# Lifting the veil from condition-based maintenance



## Expert interview with Dr. Abdel-Moez Bayoumi, Director of the Center for Predictive Maintenance

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*By Lauren Burakowski*

The Facilities Forum's Michael Fischer sat down with Dr. Abdel-Moez Bayoumi, the Director of the Center for Predictive Maintenance at the University of South Carolina, for an exclusive Q&A about condition-based maintenance and what it means for the future of maintenance in higher education.

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Dr. Abdel-Moez Bayoumi is a professor of mechanical engineering and biomedical engineering and the Associate Dean of the College of Engineering and Computing at the University of South Carolina. The Center for Predictive Maintenance hosts a versatile facility for testing aircraft components and supports the adoption of the condition-based maintenance (CBM) paradigm within the U.S. Army Aviation community.

**Q: Thanks for taking the time to speak with us. Let's start with a basic question: what is condition-based maintenance?**

*Bayoumi:* Condition-based maintenance (or CBM) is a process to maintain systems based on the actual usage and the health of the components. It involves tracking faults in a system, translating the condition of faults into a health status for each part, and customizing maintenance to the condition of the fault.

**Q: How does CBM differ from other models of maintenance, such as preventive or predictive maintenance?**

*Bayoumi:* That's a good question. CBM is a predictive maintenance approach and combines onboard sensors with logistics to provide diagnosis, prognosis, and predictions in the moment. The beauty of CBM is that it allows you to change the tire at just the right moment to prevent failures and maximize the life of components based on exact health, which is a highly reliable and low cost approach.



**Q: How does CBM benefit Facilities leaders?**

*Bayoumi:* The benefits of CBM can be presented in terms of three segments: cost, time/availability, and intangible benefits. First, if you are dealing with very tight budgets and need to control expenses, CBM helps you minimize costs through reductions in parts purchases. CBM creates predictions of component behavior and enables institutions to better schedule work, including just-in-time ordering of parts. As a result, you can lower costs by avoiding changing parts too frequently and using fewer parts.

The second benefit can be communicated through measures of time or availability. If the time that the system is available or functioning is more important than money, then cost is less important. CBM allows you to fix a system right before it breaks, keeping it up and running for a maximum amount of time between shutdowns while minimizing

unexpected failures.

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The third category is intangible benefits. One such benefit is reduced stress from fewer unexpected system failures, which may be important to leaders who prioritize the well-being, safety, and morale of their staff. CBM can help improve working conditions for staff and a more predictable schedule of maintenance activities. If you care about all three factors, you can normalize outcomes to bring each of them onto the same scale so benefits can be compared across categories.

**Q: What about any pitfalls to keep in mind?**

*Bayoumi:* We once presented findings to the Army that showed them how they saved millions of dollars on parts for one component, and one general wanted to reduce their budget by that amount! That's not a logical approach, because when you uncover savings, it's generally only one bottleneck. Solving one bottleneck does not necessarily eliminate all issues with a system or that every output of the system will reflect that solution. The cost-benefit analysis must address all components in that system to check for overall elimination of the bottleneck, which would then reduce the time between overhauls (TBO) and result in savings.

For example, if you focus on only one mechanical bearing and improve TBO by 500 hours, this does not mean that the other components connected to it as an output will reflect that 500-hour increase. You might actually contribute more damage to the neighboring components through increased wear. CBM ultimately looks to gradually shift focus from component pieces, to sub systems, to a whole system health point of view.

**Q: Are there certain prerequisites for CBM to be successful and provide significant ROI?**

*Bayoumi:* Yes. First, a specific person or team should have the responsibility and training to collect and analyze data. Second, programmers should create algorithms that collect and organize the data. Those programmers need to understand the engineering and physics involved in the systems and processes generating the data. This understanding is essential to be able to process and represent the data in a useful and comprehensive manner.

**Q: Is it feasible for higher education institutions to invest in CBM?**

*Bayoumi:* Absolutely, now more so than ever. When I started on this career path 20 to 25 years ago, I was actually involved in inventing smart sensors. The problem was at that time the sensors were energy harvesting. We wanted to include sensors in bridges and roads but the sensors required a hard wire to feed them energy. Nowadays there are several types of energy-creating sensors that produce their own energy off of the grid.

The best thing an institution can do is to conduct a quick feasibility study to identify where value can be added by implementing CBM. The feasibility study will yield a few areas to explore during the proposal stage, and a leader who wants to take the next step in improving maintenance processes should build out this component and examine resulting outputs. It is an involved process: there are at least a dozen steps between the feasibility study and a well-implemented predictive maintenance program.

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