

Predictive Maintenance:

How Artificial Intelligence Can Keep Your Critical Infrastructure Running

Richard Arena, MBA
CMCA, CBC, LCAM
ARC Systems Management
Sarasota, FL

V3





Presentation Synopsis

- Traditional Maintenance Classifications
 - Routine (normal, generally OPEX)
 - Preventative (scheduled – mixture of OPEX and CAPX)
 - Critical or Emergency (unplanned and unbudgeted – very expensive)
- Predictive Maintenance
 - Anticipate Equipment Failures
 - Big Data, Large Universe of Information
 - Superior outcomes:
 - Reduced Maintenance Costs
 - Increased Equipment Uptime
 - Longer Asset Life
 - Superior Community Satisfaction



Concepts to Implement Predictive Maintenance in Community Associations

1. Under-the-Hood Look
 1. Artificial Intelligence Applications - Differences & Complexities
 2. Historical Perspective

2. Short Term Tactics
 1. “Hearts & Minds”
 2. Association Budgeting

3. Long Term Strategic Objective
 1. Product Offering(s)



Predictive Maintenance - Objective

- Provide high-end Association CAMs and Property Managers with the tools to implement Predictive Maintenance methodologies on campuses and sell the Boards and residents on the value add of such solutions
- Constraints:
 - Initial implementations will be a subset of all Community Associations
 - **Primarily** high rise associations located where land values mandate building UP, not OUT
 - Attractive coastal areas
 - Large metropolitan cities
- Eventually, methodology will spread to other associations
- **High-Rise campuses WILL be the EARLY ADOPTERS**



Historical Context of Artificial Intelligence

- AI has been studied (and rudimentarily implemented) for decades
- Originally called “Machine Learning”
- Key initial funding vehicle – DARPA (i.e. Department of Defense)
- Calculations performed by massive mainframe computers (e.g. IBM 360/370 series)
- Limited by external factors that have been corrected
 - Glacial processor speeds
 - Slow computer memory and data paths (4-8 bit bus versus 64 bit today)
 - Magnetic tape drives for long term data storage versus non-volatile RAM (as in cell phones)
 - Non-standard protocols and databases
 - Biggest obstacle – connectivity – ***NO HIGH SPEED INTERNET***
 - ~ 1,000 bits/sec (1 Kbps) dial-up versus 1,000,000,000 (1 Gbps & higher) fiber optic today



Early Example of Predictive Maintenance – U.S. Department of Transportation

- Boeing's Vertol Division designed Apollo lunar lander for NASA
- Apollo program cancelled - Boeing-Vertol looked for new contract opportunities
- Coincidentally, US DOT was looking for new subway cars
- SO.... Boeing-Vertol designed a new LRV (Light Rail Vehicle)



- Analysis of LRV's performance/availability req'd prior to contract
- Simulation –thousands of lines of computer code on mainframe
- Failure data delivered weekly on mag tape reels - real time (LOL)
- End result –
 - Unacceptable, but – BOEING STILL AWARDED CONTRACT
- Important concept: **CONFIRMATION BIAS**



Growing Awareness of Artificial Intelligence in 20th Century

- Scientific Papers
- General Reading Materials & Science Fiction Books
 - “I, Robot” by Isaac Asimov
- Movies
 - “2001 – A Space Odyssey” - HAL 9000
 - “Terminator” Franchise
 - “Matrix” Franchise
 - “I, Robot”
- **BUT WHAT PARADIGM SHIFTING EVENT DEMONSTRATED TO THE WORLD THAT ARTIFICIAL INTELLIGENCE (aka MACHINE LEARNING) WAS REAL AND HERE TO STAY??**



The Story of “DEEP BLUE” – Emergence of AI

Add one Application Specific, Chess
Playing Super Computer: **IBM’s DEEP BLUE**

Take One Chess Grand Master:
Gary Kasparov

And Have a **Chess Tournament**
(6 Matches)

Result: Deep Blue Won the Tournament – 2 victories, 1 loss, 3 draws

Machine Learning (Artificial Intelligence) Had ARRIVED (1997)



Truisms about Artificial Intelligence

- It is pervasive
- AI technology is advancing very rapidly
- Many people are using AI, even though they do not know it
- AI does have human traits – it can make mistakes and can be tricked
- Many (most?) ERP (Enterprise) software companies claim to have AI capabilities
- Far too much purported AI software capability is “vaporware”
- While AI has capabilities that can enhance productivity, it has a dark side also.



