Contemporary Analysis
Work smart.

Mechanical Failure & Predictive Analytics:

Prevent breakdowns by listening to your assets.

Get in touch. Call us at 531.333.3282 or write us at support@canworksmart.com.

Pain keeps us safe. Pain tells us when we need to slow down, be careful, avoid danger, and seek help. Our nerves are constantly listening for pain and report pain immediately to our brains. This allows us to respond to problems quickly; often preventing a breakdown.

What if you could detect problems before a breakdown?

Unfortunately, machines, structures, and systems don't experience pain; they just stop working. We only know that something is wrong after a breakdown.

While most machines have sensors, they aren't connected to a "brain". Dashboards can tell us know how fast an engine is spinning, how much fuel is being burned per minute, and the engine temperature, but we don't know about the wear of the engine. An engine can fail because the shaft is out of alignment causing the piston to rub against the wall of the engine, or a value is stuck causing condensation to build up in the engine. However, none of these things show up in the dashboard. Machines can feel pain, though, if we let them. The solution is to cover machines, structures and systems with nerves (sensors and actuators), and then connect them to a brain (motherboard).

Internet of Things

We have digitized nearly all of the world's knowledge and information. There are records for nearly every conversation, purchase, and decision. The next frontier of the information revolution is to digitize objects and our bodies; creating a network of

everything in the world.

Once we connect objects to the Internet, embedded sensors and actuators will allow the machine to sense, communicate and adjust to the environment. Objects are able to register and report "pain", and communicate "pain" to humans.

Cisco Software estimates that as of July 29th, 2013 there are 8.7 billion connected objects, or 0.6% of all objects in the world.

The following are examples of how the Internet of Things could impact cars and driving:

Self-driving cars--Someday every person will be a passenger. Freight could even be moved passenger-less. Using a variety of sensors, computers, satellite connections and cameras, cars and trucks will drive themselves, making their own adjustments based on weather conditions, traffic patterns and vehicle location. Cars and trucks will drive more efficiently because they will monitor the entire network: every car, every construction crew, every emergency, and every weather condition. The increased efficiency will allow for higher speeds, fewer accidents, and increase the capacity of our current roads.

Also, because these self driving cars are covered in sensors, they can also provide better "pain" indicators. Cars will know when to let service people know something is about to fail, and how to fix it; long before it breaks, and long before the passenger is stranded on the side of the road.

The Internet of Things could also change how we buy things. Once objects know how much they are being used, companies can change their pricing. Instead of selling cars, companies can charge by how much a car is being used. This is already happening: General Electric retains ownership of their jet engines and charge airlines for the amount of thrust used. Also, Electric companies are moving to a dynamic pricing model based on how much it costs to generate each kilowatt, instead of a flat monthly rate. This is different from a lease which is based on an estimate of how often you drive.

The case study

CAN worked with a Fortune 500 Telecommunications company to predict the failure of roofs on telecommunications server huts. The

huts protect the servers that are the traffic cops of the Internet, TV and telephone; making decisions about who gets what when. While individual servers might fail, telecommunications networks are self-healing. The loss of one server isn't too bad, however the loss of an entire group of servers leads to sever service interruptions. The failure of the roof quickly destroys every server and appliance in the server hut.

The company had 5 property mangers, managing 2,500 telecommunication huts spread across the Western United States. Each manager roughly had 500 locations in areas that are sparsely populated and hard to reach. CAN's manager was responsible for Nebraska, Kansas, and Eastern Colorado.

With his current budget he could afford to visit each site once a year for routine maintenance. The only other time huts were visited was if something was broken down, weather had gotten in and the servers were destroyed. In fact, the servers were his only way of knowing if a roof had failed. He needed a better way to manage his properties.

The solution

After each annual and emergency visit, crews would send the manager an email to report what they had fixed and provide a general rating of the roof. We decided to take this one step further. We developed a survey that crews could complete during or after working on the roof. The survey asked questions about each element of the roof, and asked about the existence of specific conditions, and have them rate each element of the roof from excellent to failed using a 5 point scale.

