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CAD software draws on the concept of innovation

From drawing tables and T-squares to computer-aided-design, the tools for design have evolved with technology to make the process faster and easier

By Rick Rice, contributing editor

Over the years, the focus of my Technology Trends columns has been on the hardware. I draw on my experiences as a man in the trenches to add perspective to the ever-forward march of time and progress. Technology has moved so far in the 34-plus years that I have been in automation that it is hard to imagine doing what we do using the tools that we had back then, but the fact is, we did.

If we remember back to those earlier days, even before the use of programmable controllers, we will find that at its core we had the same basic elements in hand, but they came from an earlier generation. There was still a power supply, relays and contactors, drives and motors, and valves and cylinders. With the introduction of controllers, there was programming software, but, behind all that, at the very base, was a design.

The design was, literally, lines on paper that represented the physical connection of wires to make up a control system. From these simple beginnings, all things became possible. Many of us who have been in the game for a while would say that a design actually starts as a scribble on a napkin over a beverage, and that scribble is born from a need.

The process that takes us from a scribble to a set of prints has changed greatly over the years. I am about to date myself, but I learned how to make electrical schematics with pencil and paper, on a device called a drafting board.

Lines were drawn on the paper using a special drawing tool called a T-square. This was a long straight-edge with a second edge secured at 90º to the long edge. To draw a horizontal line on the page, the T-square is pressed up against the vertical edge of the board and then moved up and down to draw horizontal lines that are parallel to each other.

To draw vertical lines, the T-square is hung across the top of the drawing board and vertical lines are drawn by sliding the square edge along the top edge of the drawing board. To draw lines other than horizontal or vertical, tools called squares are used. The common squares have a 90° angle at one point and either a pair of 45° angles or a 30° and a 60° angle. The squares are rested against the T-square in either the horizontal or vertical orientation to achieve a 30°, 45°, 60° or 90° line from the T-square edge.

Squares can be combined to get other angles. A 45° edge can be combined with the 30/60 square to get 75° or 105°, for example. Design, using the pencil- or pen-to-paper method, also relied on excellent penmanship to apply labels and lettering to the drawing sheet. Generally, lettering was free-form and relied on the designer's skills to put legible notes on the paper.

As one could imagine, the time invested in creating just a single page in a set of electrical schematics was extensive. Worse yet, since we are human, we are subject to making mistakes. The designer's best friend was an effective eraser. Any change in design would likely include erasing the previous line and making a new one.

For this reason, plenty of forethought would have to be expended prior to setting pen to paper to reduce the possibility of having to make changes once the design landed on the paper.

Speaking of paper, early electrical design also had to consider who was going to be using the finished set. In most cases, there was more than one individual or group that would have a need to see the prints, and, for that reason, methods of reproduction would have to be considered.

Drawings generally need to be seen from a bit of a distance—arm's length or more—so page sizes must be larger and the information on that page must be easily read from further away.

Common sizes of 18x24-in (B-size) 24x36-in (C-size) and 36x48-in (D-size) were in use. Since multiple copies of a drawing set were necessary, processes were followed that allowed for reproduction by a method called blueprinting. This was a contact printing process where the design is laid down on light-sensitive sheets. First invented in 1842, the process would produce white lines on a blue background, essentially a negative of the original, thus giving the finished product the description of a blueprint. By this means, an infinite number of reproductions could be produced.

The main challenge to producing originals on light-sensitive paper was the relatively fragile nature of the paper. Handling it repeatedly would lead to rips and tears and a general deterioration of the media.

A new method was introduced to use a product called vellum. Vellum has been around for hundreds of years. A translucent media type, the earliest version of vellum was stretched animal skin or a membrane of some type. To write on vellum, one scrapes away the surface of the membrane to etch the information onto the media.

As technology has progressed, variations on the paper and vellum methods led to ink on a synthetic vellum and lettering sets that were used in conjunction with the T-square to produce mechanically improved letters on a drawing.

Regardless of the improvements, these methods of creating engineered designs on drawing sets was a long, drawn-out process. Fortunately, like every aspect of our control designs, the means by which to get a drawing set produced has benefitted from the march of technology.

