Building on belief

Applying Value Engineering in Operational Technology

Energy & Resources

Abstract

The concept of Value Engineering (VE) first evolved in the 1940s at General Electric, during World War II,[1] and has gained considerable traction since. VE has been applied successfully in diverse industries to derive optimum value for initial and long-term investments. Previously, a huge amount of work was done in the application of VE principles in various areas such as new product development across domains.

It is common practice to carry out commercial engineering for large IT and digital transformation programs. Application of VE principles in the engineering industry is fundamentally built on the premise of focusing on excellence in the primary functions of the products or services rather than auxiliary functions. This paper describes derivation of the VE principles' application-based benefits in the Operational Technology (OT) world. It also touches base upon some methods to conduct VE exercise in the OT area.

The gist of value engineering

Since value is calculated as a ratio of function to cost, value addition to a product can be achieved by either cutting down on cost or improving the function. More often than not, companies use VE engineering primarily as a cost-optimizing strategy or tool, where the basic function of a product is conserved or enhanced, and not compromised during the process.

A small manufacturing company spends nearly 6% to 7% on OT systems, a mid-size manufacturing company spends 4% to 6%, while a large manufacturing company allocates nearly 2% to 4% of their overall spending on OT systems.

Meticulous VE in OT is the need of the hour for all manufacturers and industries, for two reasons – (1) Critical budget provisioning for OT (2) Unwanted incidents in OT may result in production loss as well as impact the quality of production. VE done right for OT by the manufacturer or business owner or the IT and OT supplier - across all the phases of the OT lifecycle - results in endurance and sustainable growth. In the era of Industry 4.0, Value Engineering as a Service (VEaaS) is the key to success.

OT systems are the backbone of the entire value chain across upstream, midstream and downstream functions in the energy and resources (E&R) sector, which govern global economy dynamics. With much at stake, implementation of established VE practices in E&R as well as cultivation of value as an attitude among service providers and end users is crucial.

[1] Investopedia; Nov 28, 2020; https://www.investopedia.com/terms/v/value-engineering.asp; Accessed June 6, 2021

We believe the VE process should be built on the beliefs of all the stakeholders including the enterprise, service providers and vendors, and not solely on client GIS and management ideologies.

Today, the biggest challenge faced by the energy and resources industry is the over or under focus on OT systems. To mitigate this, optimization based on function analysis is vital as elucidated in Figure 1 below.

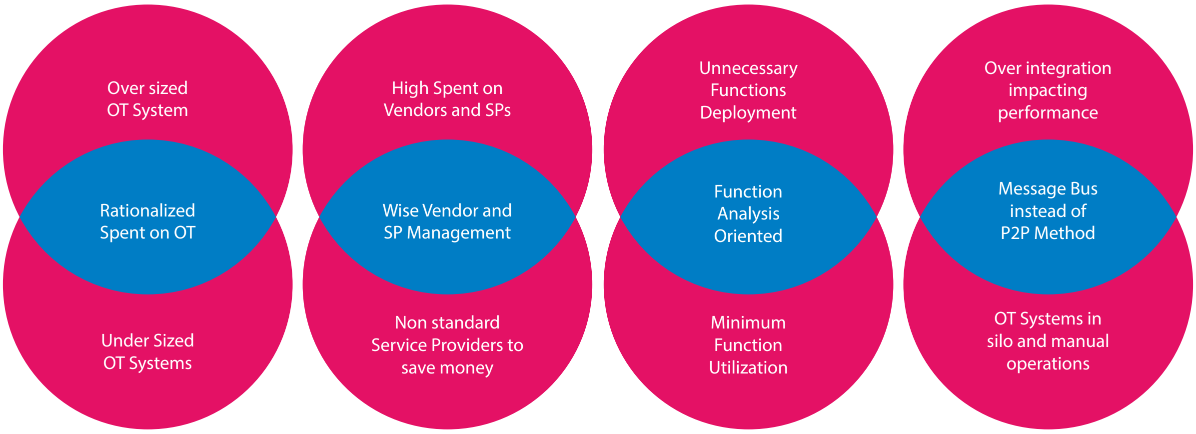

Figure1: OT focus factors

VE in action

A pragmatic approach to VE promotes omitting secondary, unrequired products and processes in design thinking, and focus on core value delivery to the end user. VE concepts, though evolved especially for product or part design, should be applied to systems (hardware and software) and services in OT area by usage of robotic process automation (RPA), mobility, and data and analytics. Both CapEx and OpEx can be drastically reduced with the application of VE principles and implementation of VE projects in the OT space across E&R, utilities and manufacturing verticals.

