WHITEPAPER

The Role of Plant Engineering Software in the Process Industry and Testing Solutions

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Transforming the World Through Quality

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Contents

Management summary

This white paper describes Product Lifecycle Management, employing process engineering software and its testing solution. A process engineer solves practical problems with the help of the software as well as maintaining all the track records in the software database. Maintenance of the process industry is one of the key values added by the software.

Process engineering software optimises processes as well as increasing the Key Performance Index (KPI). Generally, manpower involvement is reduced by the software to running the process industries, thus helping management to increase efficiency in this area.

Keywords

PROCESS INDUSTRY

PLANT ENGINEERING SOFTWARE

PLANT AUTOMATION

TEST AUTOMATION

AUTOMATION INDUSTRIALISATION FRAMEWORK

Introduction

In the manufacturing industry there is an increasing need for process management, people management, cost reduction and time reduction amongst others. Most organisations focus on achieving goals such as profitability, revenue/margin, optimum utilisation and cost savings. To succeed in all these challenges, we need smart, efficient software. We would like to give an overview of the process industry, focusing particularly and specifically on the non-discrete aspects in the power sector. Below we set out the challenges faced by plant engineers/managers and their solutions, and the role of plant engineering software and its testing solution based on our own experience.

Market analysis

The increasing need for automation and the growing adoption of integrated solutions for analysing and designing engineering systems means the global engineering software market is flourishing. And the growing penetration of mobile devices such as smartphones, tablets and laptops has increased the availability and accessibility of engineering software which, in turn, is strengthening the growth of the engineering software market. However, high maintenance and licence costs coupled with a lack of technical expertise in operating such software are hampering market growth globally.

The global engineering software market defines the use of different software such as computer-aided design (CAD) software, computer-aided engineering (CAE) software, computer-aided manufacturing (CAM) software, electronic design automation (EDA) software, and architecture, engineering and construction (AEC) software. The global engineering software market was valued at US$ 19.98 billion in 2014 and is forecast to grow at a CAGR (Compound Annual Growth Rate) of 12.4% from 2015 to 2022 [1].

Process industry

This is where the primary production processes are either continuous, or occur on a batch of materials that is indistinguishable. ‘Continuous’ means, from receiving the raw material to transforming it at the different process stages and finally creating the finished product per design. This industry can be divided in two major types – **Discrete** and **Non-discrete**.

- **Discrete Industry**

  Discrete manufacturing is all about assembling things, and making things that are exact. The products are typically manufactured in individually-defined lots. The production work sequence may vary for each lot. Thus, in discrete manufacturing, the product is made using sequential steps. Discrete manufacturing is based on production orders and the product may change frequently from order to order.

  Discrete manufacturers make finished goods that may have screws, nuts, handles, etc. that can be taken apart and used on something else if needed. In discrete manufacturing, workers on the shop floor construct products based on orders. The individual products are easily identifiable. Any expert can strip a car or a mobile phone back down to its initial components

  Sectors: Automotive

- **Non-Discrete Industry**

  Non-discrete process manufacturing can be described as follows: a product requires a set of processes in order to be completed, yet each process has certain specific requirements and therefore it is better to separate each process from the other while planning and defining the manufacturing requirements. Thus the processes are better controlled and maintained if they are dealt with separately.

  Process manufacturers build something that cannot be taken apart; technically you can take a mix out of a container and reuse the container, but you can't take the ingredients out of the finished goods produced. For example, no one can convert the electrical energy generated in power plants to the mechanical energy of turbine rotation and then to heated steam in a reversal of the generation of electricity. This makes the industry 'process' or formula based.

  Sectors: Power, oil and gas, chemical, etc.

For such industries, plant engineering software plays an important role, from design all the way through to plant maintenance. It helps plant design engineers and plant operating personnel to boost productivity and quality, minimise design costs and time, and maximise equipment uptime by optimising their workflows with the help of different phases of plant engineering software as described in Table 1.

We can use the Power industry as an example. Details of the different stages are elaborated below:

1. Concept design

- At the initial stage of a project, the concept of the power plant process is usually represented by a block diagram as per the tender document.
- Design cases are imported from the various simulation programs, e.g. AspenPlus (AspenTech), ProMax (Bryan Research & Engineering Inc.), UniSim Design (Honeywell Process Solutions).
- A PFD (process flow diagram) is created, which is the graphical representation of a process that schematically describes the conversion of raw material to finished product without specifying the details of how the conversion occurs.
- Dimensioning of equipment as per design calculations.

