

# PLANT DESIGN

## FOR THE PEOPLE



**Gary Carson,  
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explains how the  
democratisation of  
plant design can  
benefit companies.**

**I**n the 1970s and 1980s, plant design tools were restricted to the large engineering, procurement and construction (EPC) firms in the wealthy, westernised countries, while the skills to run these programs within these firms were held by a small number of people. Access to these tools were the realm of the 'haves' of the world because only the largest companies could afford the hardware, software, staff and training infrastructure required. These mainframe systems could cost US\$ 600 000 – 800 000 or more to set up and required years of training and customisation to run. Even though 3D information could be input into these systems, they typically did not offer any 3D visual interactivity, leaving users to wait for plot runs and screen shots to show designers that they were on the right path. The benefits were substantial, but the process was slow and time consuming, in addition to being expensive.

## People barriers

Because of the economies of scale needed to implement these systems, many resources were often shared among dozens or hundreds of designers and engineers. CPU time was precious, leading workers to access computing power using workstations or by running certain processes overnight. For example, it was common for isometrics to be run overnight or over the weekend. If a designer wanted to run off isometrics during the workday, it was not going to happen.

## Silos of information

While these automated systems boosted productivity, they delivered little or nothing in the way of collaboration when compared to the drawing board or standalone workstation. Therefore, a change to something as simple as a nozzle elevation, steel size or a routing change due to stress requirements would not always be reflected in the design nor would that information be made easily available to those affected by it. Each department, group and/or person was an information silo doing their thing, and because there was no concurrency between departments, they were often not working with the latest information.

The budgetary effect of this lack of concurrency often showed itself in the construction, installation, commissioning and startup phase of the project, as whole teams of designers and engineers were stationed on site to interpret and reformulate the designs passed on at handover. These teams sometimes spent years on site playing catch up as they attempted to create the as built drawings and documentation that reflected the existing conditions of the site.

## Seeds of democratisation

As more powerful personal computing capabilities became more available, Microsoft, Autodesk and others were developing tools for the PC that would become foundations for the future democratisation of plant design. For example, the Microsoft Windows operating system with its standardised, friendlier, menu driven, graphical user interface and multitasking capabilities expanded the popularity of the PC in the corporate world and then design world; and, Autodesk's AutoCAD brought easy to use computer aided design to the PC. In recent years the worldwide web has also played a key role. Search engines such as Google, online networks, wikis, and other web based tools have made online access to information and online collaboration easier and more readily available.

## Collaborative plant design

Among today's developers, COADE took an early lead in democratising plant design with its PC based pipe stress analysis solution, CAESAR II. A few years later, they introduced PC based PV Elite for vessel and exchanger design and analysis. Later came their AutoCAD based plant design solution, CADWorx, which then added the unique ability to interface and collaborate easily with the company's earlier released CAESAR II and PV Elite engineering analysis packages. They accomplished this by leveraging these widely available and popular

systems, platforms, and standards with which people had become familiar and on which they had learned to rely, thereby removing barriers that had prevented the broad use of these plant design systems.

## Removing barriers with the push of a button

By concentrating on integration and interoperability among disciplines and products, these collaborative plant design solutions allowed, by a simple push of a button, the ability to share data between plant design and analysis. This eliminated many of the bottlenecks between the designer and engineer.

Artificial intelligence was also brought into the mix. The software developers looked at the roles of the designer or engineer and the processes and tasks involved in them carrying out their jobs, and placed many of those capabilities into the software so that more of these specialised tasks could be performed automatically. For example, if a stress engineer wants to produce a stress isometric, it is no longer necessary to go to a designer to perform this function. Now, one just sets some parameters and has the system do the task, without needing to involve the designer. Likewise, the designer can pick up the stress engineer's modifications of the design and pull them directly into the model, without having to wait for the engineer to produce a marked up drawing of the proposed layout.

## Linking information to stay in sync

These programs are also addressing similar challenges with process and instrumentation diagrams (P&IDs), from which piping designers get their process information. Before collaboration, it was rare that one could find something that linked the 3D model to the P&ID. COADE's solution allows the designer to access this information by opening up a dialogue box in the CADWorx Plant software and pulling piping components from the P&ID into the CADWorx Plant model. This process flags that the component is present in the model. This type of information sharing and linking lets people do their jobs and keep things in sync with others downstream and therefore requires no reinterpretation.

## A continuous process

Democratisation through integration, data sharing and interoperability has transitioned plant design from a batch process of static information silos into a continuous process. For example, CADWorx Plant allows all designers to work on their individual areas and systems, and as changes are made, everybody can be sure that the information they have is current. Likewise, if the stress engineer's analysis determines that changes are required, these can also be automatically incorporated, with similar benefits.