The biggest boon to control design came in the guise of personal computers, particularly those utilizing a graphical user interface. With the use of computers came the prospect of computer-aided design (CAD). Early CAD software ran on mainframe computers, but, with the advent of the personal (desktop) computer, CAD came to the forefront.

The most popular CAD software today is AutoCAD, but other software packages have been released over the years, each with a niche market segment in mind. Names such as Microstation, first released in the mid-1980s; SolidWorks, mid-1990s; CATIA; FastCAD; and many others, including open—free—versions exist today. Regardless of your favorite version, CAD software is here to stay, and every new version aims to make the designer's job easier and quicker with greater accuracy.

Most of the CAD platforms mentioned above have base versions—2D or 3D—that accomplish basic electronic drafting, but the best part of these packages is the add-on kits that bring enhanced functionality to the basic package.

These kits have specialized menus and functions that are specific to the type of project that the user is working on. Examples of this include mechanical, electrical, architectural, HVAC and MEP (mechanical, electrical and piping). Of particular interest to a control designer is the electrical package.

With my favorite CAD package, I am able to create and manage sheet sets. I can define templates for the various types of drawings that I produce. I have a standardized layer definition that I use across all of my drawing sets. Individual pages or groups of pages can easily be extracted from an already complete drawing set to create a new set, saving a great deal of time by using a library of designs.

Specific information on the drawing set—such as project or customer name, sheet numbers, date created or revised—can be globally updated instead of opening up each drawing and revising each one separately.

Drawings created by other vendors or companies can be imported into a drawing set and then standard items such as layers and colors, terminology, naming and numbering conventions can be applied to the drawings in the set.

While all of the above sounds exciting, it is the collaboration of CAD vendors and hardware vendors that has really enhanced the design process. Most major CAD vendors have included libraries of components by most of the popular hardware vendors. So, instead of just inserting a normally open push button on my electrical schematic, I can provide further information—at insertion or at a later date—to assign the actual part number to the object on the screen, or page.

This method is very handy because it automatically assigns not only the part number, but also the terminal designations and ratings for that particular device into the database that is the drawing and set. An example of where this is very useful would be the insertion of a control relay. Perhaps at the outset of my design, I just need a single-pole control relay with a 24 Vdc coil. I select one from my favorite vendor and move on with my design.

The software program automatically assigns the terminal designations as defined by the manufacturer and not only the relay coil but the contact terminals, as well. By selecting the coil or the contact, once inserted, the software will bring up a summary of the device and what contacts have been used and what are still available.

Inserting additional contacts will automatically assign the terminal designations, and the software will notify the designer if the relay no longer has any available contacts. With a click of a couple of selections, the designer can choose another relay with more contacts on it, and the software will automatically update the database in the drawing to reflect the selection of a different component.

Common with all CAD software programs, each drawing is a searchable file that contains information about all of the components on the page and drawing set at a

While discipline-specific designer kits are available, the ability to combine disciplines has come to reality.

whole. Designer tools in the software create reports of the components in use in the drawing sets, and cross-reference reports can be generated to show where all the components exist.

Here is where things have gotten interesting the past few years. While discipline-specific designer kits are available, the ability to combine disciplines has come to reality. Starting with an electrical schematic, the designer can also design the control-panel layouts, using mechanical design kit and then, in the best part of all this, can insert mechanical components in the panel layout.

The software will automatically add the component to the electrical schematic database. Further, once the link is established, the software will also take a component on the electrical schematic and add it to the panel-layout database. Any component added to one drawing set becomes part of a selection list for the other set. The advantage here is that the designer doesn't have to keep track of additions at design time because the software keeps track for them.

Conducting an audit at any time in the design process will reveal items that are in one database and that aren't inserted on a drawing in the other drawing set or sets.

Computer-aided-design has taken that sketch on a napkin into a realm that is hard to imagine. It would be nearly impossible to design control systems without the use of CAD software, and the modular aspects of drawing sets created electronically has dramatically reduced the amount of time needed to bring a design to life. How did we ever live without it?

