As the cost of raw materials and labor continue to increase, it is becoming even more important to have increased productivity and reduced unplanned downtime. Depending on the industry, downtime costs can be in the hundreds of thousands to millions of dollars. Companies are continuously looking for ways to limit their exposure. One way to do this is through the use of predictive maintenance techniques. Specific to the hydraulics market, there is a trend toward electrification, allowing for increased diagnostic and monitoring of equipment. The hydraulics market is also seeing a significant portion of the workforce going into retirement, resulting in fewer trained personnel that have in-depth knowledge of how a hydraulic system works. The use of equipment diagnostics eases this transition to the new wave of the hydraulics workforce.

Another phenomenon happening across all industries is the Internet of things (IoT). Everybody has smart mobile phones and expects data to be at their fingertips at the ease of pushing a button. Eaton’s LifeSense® is one of the first technologies in allowing the IoT to become a reality in the hydraulics world. This technology monitors hydraulic hoses and is able to detect an impending hose failure before it occurs. The notification of this alert can be done on the equipment itself, or via the IoT, the alert can be sent through e-mail or text message. These type of technologies will only continue to become more prominent and will soon be the new norm in the hydraulics industry to combat the higher operating costs.

I. INTRODUCTION

Unplanned hydraulic component failures are responsible for high costs and safety concerns across the industry. Basic maintenance techniques are not able to sufficiently prevent failures from occurring, whether it be visual inspection or time-based preventive schedules. With advanced technologies, electrification is being added to components which allows advance maintenance techniques to occur by the operator or via remote monitoring.

II. MAINTENANCE ANALYTICS

It has traditionally been very common in the hydraulics industry to run a component on a piece of equipment until it has failed. This method is extremely inefficient but in many cases is the only option as there is no good way to know when failure will occur. Unfortunately, with a failure comes consequences (see Figure 1). These consequences can be very costly and timely to deal with. Depending on the application, downtime costs can be in the thousands to millions of dollars a day. As system pressures continue to increase, collateral damage, environmental damage and safety continue to be of increasing concern.
environment, and robustness of the product. If one chooses to replace a component every 3 years, there is no guarantee that the product will last 3 years. On the other side, that particular component may last 6 years and the component was replaced when 50% of its useful life remained. Figure 2 is an example of a hydraulic hose and how the MTTF can vary. With this range of performance, it is difficult to determine the exact interval a hydraulic hose should be replaced without (1) discarding a good hose or (2) without preventing a failure from occurring.

**Figure 2: Hydraulic Hose Life Range**

Based on this variability, there is a preference to have more predictive maintenance, and to take it one step further, have true condition monitoring of a system and the components that make up the system.

Another benefit of predictive maintenance is there is an aging of the workforce inside hydraulics, resulting in fewer trained personnel who understand how hydraulic system works and their ability to maintain them. This is especially prevalent in the oil & gas industry as it is estimated that over half of the workforce is ready to retire now.

### III. INTERNET OF THINGS

Not only in hydraulics, but across all industries there is a megatrend around the whole Internet of Things (IoT). This term is credited to be coined by British entrepreneur Kevin Ashton in 1999. The basic concept is that objects (components/systems) are embedded with electronics hardware that would consist of software, sensing capability and ultimately network connectivity capability that then allows for the exchange of information. With the network connectivity, now the information is in the cloud where it can be used to monitor the incoming data and/or give command controls remotely. Each device that is connected to the Internet will have an IP address that uniquely identifies that device. Figure 3 shows an example of how this information can flow. One challenge that needs to be overcome is the amount of power required, for example on a sensor. In many cases, there is limited power supply and limited installation space available in a hydraulic system.

![Figure 3: Wireless Network Architecture](image)

Traditional hydraulic components are more mechanical in nature and are not equipped with electronic components. Therefore there is also a trend of electrification happening within the hydraulics industry. With the ability now to monitor systems and the components that make up that system, organizations can streamline their maintenance operations and practices to reduce safety concerns, environmental concerns, and costly downtime. In addition, maximum system efficiency and productivity can be obtained by allowing operators to measure where they’re at and make any necessary adjustments, or the system could be programmed to make the necessary adjustments without any human interaction.

As another offshoot, the ability to monitor the operation of components / systems allows design engineers to better understand how the system is operating to make design changes instantly or the development of products for the future. One could also track where that product is being used at to better understand the application.

There are limitless platforms and applications where this can be applied. In a hydraulic system the monitoring could be on hydraulic hoses, pumps, motors, valves, filters, fluid temperature, system pressure. The IoT can be applied in stationary markets for process control and equipment utilization, whether it be on an injection mold machine or in a steel mill. Mobile markets are another perfect opportunity as equipment gets moved from job site to job site. Fleet managers can use this information to understand how their fleet is running and when to scheduled required maintenance. In the mining industry, there could be a future where there are driverless trucks that will need to be monitored to prevent accidents from occurring. All of this information can be made available at your fingertip with the simple push of a button.
The estimates are astronomical as just in the next 5 years, it is estimated that the IoT will consist of anywhere from 20-50 billion objects by 2020. As a result, ABI research estimates that maintenance analytics will generate close to $25 billion in revenue in the same time period, driven by predictive maintenance and IoT.

IV. EATON LIFESENSE HOSE

One of the first IoT enabled products in the hydraulics industry is Eaton’s LifeSense Hose. It is a true condition based hose monitoring system that is designed to detect failure related events both inside and outside the hose and to notify the appropriate person to replace the hose before it actually fails. This hose monitors both internal fatigue and external abrasion, as abrasion is the number one cause of hose failure in the field. Once impending failure is detected, the next step is the notification of that impending failure. There are two options available, a wired system and a wireless system.

The wired system consists of a sensor connected on the hose assembly with a wired routed from the sensor to a hose diagnostic unit. The hose diagnostic unit is then able to interpret the data and alert the operator if a hose needs to be replaced. Figure 4 shows a simple block diagram of this interaction.

The wireless system consists of a sensor connected on the hose assembly that communicates wireless via a high frequency radio signal to a hose diagnostic unit. The hose diagnostic unit also doubles as a gateway where it can communicate this information to the cloud via Ethernet or Wi-Fi. With the information in the cloud, it can be sent to whoever needs that information via text message or e-mail. The wireless system also provides a customer portal that can be used as a user interface for remote monitoring. Now the true condition of that hydraulic hose can be monitored anywhere any time. Figure 3 above shows a block diagram of how the flow of information can occur.

V. SUMMARY

Pressure and temperatures only continue to rise in the hydraulics industry. Raw material costs and labor costs also continue to rise. As a hydraulic component failure occurs, safety, environmental concerns and downtime costs become a major concern.

To minimize the effect of a component failure, companies want to move past basic maintenance techniques and use more predictive maintenance techniques. In combination with the Internet of Things, predictive maintenance can be accomplished via remote monitoring to allow users to maximize equipment efficiency while reducing any safety concerns. Productivity could be increased by the operator or in some cases without any human interface.

Eaton’s LifeSense Hose is one of the first products in the hydraulics industry that allows predictive maintenance to occur on hydraulic hose. This product is able to detect an impending failure and provide a notification prior to actual failure. This remote monitoring can be completed by anyone anywhere. These type of products will only continue to become more prominent in the industry.

REFERENCES

1) http://m2mworldnews.com/2014/03/28/
2) http://www.miningglobal.com/tech/1669/Mining-equipment-Internet-of-Things