Innovations for Automation and Efficiency in Industrial Pneumatic Systems

Build Smart and Efficient Pneumatic Systems Today and In the Future

Parker

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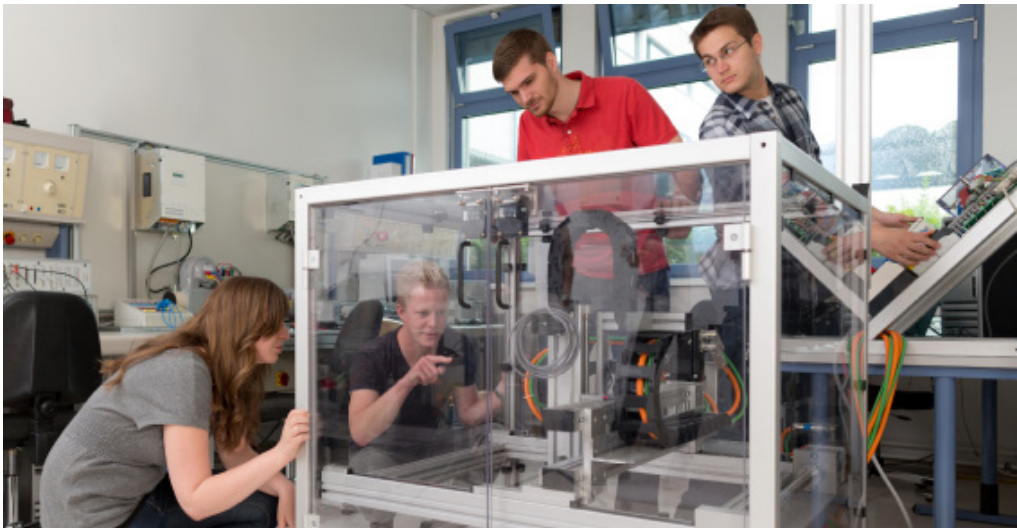
Introduction

When asked what keeps them up at night, a quarter of design engineers will tell you that staying current with new and emerging technologies is the primary concern. Other concerns weighing on design engineers include product reliability and quality along with a lack of design resources.[1] Resources from suppliers like this paper can help alleviate those concerns, and staying abreast of industry trends and growing technologies will help design engineers face those challenges and sleep more soundly.



Pneumatics are clean, low cost and effective, making them a smart choice for industrial motion applications, especially if the application does not require high power densities. For today's industrial pneumatic systems, automation and efficiency continue to be driving factors in design. Automation in pneumatics incorporates a variety of design strategies and considerations, this paper will focus on the use of smart pneumatics, designing for cobotic applications and related safety issues along with pneumatic system efficiency.

Automation

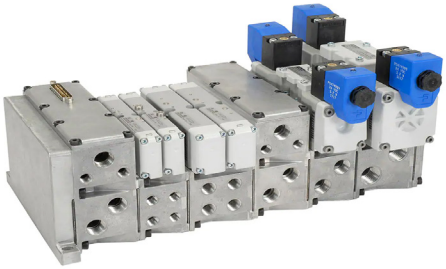
Smart Pneumatics

When it comes to industrial machinery, Industry 4.0 or the Industrial Internet of Things (IIoT) are big buzzwords, but these solutions are not fully developed yet. As design engineers work toward creating closed-loop automated systems, questions to consider include:

- How do you develop the next-generation Smart Factory?
- What is the path toward a fully automated factory?
- How can maintenance requirements be triggered without any downtime?
- What data input can you use and how do you capture that data?
- How do you diagnose maintenance issues at the component, system or process level?

Smart connected pneumatics help you answer these questions. For design engineers, smart pneumatics can mean complete flexibility; this is the ability of that component to communicate over the network, multiple uses for a single device, ease of integration and commissioning, as well as troubleshooting. Smart products are where you see the most difference in pneumatic systems. The diagnostic aspect of smart pneumatics is important to help achieve zero downtime.