Hardware, firmware and software, and the processes that are eligible for VE consideration in the metals and mining industry are indicated below in Figure 2. High level production processes and process steps are mapped to the systems and applications in OT.

Systems and Applications Eligible for VE Analysis based APR in Metals and Mining								
Processes	**Excavating**	**Transport**	**Grinding/ Sizing/ Palletizing**	**Melting**	**Casting**	**Rolling**	**Fininshing**	**Dispatch to DownStream/ Market**
Process Steps	Blasting	Tracking	Crushing	Coke Oven	Conteneous Casting	Hot Rolling	Heat Treatments	Warehouse
Process Steps	Sampling	Yard Management	Storing	Blast Furnacing	Tubing	Cold Rolling	Slitting, Cutting, Finishing, Coating	Packaging
Process Steps	Tailing Management	Fleet Management	Blending	Smelters	**Wiring**	Custom Structural Rolling	Water/ Other Agent Treatments	Tracking
Systems and Applications Eligible for VE	Hardware - Equipment and Parts, Sensors and Final Control Elements, I/O Cards, Communication Cards, PLCs, Controllers, HMI Firmware & Software - PLC/ CNC, I/O Cards, Communication Cards, HMI, SCADA - Programming, Configuration, Installation and Commissioning Application/s, Engineering Workstations, Historian Configurations, LIMS, MES, Maintenance Applications, Planning and Scheduling, Quality, Warehouse and Transport Applications & Systems Processes - Integration methods and Tools, OT Monitoring, OT System Security Related Tools and Practices.							

Figure 2: Process-wise systems and applications in metals and mining for VE

The processes that are eligible for VE consideration in the oil and gas industry across hardware, firmware and software are shown in the map below in figure 3.

As illustrated, systems and applications in the OT domain are broadly segregated as upstream, midstream and downstream high level processes.

In the upstream segment, assembly concepts such as 'Christmas Tree' for regulating the flow are classic examples of VE along with safety. 'Pigging Pipeline' is a classic midstream example of VE along with maintenance. The downstream oil and gas industry has multiple examples including plant layout and design which are VE examples, ensuring overall equipment efficiency (OEE). Similarly, OT systems are also highly eligible for rationalization with the help of novel VE principles.

Systems and Applications Eligible for VE Analysis based APR in Oil and Gas			
Operations	**Upstream**	**Midstream**	**Downstream**
Process	Exploration	Storage of Crude Oil and Natural Gas	Thousands of Finished Products Production
Process	Production of Oil	Transport of Crude Oil and Natural Gas	Hundreds of Processes For producing Petrochemical Products
Process	Production of Natural Gas	Pumping Stations	Road Construction Products
Systems and Applications Eligible for VE	Hardware - Equipment and Parts, Sensors and Final Control Elements, I/O Cards, Communication Cards, PLCs, Controllers, HMI Firmware & Software - PLC/ CNC, I/O Cards, Communication Cards, HMI, SCADA - Programming, Configuration, Installation and Commissioning Application/s, Engineering Workstations, Historian Configurations, LIMS, MES, Maintenance Applications, Planning and Scheduling, Quality, Warehouse and Transport Applications & Systems Processes - Integration methods and Tools, OT Monitoring, OT System Security Related Tools and Practices.		

Figure 3: Operation-wise systems and applications in oil and gas eligible for VE

Leveraging VE in OT system rationalization

Just as additive manufacturing using 3D has inbuilt belief that only primary and key function providing parts are considered in the digital design of the object, OT system rationalization too should adopt VE principles built on the belief of fulfilling basic expectations first, while carrying out systems and application portfolio rationalization in the OT world.

Application rationalization is the practice of strategically identifying business applications across an organization to determine which applications should be retained, replaced, retired, or consolidated. The goal is to achieve improvements in business operations.

Two major factors – i.e., business criticality and total cost of ownership (TCO) are considered to plot a quadrant diagram as shown in Figure 4.