## More time for better designs

When they are rushed, workers do what they have to do and move on to the next urgent task. When people have more time on their hands, they have more time to do the job better. With democratisation, people, meaning

the designers and engineers involved in plant design, have more time to do a better job because everything is more efficient. With more time, they have the freedom to invent, to conceptualise, and to optimise the design.

## Opportunities

Democratisation of plant design has allowed small companies all over the world to get involved in plant design because these new tools only require a PC, a link to the Internet, and easily obtainable skills in Microsoft and AutoCAD. No systems manager, database manager, or software manager is required to install and run these PC based solutions. Also, if necessary, users can train themselves online or by video, with minimum overhead, and become productive almost immediately.

## Safer facilities

For the rest of society, there is even more at stake than cheaper and more accurate designs, and that is safety, because, if a design does not consider all of the inputs required, it could present a safety risk. When safety is at stake, the costs are not only monetary, but also the risks to people's jobs and lives. There is also the potential environmental impact of spillage, emissions, and damage to plant and animal life due to an unsafe design. However, with concurrent and accurate engineering and design of the plant facility, all of the inputs are more easily considered, which helps deliver a safer design.

## Global 24/7 productivity

Global collaboration also offers the option of outsourcing in ways that can benefit all. For example, the firm can access high value solutions and send the work to those areas where it is most efficient, based on proximity to the plant, to vendors, to staff and/or access to the lowest labour cost. Collaboration allows the person to do the task for which they are best trained, regardless of location.

Global collaboration also allows the company to work around the clock, starting the project and handing off to various time zones, on a daily basis, all sharing the same plant and analysis information, therefore finishing the project much faster.

## Expanding intelligence

To do the work in plant design, a person still needs to be an engineer or designer with an acceptable level of skills, training and knowledge. In the future, more expert systems and artificial intelligence in plant design programs will become apparent. This type of shift has occurred in the medical field as tasks that were, in the past, performed only by doctors, are now performed by nurses or medical technicians. The same can be effected in plant design by taking the level of knowledge, skill, or experience of the highest level designers and engineers, and using expert systems to automate skilled tasks to make those capabilities accessible to those with less experience.

An example is the piping loop wizard in the CAESAR II pipe stress analysis software, which takes democratisation beyond just supplying computer power. This automation tool captures the engineering skills of a person with years of experience and brings that

knowledge to engineers of any skill level so that they can perform involved and complicated tasks.

Another example of how to leverage expert systems is in the checking work of plant design. Typically, the most experienced people would be called upon to check everything about a design: the face to face dimension of the valve, the length of the flange, cut pipe lengths, bolt lengths, etc. Now, the designer trusts these new systems to do those checks on these standardised items quickly and accurately.

One of the latest expert systems being developed by COADE will allow the stress engineer to select lines for analysis directly from the model. Once the engineer has run the analysis and modified the design, the information can be passed to the plant designer in real time. This will allow the designer to evaluate and incorporate the changes immediately rather than waiting on the engineer to check the design at a later stage or when the design is complete.

Similar efficiencies are planned on the design side, allowing a preemptive analysis of the piping system to see if a part is overstressed. By selecting a line for attention, the expert system will show if the line is overstressed. If so, the designer can easily reroute the pipe to resolve the problem, pushing potential problems, errors and rework upstream to earlier stages in the design process where they are much less expensive to address.

## Addressing employee turnover

Bringing expert knowledge to the next level is important for another reason. In the plant design industry today, approximately 50% of the workforce consists of highly skilled people with over 20 years of experience. Most of these are slated to retire over the next 10 years or so. Because of this, the industry will struggle to replace or maintain the knowledge and skills that these workers currently hold.

While most of the newer people coming into plant design are educated, skilled and knowledgeable, they do not have this experience. Artificial intelligence systems are the best way to bridge this gap by capturing experience that would otherwise take years to acquire.

## Conclusion

The development of these new collaborative plant design tools has actually been a continuous process at COADE that began in the early 1990s when they expanded from engineering analysis software into plant design. A key to being able to lead the world toward democratisation in plant design was having all the component solutions in house, with everything from plant design to pipe stress analysis to vessel analysis, to vessel drawing production, to model review and walkthrough.

Further democratisation of plant design through expert systems will continue to allow access to the specialised experience and skills for more people. This can only continue to benefit companies, their employees and plant owners. This will also further benefit the world's economies and societies by speeding up the design process, lowering costs, expanding economic opportunities, and delivering higher quality and safer plant facilities. 