HMI software makes the user experience

While the hardware chosen for a human-machine interface makes the HMI software choice easy, it's always the software that makes the application shine

By Dave Perkon, contributing editor

Human-machine-interface (HMI) software has come a long way over my 32-year automation career. I have developed many simple HMI applications using a DOS-based operating system and experienced its rise with the introduction of Windows decades ago and the open systems of today. But it's not the hardware I remember; it's the HMI software.

For me, my HMI experience didn't start with a monochrome display; I started designing operator-interface panels full of illuminated pushbuttons requiring that holes be drilled and each device be wired. There would be 25 or more of these devices controlling the machine cycle and manual functions. Every motion had an illuminated pushbutton controlling the motion and displaying its status with a light.

A one- or two-line text display was a luxury, but imagine programming a hundred or more alphanumeric status and fault messages and controlling them via ladder-diagram programming to display what's important, especially when many needed to be displayed at the same time. It wasn't easy; it was time-consuming and there was never enough information.

The graphic world of Windows certainly helped to simplify HMI software development in the early days. However, electronic help documents within the program were OK at best, but the user did receive a large stack of printed manuals to help guide the way. Today, the availability of online-help multimedia is important, but some HMI software suppliers do it much better than others. Take the time to view the available online training documentation and videos from beginner level to advanced. It may likely be a differentiator when selecting an HMI software package.

The multimedia training is impressive with some HMI software. And it gets even better. The HMI software of today goes well beyond the software capabilities of the past. A single HMI can connect to multiple PLCs monitoring and controlling them all. Some act as a gateway tying multiple PLCs together, sharing data between each. While it isn't really for real-time control, it can pass informational data back and forth such as status, batch and lot numbers, and other non-time-critical data.

It's the higher-end HMI software packages that really expand the user experience and makes the connections. And, by connection, I mean connecting to everything on the factory floor and everything above it, as well including data historian, ERP and the cloud. The resulting HMI and SCADA enable viewing industrial applications on desktops, high-definition TVs, tablets and mobile devices. And it's all integrated in a single development environment, the HMI software.

The right HMI software allows use of development tools, component libraries and database integration to quickly create just about any industrial HMI application needed. Pick the right software and the Industrial Internet of Things (IIoT) is literally at your fingertips—but a PC and Ethernet connections will be needed.

These applications range from a simple HMI or overall equipment efficiency displays to centralized data acquisition, device monitoring and control, and enterprise-level analytics. If it's in the requirements, the programmer's mind or noted as a future requirement, some HMI software can do it, so be sure to take the time to find an easy-to-use platform with the features that fit well with the IIoT.

Often, more than one developer is involved with an HMI development project. HMI software that allows multiple programmers or even an unlimited number to work with the software at the same time is an advantage. Other software packages charge for individual licenses to do the same work, but, clearly, having a single software platform that can bring together as many programmers as needed along with the data and systems needed to create multiple industrial applications is the better choice.

The HMI software may come with everything needed to create the application, but the future demands more. And don't think the software is for a single HMI. It can be scalable for many HMI displays, It’s the higher-end HMI software packages that really expand the user experience and makes the connections.

and software modules can be added and developed without impacting existing applications. And it is all designed to work seamlessly with them.

Take the time to look at the capabilities of today’s HMI software. It can create just about any industrial automation solution needed whether it’s just a local machine display, a plant SCADA system, connecting to the IIoT, tracking operations using MES or beyond. HMI software can do it, or it can likely be expanded as needed. Adding the connections, reports, charts and tables for a clear view of the machine, process, system or facility has never been easier.

Where's the logic in the PLC?

PC-based control is still forging its way amidst a ladder-logic world

By Jeremy Pollard, CET

Way back when, I declared that PC-based control would take up over 40% of the market from the standard firmware-based PLC. Why?

Because of the cost and the availability of having the control, as well as the HMI, on the same machine. The operating systems were varied, from Windows to VxWorks real-time OS. Various OS kernels were developed to provide a more real-time response to occurrences in the field due to the interrupt-based systems, typically, the IBM PC platform. A problem arose, however, since basic hardware configurations were used. These included things such as a CD drive and more interrupt-driven resources that were placed on the system.