How Does a Key AI Engine - ChatGPT - Work?

- Queried ChatGPT-3.5: Draw illustration of ChatGPT gathering query information from data sources.
- Could not be answered by version 3.5. Version 3.5 cannot draw pictures or read spreadsheets.
- Made same query of ChatGPT-4o. <https://chatgpt.com/?model=gpt-4o> Returned...



Artificial Intelligence – Degrees of Difficulty

1. Easy – Spellcheck
2. Moderate – Create a violation letter
3. Hard – Real Time Tracking of Asset Failures
4. Challenging – Predicting Asset Failures
5. Multi-Dimensional – Emulating Complex Human Thought Processes



Artificial Intelligence – Degrees of Difficulty

- Easy – Spellcheck: This word is **incorect** – corrected to **incorrect**



Artificial Intelligence – Degrees of Difficulty

- Easy – Spellcheck: This word is **incorect** – corrected to **incorrect**
- Moderate – Create a violation letter : **<https://chatgpt.com/?model=gpt-4o>**



Violation Letter – Created by ChatGPT-4o Request

Query: **Write a violation letter to a condo owner that is late with assessment payment**

[Your Name]
[Your Position], [Condominium Association Name]
[Address]
[City, State, ZIP Code] [Email Address] [Phone Number]

[Date]

[Condo Owner's Name] [Condo Owner's Addr

Subject: Notice of Late Assessment Payment

Dear [Condo Owner's Name],

I hope this letter finds you well. I am writing to inform you that our records indicate your assessment payment for [Month/Year] is currently past due. As of [Current Date], your outstanding balance is [\$ Amount].

Timely payment of assessments is crucial for maintaining the quality and services our community relies on. As outlined in our condominium bylaws, assessments are due on the [Due Date] of each month. Failure to remit payment by this date results in a late fee and potential further action as necessary to collect the owed amount.

Please remit the outstanding balance, including any applicable late fees, no later than [Final Deadline Date]. Payments can be made via [Payment Methods – e.g., check, online payment portal, etc.]. If you have already sent your payment, please disregard this notice.

Should you be experiencing financial difficulties or have any questions regarding this matter, we urge you to contact us immediately to discuss possible payment arrangements. Our goal is to work collaboratively to ensure all dues are settled promptly, avoiding any further complications.

We value you as a member of our community and appreciate your prompt attention to this matter. Failure to address this overdue balance may result in further action, including additional fees, interest, or legal proceedings, as per the association's policies.

Thank you for your immediate attention to this important matter.

Sincerely,

[Your Name], [Your Position]
[Condominium Association Name]

Would you like any specific details added or modified in this letter?



Artificial Intelligence – Degrees of Difficulty

- Easy – Spellcheck: This word is **incorect** – corrected to **incorrect**
- Moderate – Create a violation letter: <https://chatgpt.com/?model=gpt-4o>
- **Hard – Real Time Tracking of Asset Failures – automation factors**



Multi-Dimensional – AI Emulating Complex Human Thought Processes

Testbed Air Force F-16 – AI Controlled
4th Generation Fighter. Flown May 2024
Thousands of “standard” (non-AI) planes
in active duty across the world today

6th Generation Stealth
Fighter – Delivery in
2030’s. Projected Extensive
AI Capabilities

F-35 Stealth Fighter. Currently
being deployed by US Air Force
& Navy and U.S. Allies. Trillion
dollar international program.
AI Capabilities



Artificial Intelligence – Degrees of Difficulty and Development Expense

- Easy – Spellcheck: This word is **incorect** – corrected to **incorrect** \$
- Moderate – Create a violation letter: <https://chatgpt.com/?model=gpt-4o> \$
- Hard – Real Time Tracking of Asset Failures – **automation factors** \$\$
- Challenging – Predicting Asset Failures – **“Predictive Maintenance”** \$\$\$
- Multi-Dimensional – Emulating Complex Human Thought Process–**“Military”** \$\$\$\$\$\$\$\$\$\$



Predictive Maintenance – Factors to Comprehend

- Confirmation Bias
- Programming Bias
- Innocent Errors
- Data Manipulation (Not Innocent Errors)
- Prevarication (Lies) – Facebook AI discovery
 - “Ghost in the Machine”
- Complexities & Cost – What is available?
 - Internet availability & connectivity
 - Sentient devices
- Why Are Factors Important?
 - First Rule of I.T.: GIGO Hygiene
 - Garbage In – Garbage Out