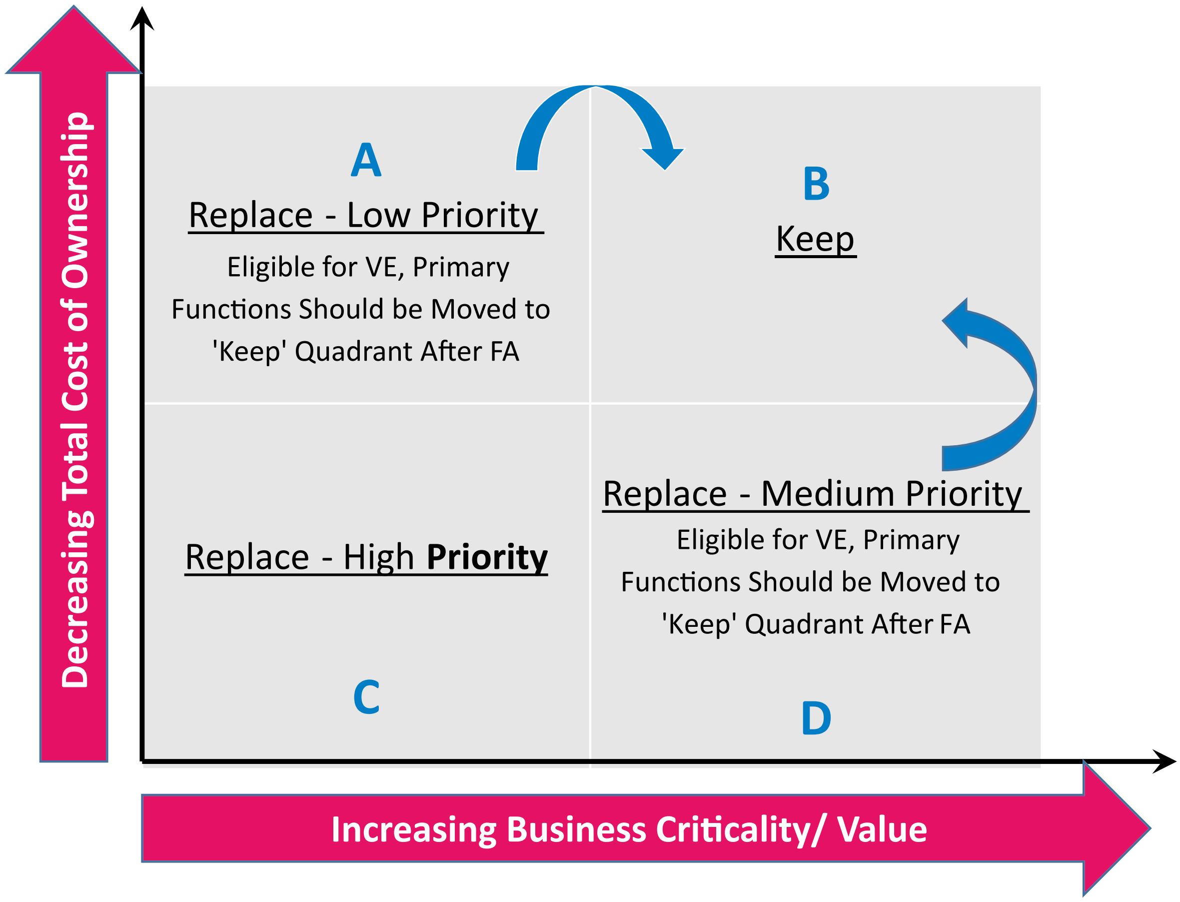

Figure 4: Rationalization quadrant diagram

The TCO is derived by considering multiple key performance indices (KPIs) such as technical complexity, vendor and service provider alignment, releases and patch management, infrastructure overheads, nonfunctional requirement and performance overhead and IT security of the OT system. While deriving business criticality, other sets of parameters including the number of users, impact analysis in case of unavailability of the application or system, and overlapping functions are to be considered. The life of the system in the dynamically changing technology landscape in the Industry 4.0 era is also to be taken into consideration.

Function analysis based on VE principles should be applied to systems and applications residing in quadrants A and D. The primary functions derived from function analysis should be analyzed and checked if they can be moved to systems and applications in quadrant B. While deciding on functionalities, a wise approach would be to include a team of enterprise architects to consider integrated solution or point solution for better scalability, flexibility, maintainability and eventual TCO (CapEx +OpEx).

Function Analysis System Technique (FAST) diagramming is a tool that was introduced in 1965 and continues to be a good way to understand primary, secondary and unwanted functions of a part or product at a glance. Usage of this tool for OT systems and applications should be encouraged.