The concept of zero downtime has seemed unrealistic in the past, however technology is evolving in that direction. Incorporating sensors into pneumatics enables end users to collect the important prognostic and diagnostic data for setting alerts and getting machine feedback. The future of smart pneumatics is complete plug-and-play configuration that is easy to manage.[2] For today's smart pneumatics, design engineers have the ability to generate data and set the alerts but are not yet making fully closed loop systems. However, this is on the horizon with end-to-end systems that can be configured with just a few clicks and the device will be able to take over, provide data and feedback into the control system that goes beyond simply allowing data dumps.[3]



Pneumatic Solenoid Valve - H Series ISO

Technology is changing quickly, and more people are migrating to networks. According to HMS Networks industrial Ethernet makes of 52 percent of the installed networks and fieldbus at 42 percent. Industrial Ethernet networks see a rapid year-over-year growth rate of 22 percent and fieldbus is growing at only about 6 percent annually[4] as designers are migrating systems to the newer industrial Ethernet systems. This migration is happening for a variety of reasons, but overall the "line" topology of the networks makes them much easier to work on and troubleshoot.

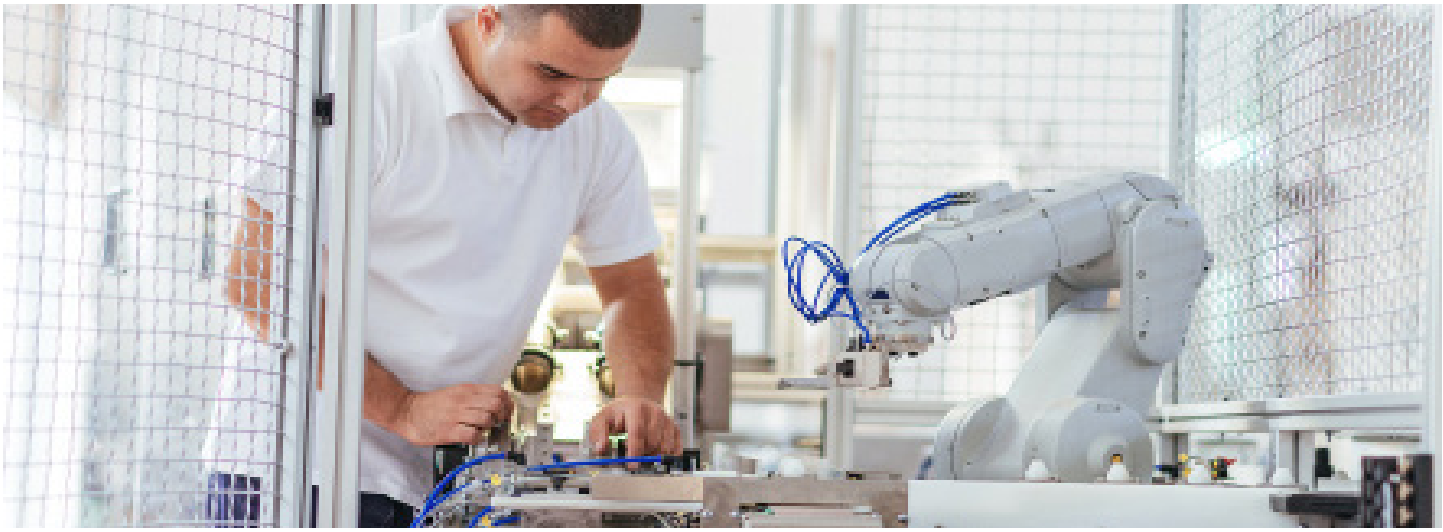
It used to be the case that each manufacturer offered the same type of components such as cylinders and FRLs. There is a large divide in the market on what is available and what functions they offer. For example, on a network node a manufacturer may provide over-voltage warnings, short circuit warnings and offer the ability to adjust the settings, whereas another maker may not.[5] Products today with integrated electronics offer many different functions through what is embedded. When specifying systems, design engineers should be sure to understand what is necessary for the machine and what value can be provided by the smart products that are specified.