Concept Design	Basic Engineering	Detail Engineering	Commissioning	Operation & Maintenance
Block Diagram	P&ID Diagram	E, I&C	Factory Acceptance Test	Maintenance
Simulation	INPUT-OUTPUT List	SW/HW	Site Acceptance Test	Optimisation
Process Flow Diagram	Equipment List	LOGIC DIAGRAM	Loop Check	Key Performance Index
Equipment Dimensions	Pipe List	Automation Interface	As-built	

Table 1: Different phases of plant engineering software

2. Basic engineering

- Conversion of a PFD into a P&ID (the P&ID includes all the details of process, piping, equipment, instruments, tag numbers, etc.).
- In a P&ID (piping & instrumentation diagram) all the DATA is managed, so lists of instruments, inputs-outputs, equipment, loads, pipes, etc. can be easily prepared in BASIC Engineering.

3. Detail engineering

- Single line diagrams are first prepared for electrical, instrumentation & control.
- Along with the SLDs, the circuit diagrams and wiring diagrams are also prepared.
- Using these cable calculations, equipment is selected and a bill of materials prepared.
- Hook-up diagrams and LOGIC diagrams are prepared in DETAIL engineering with the help of P&ID diagrams.
- The sequences of LOGIC diagrams are used to guide automation interfaces with the help of plant engineering software.

4. Commissioning

- At the initial stage of commissioning, the factory acceptance test is undertaken a couple of times.
- Once this is successful, the site acceptance test is performed.
- The final loop check is done following a positive site acceptance test.
- After physical commissioning of the plant, as-built documents are prepared.

5. Operation & maintanance

- Operation and maintenance are performed according to a specific procedure. Maintenance plans for different equipment are scheduled at plant start-up. Pop-ups on the monitors flag up any breakdowns and say when preventive or scheduled maintenance are required.
- Optimisation is achieved through project feedback.
- The factors which are key to the success of the project are evaluated.

Typical challenges faced by a plant design engineer in the power industry

There are many challenges faced by a plant design engineer while executing any project, but some of them are crucial for the successful outcome of the project, as detailed below.

Increase international competition

Every day the per-megawatt costs of power projects decrease, while material costs increase and the environment is the major issue in any project. Every nation prefers plants which will leave the lowest carbon footprint in the environment. After 2015, the United Nations Climate Change Conference made it a requirement to reduce the emission of greenhouse gases (e.g. SOx, NOx) from any plant. The emission limit for particulate matter is 30 mg/Nm3, sulphur dioxide (SO2) is 100 mg/Nm3, nitrogen oxides (NOx) are 100 mg/Nm3, and mercury (Hg) is 0.03 mg/Nm3 (units to be installed from 1st January, 2017). Hence a continuous analysis of commissioned power plants is required [2].

Increase productivity and quality

During the design, planning, manufacturing and commissioning stages, industry has to follow certain international standards (OSHA, ISO, ASME, ANSI, IS, AWS, etc.). The application of standards helps plant engineers to improve quality. Design software, upgrading of standards and continuous analysis can offer a solution to increase productivity and quality. In terms of quality, any mistake in a project generates a non-conformance report (NCR) where the failures are logged in detail. Experts close the report with best and alternative solutions at minimum cost. In such cases, database management can provide feedback experience to help learn from previous failures.

Minimise design costs and time

In any project, the major portion of the design cost is soft costs. Innovations, lessons learnt from previous projects, latest versions of the software with add-on features and international standards already minimise the cost in a logical manner.

Database management software uses data from identical completed and commissioned projects to build up data and a design structure for new projects. 3D software helps to view the future plant. These resources offer considerable time and cost savings.

Maximise equipment uptime

Plant engineers always face equipment uptime* challenges, which can affect the overall productivity of a plant. To improve efficiency, equipment uptime must be maximised.

Solution provided by plant engineering software

Nowadays the software developed for the manufacturing industry is extremely smart and gets results. The market is highly competitive, with most software helping plant engineers to reduce the amount of brainstorming required. Let's look at how software helps.

Process design and optimisation

The software packages used for design and process monitoring are integrated with each other nowadays in order to meet customer demand. 3D software can also add physical parameters like temperature, pressure, volume, material and stress in addition to dimensions, which can ensure that a designer chooses the best possible option in terms of quality and cost. The designer can also maintain the database while designing the plant, using highly accurate estimates to facilitate working alongside the installation and commissioning engineers.

Plant automation and operations

All necessary functions to monitor plant operations are integrated into the operator station, including:

- Intuitive display navigation
- Faceplate control of any device in the plant
- Integrated alarm and event management with sequence of events
- Trend curves displaying current as well as historic values

* Uptime is the total time that an equipment or process is available to perform its function.
UPTIME = Total time available – Downtime.

This will reduce plant running costs.

Plant lifecycle management

To ensure the maximum uptime of any piece of equipment, regular planned and preventive maintenance is required. Engineers can create different maintenance plans for each machine, assign these to the appropriate personnel and track all activities in real time using software programs.