Grounds: Trash & Debris, Sidewalks- Cracks/Deterioration, Driveways- Cracks/Deterioration, Fencing Problems, Lawn/ Landscaping Problems, Signage Issues, Ground Equipment Issues

Building Exterior: Failing Mortar Joints, Movement Cracks, Spalling, Efflorescence, Graffiti, Paint Problems, Damaged Window/Doors

Roof Edge: Attachment Problems, Membrane Flashing Problems, Rusting/Paint Problems, Gutter/Downspout Problems

Parpet Wall: Pulling Membrane, Membrane Flashing Problem, Counter Flashing Problem, T-Bar Problem, Caulking Failures

Vertical Wall: Pulling Membrane, Membrane Flashing Problem, Metal Flashing Problem, Punctures

Roof Penetrations: Physical Damage, Attachment Problems, Open Flashing, Caulking Failures, Rusting/Paint Problems, Plugged Drains, Pitch Pan Problems

Roof Mounted Equipment: Mechanical Problems, Piping/ Conduit Problems, Deteriorated Stands/Blocking

Membrane Roofing: Warped Insulation, Unadhered Membrane, Inadequate Ballast, Seam Problems, Punctures

Metal Roofing: Rusting, Faded Paint, Seam Problems

Shingle Roof: Missing Shingle, Damaged Shingles

BUR/Modified Bitumen: Blistering, Splitting, Alligatoring, Ridging, Bare Spots

General Field Problems: Roof Leaks, Ponding/Inadequate Slope, Vegetation, Debris, Physical Damage, Inadequate Overflows, Inadequate Walkways

The data from the surveys was combined with data from the companies accounting records. The accounting records provided us with information about: location, type of roof, number and type of repairs, the number hours by task order, and whether the task order was for an emergency or regular maintenance. Accounting data also told us what contractors and installers worked on the roof.

Manufactures provided an estimated lifespan for each roof based on type and brand. However, this wasn't enough, because many roofs didn't make it into the estimated lifespan. From his experience, the property manager suspected that the installer and the weather had equal roles in how long a roof would last.

So in addition to accounting data, we added weather data. This included the temperature range for each year, the high temperature, the low temperature, and the number of days within 5% of the high temperature, number of days within 5% of the low temperature, amount of rainfall by month, number of days per month with

precipitation, number of days with snow on the ground, and high wind speeds for each month. We also modeled the impact of hail size and wind speed on each roof.

The deliverable

CAN used the data that we collected to create a survival model for each roof. This created more realistic lifespan estimate than the manufactures one-size-fit-all claim since it took into consideration the current state of the roof, the installer, the location and the weather.

CAN also provided estimates of when maintenance tasks would need to be completed and ranked roofs from most critical to least critical. CAN prioritized the roofs based on how likely the electronic contents of the huts would be damaged and how many customers a hut served. This included the probability of failure under normal conditions and in the event of storm with hail and/or high winds.

In addition to the lifespan forecasts for each property and the property ranks, CAN combined the data form the survey, accounting records, weather and models into a dashboard. This allows the property manager to compare his properties, identify the most common tasks, identify outliers.

In the end, CAN helped the property manager prevent critical roof failures, optimize his budget and hold his contractors accountable. The goal of holding his contractors accountable came out of discussions about why different roofs have different lifespans. This is a good example of how developing predictive analytics needs to be a collaboration between data scientists and the client.

Conclusion

CAN can help maintenance teams understand the variables that predict breakdowns. With the right data and input from the managers and technicians, CAN can produce accurate lifespan models to replace the general lifespan forecasts offered by manufactures; saving time and money. This allows companies to better understand and pro-actively manage their assets.

Contemporary Analysis
Work smart.

Since 2008, Contemporary Analysis has used predictive analytics and data science to help companies of all sizes work smart.

We help our clients implement data science through use of Data Science as a Service, Staff Augmentation, and Training.

Our solutions are used by fast-growing technology companies, Fortune 500s, as well as small- and medium-sized organizations. Our clients are in a variety of industries including construction, insurance, education, healthcare, government, not-for-profit, software and engineering.

Our vision is to make predictive analytics simple and affordable because all companies, not just the largest, should be able to benefit from predictive analytics and data science.

Our principles:

1. We care about business.
Each business deserves a custom solution. Problems are our passion.

2. We solve core business problems.
We make a big impact quickly. Value is our focus.

3. We don't have all the answers.
We help our clients make better decisions. Less wrong is the goal.

4. We are technology agnostic.
We focus on the solution. Technology is just a tool.

5. Our job is to solve problems, not introduce complexity.
Our solutions are simple because our clients are busy.