Innocent Errors – McDonalds

- McDonalds Cost Reduction – Replace server staff with kiosks
 - Internal Project by own I.T. Staff
- Family “speaks” to kiosk to purchase 2, 10-Chicken McNugget Meals
 - Voice Recognition issues
- Kiosk got it wrong the first time
- Customer could not delete
 - Customers laughed about it and drove away – McDonalds Lost Sale
- Result – McDonalds disbanded internal program and outsourced
 - Another datapoint – Wendy’s has 14% error rate



Data Manipulation (Not Innocent Errors)

- Google has had issues with AI Implementations
 - (Programmer Bias?)
 - “Rocks were healthy to eat” recommendation.
- Pizza Prank – started by known internet troll
 - Bot magic - flood internet with fake articles & recommendations
 - Topic - prevent cheese from slipping off pizza
 - Solution: GLUE cheese to pizza!!
- Tide Pod Challenge – convincing people (mainly children) to eat Tide Pods
- Fatalities



Data Manipulation (Not Innocent Errors) – Obfuscating Product Defects

- How accurate is your failure data?
- How confident are you that the data is not being massaged by unscrupulous vendors?
- Who is collecting and tabulating data?
- GIGO Rule

Deteriorated Window Glazing

Leaking Well Pump

Overheated Motor



Predictive Maintenance – Methodology

- Catalogue all key assets
- Important information
 - Install date
 - Warranty
 - Maintenance records
- Purchase “sentient” products if available – remote monitoring
 - Status uploads
 - Notification if out of range condition
- Compare to performance of similar products in other locations
- Adjust maintenance schedule to repair/replace product at optimal time before a failure
 - ***PREDICTIVE MAINTENANCE***



Typical Sensors and Comparisons for Predictive Maintenance

- Moisture
- Humidity levels
- Temperature of components
- Amperage draw of electrical components
- “Faults” thrown, even those without failures
- Utility utilization above or below normal
- Excessive runtimes



Problem is Understood. Which Company (ies) Provides Software to Meet Requirements?





Answer

- None of the usual suspects. But all are “working on it”.
- But – there is a solution in operation today:
- IBM Maximo Software, running on a Watson supercomputer (cloud based)
- Marketing Orientation has not included Community Associations
 - Factories
 - Commercial Real Estate (not condos or co-ops)
 - Government Buildings
 - Schools
 - Utilities
 - Research Facilities
- Will discuss reasons for IBM’s focus in later slides



Maximo Predictive Maintenance Demonstration

Predictive Maintenance – IBM Maximo Application Suite

<https://youtu.be/TxLnIphwNRg?si=PnjtZ1fUicISNZE0>



Current Situation

- IBM has wanted to crack the condo market but has been unsuccessful
 - Inappropriate approach – Developers, pre Turnover
- IBM now understands pricing model for commercial buildings may be incorrect for condominiums and co-ops (commercial/residential hybrid)
 - Commercial building occupancy issues (domestic & international)
- Appreciate what CAI can potentially bring to table
- Still very early in discussions and IBM moves slowly
 - Obviously no commitments have been made
 - IBM's openness and helpfulness surprising



Strategies & Tactics for Property Managers

- Learn as much as you can about Artificial Intelligence
- Start using it in you job as a cost/time reduction
 - Microsoft, Adobe, Zoom applications
 - Basic letters, job descriptions, employee reviews
- Experiment with ChatGPT (especially release 4o – it's free) <https://chatgpt.com/?model=gpt-4o>
- Whenever purchasing products, ask if IBM Maximo compliant for maintenance
 - API (Application Programming Interface) is available to interface with Maximo
- Upgrade Internet capabilities on campus
- Ask your management company when they will offer predictive maintenance on ERP software. Similarly ask any company whose software you use for maintenance the same question.
- Budgetary Considerations
- Impact on Reserve Funding



Is Maximo Appropriate for Community Associations or Should C.A.'s Wait?

Discussions Points:

- Pricing
- Availability
- Maintenance & Support
- CAI Members Open Forum
- Short-term / Long-term Implications

- IBM Marketing Re-evaluation

CAI High-Rise Managers Workshop



Questions & Answers

Thank You for your Participation

CAI High-Rise Managers Workshop



Contact Information

Richard Arena, MBA

CMCA, CBC, LCAM

ARC Systems Management

Sarasota, FL

Tel: 941.227.9646

E-mail: rjarena@arcsyst.com