The software packages not only provide solutions but also interface with each other to increase the transparency as well as the agility between client, vendor and contractors. With their global perspectives, they allow anyone linked with the particular project to convert their visions into a reality.

Joint ventures

Nowadays, industries are coming together to bid for contracts in order to offer the best possible outcome.

Test automation for plant engineering software

With software expanding into every area of life, testing has become essential. Newer versions with added features and an agile approach are released in ever decreasing timescales. This activity has increased over the last 5-6 years and people in general are seeing the value of automated test cases for each release to prevent defects in the live environment.

Products are constantly increasing in complexity. Integration with other similar or different kinds of products is a necessity based on global customer demand, and testing has become highly important and even crucial. Test automation plays a key role in product quality assurance and maximum test coverage can be achieved in a short time, resulting in a better quality product.

Automation industrialisation framework

Automation industrialisation is a proven approach adopted by SQS for large and complex products. Put simply, it is a “keyword driven approach” where test cases are divided into smaller actions called keywords or action words. One action or group of actions is combined in one keyword or action word and these keywords are used to create a test case. Put another way, it can be considered an “action word driven approach”.

In Figure 1, different action words/keywords are created for actions carried out. Using these keywords, an automation test case is developed.

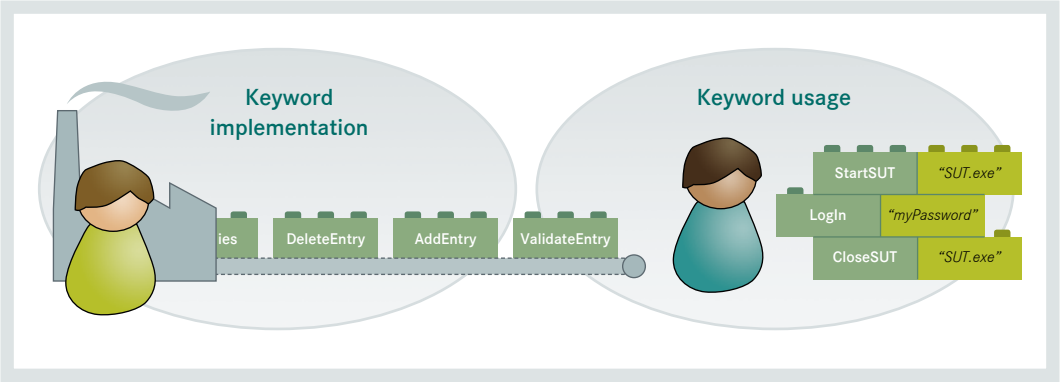

Figure 1: Keyword-driven testing [3]

The benefits of such an approach are

- Higher quality
- Robust and scalable framework
- Modularised code
- Continuous improvement
- Standardised automation method
- Increased repeatability and reliability
- Cost-effective, innovative solution
- Automated test creation by manual tester with less or no knowledge of scripting

This approach works best with an agile system. We can create independent action words for new functionality or update existing data by adding/updating existing actions. This increases test automation coverage and goes hand in hand with development testing to ensure higher product quality.

Continuous integration

In any automation project, continuous integration plays an important role. Automation testers are continuously developing and updating automation code which may result in other test case failures. To minimise this failure rate, we have developed some in-house utilities.

Scheduled jobs

To generate build automation on a daily basis, a scheduled job is created. This is a batch file which downloads the latest code from source control. The code is compiled and binaries are generated. Documentation of the automation code is also generated which is helpful for anyone wishing to use the automation framework and develop new test cases. A zip file of all binaries is created and copied to a shared location. Using this build automation, any user can execute his/her test cases from the automation suite.

File watcher utility

This is a .net utility that copies the latest product build and DB onto an automation machine once it becomes available.

Execution using batch files

Using different features of the automation product and designed for unmanned nightly execution, various batch files are written which ensure smooth execution on a number of machines simultaneously.

Consolidated report generation

This is a .net utility written for consolidated report generation. This utility reads all report files and generates a consolidated report of test cases performed. A hyperlink is provided in a log location, allowing users to mouse-click and navigate to a log file where they can perform a quick analysis.

Conclusion and outlook

It is clear from our experience that plant engineering software and its testing solutions definitely add another dimension to the process industry. Together with the competence of process industry experts, it will enhance the ability of any organisation to compete and achieve milestones in international markets.

For last few years SQS has led the market, providing testing solutions for process industry software based on new technology and project management systems.

References

[1] http://www.mrrse.com/engineering-software-market

[2] Ministry of environment, forest and climate change notification, New Delhi 7th December, 2015.

[3] Image courtesy of – http://www.ranorex.com/blog/wp-content/uploads/2013/06/Keyword-Driven-Test-Automation-Framework.jpg

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