Cobots and Safety

In automotive manufacturing, robotics has been in use for more than a decade and over the years, they have shifted from being hydraulically driven to being pneumatically driven. This shift was first seen with robotic welding applications due largely in part to the cleanliness of pneumatics. In industrial cobot applications, collaborative robots known as "cobots" work with humans in some way, including as an assistant or guide in a task or process. Unlike autonomous robots, cobots, do not work alone, they are designed to work with human instruction or respond to human behavior.[6] The shift to pneumatics for robotics means that cobots are mostly pneumatically driven.

Cobots are the next big thing in industrial applications as the cost of robotics comes down and newer opportunities are being developed. Leading cobot applications can include:

- Machine tending where cobots can load and unload tools and accessories to decrease manual handling.
- Pick and place where cobots can complete careful picking and moving, then place and position products or parts.
- Assembly and flexible manufacturing where cobots insert parts, screwdriving and other assembly tasks with appropriate end-of-arm tools.
- Packaging, loading and unloading when aided by suction or gripper attachments, cobots move finished products through packaging.[7]



1. *2017 Hydraulics & Pneumatics Annual Salary and Career Report*
2. *Interview with Linda Caron, CMSE, Factory Automation, Parker Hannifin Corporation Pneumatic Division*
3. *Interview with Herman Wang, Director of Global Business Development, Parker Hannifin*
4. *HMS Networks data as shared by Linda Caron*
5. *Interview with Linda Caron and Herman Wang*
6. *https://www.techopedia.com/definition/14298/collaborative-robot-cobot*
7. *https://expert.alliedelec.com/industrial-control/cobot-applications/*

Pneumatics come into play for cobots mostly in gripping and picking applications where the vacuum or grip motion is pneumatically driven. [8]

The strict separation between the manual work of the factory worker and the automated actions of robots is becoming an increasingly gray area. Their work ranges are overlapping and merging into a collaborative working space. In doing so, human and machine will be able to simultaneously work together on the same workpiece or component in the future—without having to be shielded from each other for safety reasons.[9] Due to this, safety is the largest consideration for design for cobot applications. However, there can be some confusion on which safety standards to follow in applications with cobots due to the divide between traditional pneumatics and entering the world of robotics. Standards and their adoption vary among engineers and facilities, it is important to make sure you know which standards to apply, design engineers should understand:

- ISO 10218 which specifies the requirements and guidelines for inherent safe use of industrial robots and outlines both hazards and the requirements to reduce or eliminate risks associated with them.[10]
- ISO/TS 15066 is not a standard, but a technical specification which builds upon ISO 10218, addressing specific questions related to collaborative robots. Designers can consider this specification as a best practice for cobot applications.[11]
- ISO 13849 which offers guidance and requirements for design and integration of safety-related parts of control systems, including design for software.[12]
- ANSI/RIA R15.06 is the subset of a standard that applies to safe design, protective measure and information for using industrial robots.[13]

For incorporating cobots into a plant, engineers must understand the required standards for the facility and compile the necessary documentation and technical file with due diligence, testing and validation of the controls architecture.

What design engineers can do now related to smart pneumatics and cobots:

- Learn more about ISO standards and make use of ISO and NFPA standard components in designs rather than proprietary standards in order to improve maintenance and performance for pneumatic equipment down the road.
- Expand knowledge in mechatronics as the mechanical and controls engineering worlds will continue to overlap and the complexity of products grows.
- Begin considering broadly what you want to utilize for a pneumatic system, including components as well as what type of system (ie centralized or decentralized), system architecture and desired data to collect.
- Review and understand how robotic safety standards apply to your applications.

Efficiency

Lower upfront and maintenance costs combine to make pneumatics the most popular and cost-effective choice for executing mechanical motion. It's hard to beat the simplicity and reliability of pneumatics. New improvements in designs and efficiency of compressors, and the standard use and distribution of clean dry air in a manufacturing facility, also make pneumatics a good choice for industrial automated machinery.[14] Smart pneumatics aim to help generate and maximize data and also minimize compressed air use. Compressed air use by industrial machines is a close second to the use of electricity in terms of cost, and well ahead of other utilities such as water and natural gas in most plants and facilities. Electricity is less expensive per dollar of unit energy, but compressed air and pneumatics have many other advantages encouraging their use.[15]