So the platform was redefined, and finally the control software had a good place to execute the algorithms and code needed to control the process.

We take so much for granted in a PLC environment because our interface to it is a slick programming environment—an integrated development environment (IDE)—which provides all the commands and instructions needed to create, download and monitor the process software.

With PC-based control it was no different. You would never really know the difference by looking at the screen where you would create and monitor your application software.

Windows CE was a common platform for embedded OS-based systems. The IBM PC board design and chipsets were copied into different form factors, such as PC104, VME bus and PCI. This allowed the control software to reside in an embedded system and allowed for better control methodologies.

One of the very first PC-based control systems was a product called FloPro which was developed by Ron Lavallee in the mid-1980s. It was based on flowcharts, which constitutes a decision-by-decision method of creating a process flow.

However his first go-round was a post processor that took flowchart symbols and converted them to ladder logic using code that was generated on an HP-85, which is another story.

In fact he demonstrated his development to Gould Modicon, which made overtures about buying the technology but moved away from it for some unknown reason.

FloPro moved over to the IBM platform, and, with the addition of a communication card to connect to Allen-Bradley remote IO system, FloPro made it into the development world at General Motors, and a new paradigm was born.

Sequential function chart (SFC) was alternative-state-based control software that was used in PLC firmware. It is now available in many hardware formats, and has replaced flowcharting as a control software state-based system.

Mike Klein started a flowcharting company called Steeplechase, which had early success in the world of computer-based control. It was Windows-based and provided a much better interface than FloPro by all accounts. Steeplechase formed alliances with various companies and in fact spawned additional flowcharting companies such as Think & Do.

Another company that was formed because of FloPro was FlexIS process control. It was a post processor that took SFC programming of the control algorithms and converted that to Allen-Bradley's PLC-5 subroutines in ladder logic. It was really slick and very well done, but there was some pushback from the industry regarding these graphical languages because the development minds really didn't think in the way that was needed. Their minds were geared for ladder-logic development, and most of the development occurred one rung at a time.

I actually ran into a system at the Nike distribution center in Toronto that was still running Steeplechase flowcharting software. If anything went wrong, they would have no resources to help, I would suspect. And therein lies the rub.

> IEC 61131 has been around for almost 30 years and compliance with it is now becoming accepted as a control software platform.

It is all well and good to have a novel idea and a new way of creating a controlled process program, but you have to have the resources to create, as well maintain, the end result. FloPro ran into a brick wall after a project in Windsor, Canada, as the integrator reportedly blasted the software for really bad visualization and the lack of tools for troubleshooting.

IEC 61131 has been around for almost 30 years and compliance with it is now becoming accepted as a control software platform. Beckhoff Automation uses a PC-based hardware platform and runs IEC-61131-compliant control software on the machine, which also includes the HMI. This emulates the original perceived benefit of the original reason for PC-based control.

Control software has morphed over the past 40 years, but interestingly enough most processes are still PLC-based and mainly created with ladder-logic implementations.

Almost every survey done in the past 10 years has ladder logic being the leader in how processes are controlled.
And, as luck would have it, the PLC is far from dead, but PC-based control is nowhere near the potential it could have risen to. It’s interesting that Rockwell Automation’s new ControlLogix platform has the opportunity to run Windows-based software.

A PC in a PLC—so, which is it?

Decoupling of hardware and software enables reduction of IoT device requirements

Tech software consultancy discusses compute demand, power consumption and manufacturing costs

