 attendees over two days at the iconic Memphis Pyramid.

The 2018 SMRP Symposium opening keynote featured a local – incoming FedEx Freight President and CEO John Smith – whose presentation, “Casting Your Leadership Shadow: Empowering supervisors to reinforce a culture of safety and reliability,” told the story of his experience at FedEx Freight. He explained how managing a “safety above all” approach in any business has to start with senior leaders and top management. His presentation described the new, advanced technologies FedEx Freight implements to drive safety improvements with FedEx Freight. Under his leadership as SVP of Operations, FedEx Freight has successfully adopted technologies that improve safety and efficiencies, which includes compliance with the federal electronic logging device mandate. Before closing, he stressed the importance of focusing equally on people, service and profit to ensure a safe, efficient and reliable organization.

After the opening keynote, the event broke out into track sessions led by expert SMRP members who gave their session attendees key insights to help them develop best practices and new skills to take back to their facilities. All of the track sessions followed the five pillars of the SMRP Body of Knowledge and included presentations on implementing industrial internet of things (IIoT), hiring and managing the right people, plus skills needed for the next generation of practitioners and professionals.

Wednesday concluded with a panel discussion on how to communicate the business case for maintenance and reliability to decision makers and those colleagues outside of the reliability team. This discussion featured prominent SMRP members including Bruce Hawkins, CMRP, CAMA, Shon Isenhour, CMRP, CAMA, CCMP, Ramesh Gulati, CMRP, CMRT, CAMA, and Vlad Bacalu, CMRP, CAMA. They answered questions from those in attendance and gave their expert advice on how to approach the top levels of any organization with the value of a sound reliability program. This is an area where many maintenance, reliability and physical asset management practitioners and professionals struggle, as knowing the value of a sound reliability program and communicating that value are two different hurdles to overcome.

After the closing panel discussion, it was time to participate in workshops and three facility tours that highlighted some of Memphis' most prominent companies. Attendees took part in the FedEx Express Experience Tour at the FedEx Express SuperHub near the corporate headquarters. Those on the tour learned about the day-to-day happenings within the hub and the almost 30 onsite maintenance facilities. The tour guides explained how in 24 hours, there is never a moment that a FedEx plane isn't transporting freight. In any given year, FedEx Freight carriers log enough driving time to go to Mars and back seven and a half times.

Memphis is also home to International Paper's headquarters, the largest pulp and paper company in the world, employing 55,000 employees. Tour attendees took a short trip to Olive Branch, Mississippi, to the International Paper Corrugated Box Plant, where they learned about the corrugated box-making processes and the facility's best practices that add to the company's reputation as the world's leading producers of fiber-based packaging, pulp and paper. The final tour took place at DuPont's Soy Protein Isolate Production Facility and explored the facility's equipment and maintenance programs. The tour guides discussed DuPont's use of predictive maintenance technologies such as vibration, lubrication, motor maintenance and thermal imaging.

A big thanks goes out to all of the attendees, companies, presenters and city of Memphis for helping SMRP put on an incredible SMRP Symposium. Stay tuned for information later this year on the next Symposium event!



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IN THE SPOTLIGHT

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trained since 2005, and thousands more through Mobius e-Learning products. Mobius Institute Board of Certification is an ISO/IEC 17024 and ISO 18436-1 accredited certification body that provides globally recognized certification to reliability professionals, vibration analysts, ultrasound analysts and thermal imaging specialists. Additionally, Mobius further contributes to the condition monitoring industry by hosting the International Machine Vibration Analysis and Condition Monitoring (IMVAC) conferences and website, CBMConnect.com. Mobius Institute has offices in Australia, Belgium, Costa Rica, India and the United



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Introduction to Planning & Scheduling Principles	2	Designed to provide an understanding of the fundamentals of creating and maintaining an efficient planning and scheduling program.
Advanced Maintenance Planning	4	An intensive course designed to simulate real-world situations and teach participants how to effectively execute the planning function.
Materials Management Strategies	3	Learn how to manage, organize and control inventory risk through strategic MRO inventory management.
Reliability Centered Maintenance (RCM) Principles	2	Covers all important aspects of RCM Analysis and Implementation. Learn how to effectively participate in an RCM program and implementation.
The Reliability Game®	1	The Reliability Game® is designed to teach participants to make the transition from a reactive to a proactive maintenance environment. You will follow the money to discover the business potential of reliability, including financial opportunity.
Foundational Awareness for Maintenance & Reliability Professionals	4	A comprehensive overview of key elements, which must be understood and integrated to be most effective in the maintenance and reliability profession with the basis of the course structured on the SMRP Body of Knowledge (BOK).
Fundamentals of Vibration Analysis	2	Overview seminar for those with no prior experience in vibration analysis. Students learn about causes of vibration, methods of measurement and prepares the participants for the Basic Vibration Analysis Training Course.
Basic Vibration Analysis, Category I Intermediate Vibration Analysis, Category II Advanced Vibration Analysis, Category III	4 (Each course)	These courses comply with Category I, II & III Vibration Analyst per ISO standard 18436-2: Covering vibration condition monitoring and diagnostics, measurement techniques, instrumentation set-up and interpretation.
PeakVue Mystery and Autocorrelation	3	This course provides insight into advanced functionality of Emerson's unique PeakVue™ technology and Autocorrelation.
IR Thermography Level I (with Certification Exam)	3	This class is intended for personnel who have limited or no experience in infrared thermography analysis and diagnostics. Successful completion of the course and passing of optional examinations may lead to Level I or Level II certification.
Lubrication Level 1 & Level	3	This course is designed for individuals who have limited or no oil analysis experience. Guidelines and instruction for starting an oil analysis program will be provided. The course focuses on the basic properties of lubricants and lubricant specifications including additive packages.
Wear Debris Analysis Workshop	2	Wear debris analysis is often referred to as the most important form of oil analysis. This course teaches how to apply conditions such as the environment and other outside factors to make an accurate root cause analysis.



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