8. *Interview with Herman Wang, Director of Global Business Development, Parker Hannifin*
9. *https://www.hydraulicspneumatics.com/pneumatic-valves/pneumatics-robotics-and-artificial-intelligence-come-together*
10. *https://www.iso.org/standard/51330.html*
11. *https://blog.robotiq.com/what-is-isots-15066*
12. *https://www.iso.org/standard/69883.html*
13. *https://webstore.ansi.org/Standards/RIA/ANSIRIAR15062012*
14. *https://library.automationdirect.com/why-use-pneumatics/*
15. *https://www.pneumatictips.com/pneumatic-design-101-go-flow/*

Effective pneumatic systems need properly sized, installed and maintained components from compressors to workstations. A few wrong choices can lead to everything from wasted energy to system failures. Understanding and taking the following steps can help design engineers maximize performance for pneumatic systems:

- Use the latest standards when choosing filters. Governed by ISO 8573, system filtration requirements are regularly updated so staying current can help in selecting the best performing filter.
- Incorporate pressure boosters rather than oversizing a system. Some designers will size their pneumatic systems based on the "hungriest" workpiece, which introduces unwanted costs for operation. By adding a pressure booster, which worked like a reservoir, a smaller system can support operating pressures that are much higher while still meeting the demands of individual workpieces.
- Select modular joiners to save space in FRL assembly. Modular joiners are plates that allow two sizes of air filtration units to be mated so that designers can size individual filtration units based on actual flow requirements.
- Integrate lockable regulators. Workers will sometimes adjust a system's overall pressure to get more air to individual workstations. This can choke or starve other stations, having the ability to lock regulators can not only help improve efficiency but also avoid system damage and possible physical harm.
- Integrate flow sensors in line with FRL units or at workpieces. These sensors can identify blocked filters that restrict air supply and allow contaminants to build up.[16]
- Incorporate air saver units for pulsed air. Many companies utilize continuous streams of compressed air for part cleaning, elimination of dust buildup on photo-eyes, or buildup of weld splatter, as well as in the cooling process in the production of PET bottles. Air savers utilize adjustable air piloted timers to pulse the stream of compressed air leading to air savings in the "off time" of applications.
- Specify reverse flow regulators. Actuators typically have the maximum force in one direction and not in the other. Reverse flow regulators regulate the pressure in one direction and free flow of air in the other. To save on compressed air, reverse flow regulators can be placed between the actuator and valve.
- Design systems with straight fittings rather than elbows. Turbulent flow is created when air flow changes direction through an elbow which results in a pressure drop. There may also not be enough length of tubing after the elbow for the air to return to laminar flow. Laminar flow is needed to generate the centrifugal force within your air filtration to force out water and oil along the wall in the bowl.
- Integrate zero-loss air drains. Most compressed air systems have an air receive, over time condensation inside the air receiver builds up and must be drained. Most systems use timer drains which will drain the air automatically based on a set length of time. If there is no water to be drained in the system, compressed air will be lost. A zero-loss air drain utilizes an internal float to open the drain and blow out when a certain level of condensate is reached in the tank and shut off once the level has returned to normal.[17]

Even seemingly small design tweaks can add up to large improvements in pneumatic system efficiency. These changes can save air, reduce costs, improve overall utilization and reduce downtime in operation.

What design engineers can do now related to efficiency for pneumatic systems:

- Calculate compressed air savings potentials in systems as they are being designed.

16. *4th Utility White Paper draft supplied by Linda Caron*
17. *In Plant Savings – 5 Ways to Reduce Costs with Compressed Air White Paper draft supplied by Linda Caron*

- Stay current on trends and developments in the pneumatics marketplace by reading trade magazines such as Hydraulics & Pneumatics, Fluid Power World, Machine Design and many more.
- Take advantage of manufacturer-provided trainings, white papers and tools.

Conclusion

Ultimately, customers are looking for pneumatic systems that will help them improve their operation. The world of pneumatics is growing and constantly changing, design engineers who stay current on trends and technology as well as partner with reliable suppliers can help their customers succeed with integrated smart pneumatic systems, safe cobot applications and efficient use of compressed air.

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