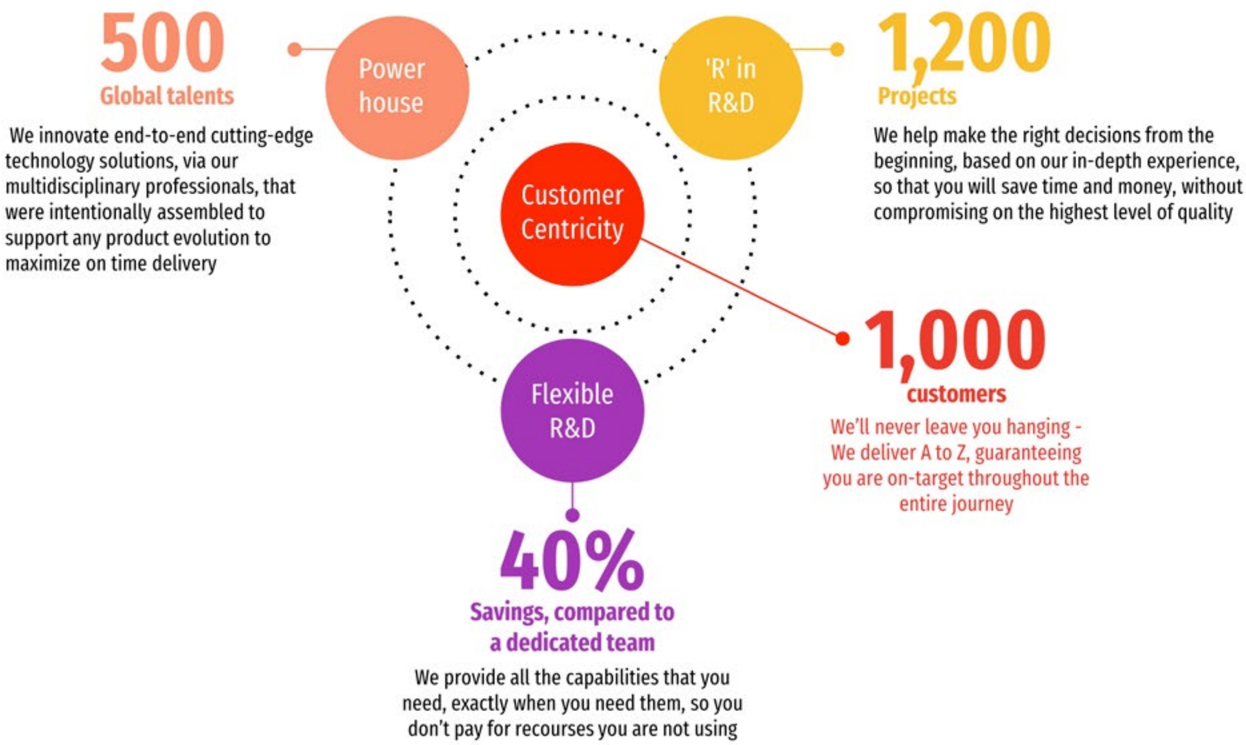
By Mike Bacidore, editor in chief

Commit (www.commit.us), an Israeli-based global technology and custom software solutions company, is expanding into North America with the launch of Commit USA. The new business unit is led by Max Nirenberg, serving as its managing director and chief revenue officer, from its headquarters in New York City (Figure 1).

COMING TO AMERICA
Figure 1: Commit, founded in 2005, has offices in Israel and Ukraine, along with its new office in New York

Nirenberg will lead and optimize Commit's growing international organization, oversee strategic planning for the global account management teams and ensure the company's delivery capabilities meet the U.S. market needs.

"The pace of tech innovation has never been more intense, with more startups launching, and failing, than ever before," says Arik Faingold, president, Commit. "A great idea alone is not enough to succeed. What many organizations lack are the engineering capabilities, development know-how and adequate resources to get their



BY THE NUMBERS
Figure 2: Commit has led more than 1,200 projects for more than 1,000 organizations worldwide, with clients ranging from early-stage startups to global brands including IBM and, SanDisk.

product into market. This is where Commit can help. Max's experience and passion for building successful sales teams and customer-centric services on a global scale will be invaluable to our organization and customers as we expand into new international markets."

Founded in 2005, Commit is one of Israel's R&D and software development firms, offering a range of engineering capabilities and resources to design and deliver any project. The firm's proprietary Flexible R&D methodology is designed to transform its clients' technology visions into high-quality products. The company specializes in a range of advanced technologies and applications for multiple industries including Internet of Things, medical technology and consumer goods.

Commit has led more than 1,200 projects for more than 1,000 organizations worldwide, with clients ranging from early-stage startups to global brands including IBM and, SanDisk (Figure 2).