While creating and selecting the interface between two OT systems, stakeholders must be cognizant that the proposed solution will carry out primary and secondary functions only and follow the solution guidelines and avoid unnecessary transaction of attributes, tags, and information. Figure 5 below depicts the use of FAST tool for identifying primary, secondary and unwanted functions in an interface or middleware layer, based on organizational principles.

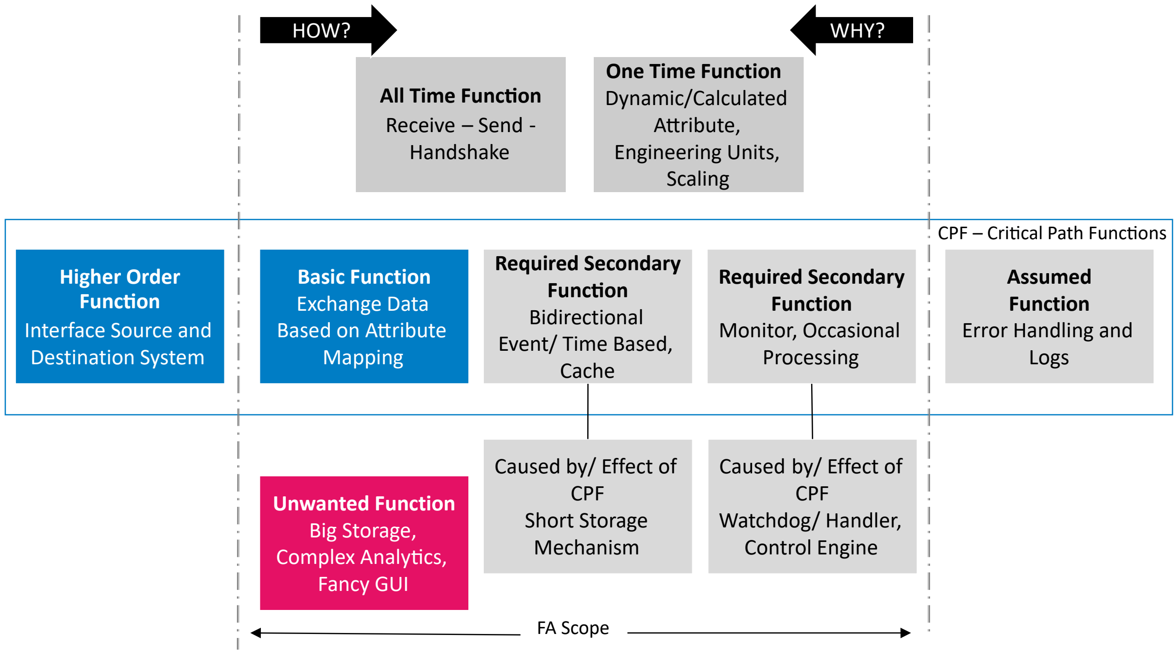

Figure 5: FAST diagram for interfacing tool

To use the FAST diagram tool, a high order function is determined first. In this example, it is interfacing two OT systems. After posing the 'how' question to the higher order function, (interface source and destination system in this case), we immediately get to the basic function (exchange data based on attribute mapping). Next, the 'how' questions generate secondary functions (bidirectional event or time based, cache, monitor, occasional processing). Identification of supporting functions used routinely or occasionally (dynamic or calculated attribute, engineering units, scaling) also helps to generate the right thought process. The 'why' question on secondary and assumed functions answers the reasons for VE implementation. Effect of CPF functions in this case are short storage mechanism, watchdog or handler, and control engine. The assumed function is log of errors and handling errors effectively to avoid any production issue. The need for huge storage capacity and fancy graphical user interface (GUI) can be eliminated as it is identified as an unwanted function in the interface.

VE systems – disruptive, yet effective

Embracing the right VE approach that is built on the belief of rationalizing OT systems and applications in energy, resources and manufacturing industries should pave the way towards successful digital transformation in the era of Business 4.0. The OT market worldwide is projected to grow by USD 17 billion, a compounded growth of 6.4%[2]. This represents enormous potential. What better way forward than to leverage VE to optimize spends, bridge the digital divide to focus on a better future and enhance return on investments (ROIs)?

[2] businesswire; Feb 28, 2020; Global Operational Technology Market Analysis, Trends, and Forecasts 2019-2025 - ResearchAndMarkets.com; Accessed June 7, 2021

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