"Commit's expert engineering capabilities and methodology for project management gives us the flexibility to provide hands-on services and shift resources to quickly scale whenever a need arises," says Nirenberg, who brings more than 20 years of management experience to Commit USA, with a strong specialty in SaaS and tech services. Previously, he served as the global chief sales officer for quality assurance company, Qualitest, where he oversaw teams across three continents and helped to sell the organization in its latest private-equity round for approximately $400 million in 2019. Prior to Qualitest, Nirenberg was an equity partner and VP sales/professional services at Venator Sales Group, a sales management consulting and training firm.

Commit is a global tech services company with offices in New York, Israel and Ukraine. The company was founded in 2005 and has more than 500 multi-disciplinary innovation experts who serve a broad range of companies from small startups to large enterprises in multiple business sectors. Commit specializes in advanced technologies and applications with dedicated practices in software, IoT, big data, cloud and cyber.

What are three key things that a machine builder, system integrator or manufacturer should know about your organization?

Max Nirenberg, managing director and CRO, Commit (commit.us): We take a product-centric approach, rather than a technology-centric approach. Our goal is to build the best solutions for our customers that not only fully meet, but exceed their product and business needs.

We believe that the original driver of both technology and product is the business and, specifically, the pains a business is trying to solve. After that, product and technology drive each other in turn. Therefore, we use product development to drive our technological innovation, and not the other way around.

Following this approach, we always tailor-make our solutions and choose the most appropriate technology for solving the specific problem at hand, as to avoid restricting our product department's capabilities and innovation. If no suitable candidate is found, we will develop one.

What new technologies are driving product development and why?

Max Nirenberg, managing director and CRO, Commit (commit.us): In recent years, we've seen a massive rise in the fields of IoT, IIoT, big data, AI and healthcare, and much of this innovation incorporates some elements of IoT, either to enable a device and its end goal or as a main data source for the operation.

The field of IoT is driven by constantly growing demand, but in the past several years, it received a significant boost due to new technologies that enabled better, cheaper, faster and more secure and reliable device-to-device communications, as well as better methods to leverage IoT capabilities.

A few examples would be:

- big data engines. Many innovations and new technologies in big data, such as Hortonworks DataFlow and Data Platform (HDF/HDP), MemQL and Elasticsearch, are enabling organizations to leverage the data from devices to generate entirely new and actionable insights, many of which can be extremely challenging, if not impossible, and expensive to calculate otherwise.
- management and provisioning. Advanced platforms for deploying, onboarding, provisioning, securing and controlling IoT devices and remote version updates are becoming increasingly affordable as a managed service. For example, AWS IOT Core or Azure IOT Hub significantly reduce time to market for leveraging IoT devices in the real world, with both control and scaling capabilities. This enables organizations to grow fast and rapidly develop, focusing on their core business and competency.

How does the Industrial Internet of Things figure into business strategy?

Max Nirenberg, managing director and CRO, Commit (commit.us): IoT capabilities and their companions, such as big data and automation, enable businesses to transition into data-driven organizations. This evolution can greatly improve the operations of all departments—business, operations, R&D, customer services—by providing new and essential tools such as automated process controls and standardized decision-making to help groups collaborate in a unified direction.

The ability to use data and collaborate better will also increase the volume and speed of operations and will force organizations to become more velocity-centric and a bit less price-centric.

For example, organizations can leverage IIoT capabilities to help with:

- business intelligence and maximizing profits. Before IoT, device manufacturers, sellers and integrators had to rely on assumptions regarding the use of their devices and services and often only received feedback from labs, beta testers, focus groups or angry customers. With the emergence of IoT, collecting business data from real-world use cases has become much faster, cheaper and more accurate, enabling businesses to make smarter decisions based on hard data.
- faster time to market with better quality. With real-world IoT data, organizations have new insight and feedback about the product in a significantly shorter amount of time, which enables development teams to solve issues faster. Supe-

rior data will also help the product and business teams to better plan for the future and align strategy with the business goals while reducing time and costs for R&D (Figure 3).
- better control & more accurate forecasts. By leveraging automation and big-data systems, organizations can develop more accurate forecasts, mitigate business and cashflow risks and, overall, react much faster to market changes and adjust their business strategies accordingly.

How will machine automation and controls alter the way companies staff their operations in the future?

Max Nirenberg, managing director and CRO, Commit (commit.us): The rising adoption of AI and automation has been transformative across operations for businesses everywhere. From streamlining workflows and procedures to the way employees are onboarded and trained, organizations will have to adapt to comply with a new way and scale of work.

Organizations are becoming more data-driven and controlled, with the ability to both react faster and work with larger volumes—customers, goods, supply chain—due to connected tools for robotically powered repetitive actions and service automation. These capabilities will increase scale of services, while reducing the need for manual intervention.

LOOK AHEAD
Figure 3: Superior data will also help the product and business teams to better plan for the future and align strategy with the business goals while reducing time and costs for R&D.

As more tasks are moved from humans to machines, staffing for operational teams will become more focused on managing automation, rather than manual labor. The entry level for many of the operational positions will rise, and add to it required technological know-how, while the positions themselves will have more responsibility spanning over a larger amount of controlled process.

Another trend we are likely to see is more extensive offload of operational functions to third-party service providers, mostly in the realms of development, support, monitoring and DevOps (software development and IT operations). This offloading will enable businesses to cost-efficiently meet the rapidly rising need for more multidisciplinary trained personnel.

Though the operational cost per single employee may increase, this change will overall yield a better ROI on operations teams due to improved efficiency and the ability to perform more complex tasks and larger volumes of operations in a lower amount of time.

How is the development of software solutions impacting requirements for hardware?

Max Nirenberg, managing director and CRO, Commit (commit.us): Aside from special cases, like video cards and their drivers, the current trend is to create as much decoupling as possible between software and hardware components. This is due to the very different lifecycles of both and the different challenges they both face.

Due to more complex and costly development and testing cycles, hardware solutions are less flexible by nature than their software companions in terms of the possible speed of introducing new features and capabilities to the market.

For example, as the Internet became faster, more data could be collected and the number of users grew, the hardware world could not keep up. The demand for increased power, memory, CPU and other server parameters needed to keep working cost efficiently became overwhelming, so, as a solution, the software world began moving from monolith services to distributed systems.

This allowed the software components to scale out horizontally. Instead of needing to invent a more powerful CPU or motherboards that can support more RAM, teams can now take several of the traditional, inexpensive servers and bind them together using the software. Whenever the need for additional compute power arises, organizations can just add more of the same hardware to answer the demand.

The decoupling trend is also moving the industry to create more generic hardware components that can be utilized by software to answer different needs. One aspect of this transition is that more and more logic and heavy lifting has moved from the embedded software layer, which is device-specific and dependent on the hardware parameters, into other application layers such as external servers and cloud solutions.

Instead of needing to invent a more powerful CPU or motherboards that can support more RAM, teams can now take several of the traditional, inexpensive servers and bind them together using the software.

Decoupling enables the reduction of IoT device hardware requirements in terms of compute demand, power consumption and manufacturing costs. It also allows IoT capabilities to yield better value to end users, as the logic—the brain—of its operation is far less constricted by the single hardware unit that it operates.

As engineering and IT continue their convergence, which one is and/or will be leading the direction of future automation and technology?

Max Nirenberg, managing director and CRO, Commit (commit.us): I don't believe there will be a specific lead in terms of progress and innovation as engineering and IT are two parts of the same solution, and both are required to close an end-to-end loop for any requirement.

Having said that, in terms of process of development and rollout of products, services and systems, the lead is assumed by engineering, as IT is there to answer the engineering requirements. The initial driver of all requirements, however, is the business need. This requirement will first come to the engineering departments to build, integrate and/or evaluate a solution.

From this point, the engineering department takes ownership of the process, and they will create a solution that meets the business requirement. Additionally, they will create the IT requirements that will have to be implemented by the IT department.

As engineers have more direct contact with the business and customers, in most cases, I assume that they will be the main driver and lead for creation of future automation technology. However, IT will have to keep up with the demand, as well, so engineering and IT will have to work hand-in-hand in order for any one of them to succeed.