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VALUE OF SYSTEMS INTEGRATION TO OPTIMIZE OPERATION IN ALUMINA REFINERIES

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Abstract

Construction of modern Refineries is a complex endeavor, technically and organizationally. Shareholders are expecting quick ROI and full optimization of the capital invested during the project. When fully commissioned, new and especially old plants are facing significant operating cost pressures. One key approach used to manage this pressure are automation, process control and production systems to optimize plant processes, manage quality, prevent equipment damages, stream line maintenance data flows and focus on problems anticipation. On the other hand, the challenge Refineries are facing is to ensure the right integration and business alignment of these systems, still be user-friendly and with low TCO (total cost of ownership). This paper will present why Automation & Process Control systems are critical and how proper systems integration can make the difference for new and existing facilities. It will present how OPEX (operating expenditures) can be reduced and major risks mitigated during commissioning and operation.

Introduction

Modern Refineries and large operation sites require today very large numbers of systems to cover all aspect of their operation and business. Controlling production in an alumina refinery is a complex task requiring the processing of large volumes of bauxites, caustic soda, lime and other raw materials by large plants to digest the alumina minerals from bauxite, separate the remaining waste materials, re-crystallize and then calcine the hydrate to produce the alumina. In order to optimize assets utilization, reduce any waste and maintain a high rate of alumina production, all across the entire refinery processes, a foundation needs to be in place: a common set of well integrated control systems. This foundation serves as well for continuous improvement initiatives.

Over the last years we have seen these following facts:

- Refineries are facing significant operating cost pressures, statutory requirements and EH&S obligations.
- Process automation and information systems are key tools to optimize the process, manage quality and reduce operating costs.
- Importance of commissioning support and operational readiness to ensure proper integration and utilisation of high performance systems.

So it has been realized that for asset-intensive organizations, good systems integration helps to grow better. However, because of the Greenfield or Brownfield nature of such massive projects, such integration is fragmented and may cause start-up and long term operation issues.

In modern plants today, the following systems are normally installed:

- Business management systems (level 4): Enterprise Planning Resources applications, supporting:
  - Human Resources and Payroll
  - Finance
  - Plant Maintenance
  - Supply Chain
  - Sales and distribution
- Production information management systems and Manufacturing Execution Systems (level 3), supporting:
  - Data acquisition
  - Production planning
  - Performance tracking
- Automation and process control systems (level 1 and 2)
- Safety systems, including fire detection and site access control
- Communication systems
- Back office systems

One of the main challenge is that the application of advanced automation and production IT systems has grown tremendously in all aspects of the metals industry over the last 30 years. The use of computer-based technology has grown from being considered a secondary nice-to-have system to a fundamental component of all business functions. The mining/metallurgical industry has not been isolated from this general trend and computer-based technology is now used to manage all aspects of industrial plant operations. This has led to a large increase in the number of systems available, their size, their memory, their complexity and the need to be integrated to each other.

1. Context

1.1. Automation and IT Risks

Even if Automation and IT assets worth only about 2-6% of the total capex value of a new modern plant, it has been noticed over the year that it could impact between 15-30% of the operation cost. This is why importance must be given to it right at the start of a project.

1.2. Cost avoidance during commissioning

From past experience, additional cost has to be injected during plant commissioning, usually because of scope omission, rework and initial equipment damage. Often, poor system programming and integration is the cause. Moreover, it may impact in the production ramp-up by slowing down its schedule, resulting in profit lost.

So, systems and IT assets, usually a small budget portion compared to the rest of the plant, can seriously impact the early performance of a new plant if poorly integrated.

1.3. Automation and Process control to maximize value

Basically, the total cost of ownership for a Refinery is the overall Opex (including financial cost and taxes) and sustaining Capex, as shown in figure 1. There are often hidden costs coming from elements of risks that are not really mitigated, which happens in the form of poor quality of alumina, equipment breakdowns, health and safety events, gas emissions, etc. This in fact impacts the production performance and physical integrity of the asset. In other words, there is a real danger of value destruction over and above the normal Capex and Opex.

On the one side, the operational costs depend mainly on utilization of the production assets, associated service contracts and labor. The on-going exercise is based on continuous improvement of existing assets and processes in order to produce more at lower a cost. On the other side, capital costs depend much on procurement of new assets and associated new or revamped design or enhancement of existing assets. The goal for Refinery here is to sustain and improve plant engineering and projects, in order to get the full value of the investments.

Key services aligned to protect and improve respectively Opex and Capex are Operation Improvement and Operation Support (under the form of Outsourced Engineering Services). Both services need agile, reliable and well integrated systems in order to really achieve their intent. The following sections will present some elements to optimize systems efficiency so the outcome can add value to Capex and Opex initiatives respectively.

Figure 1 – Capex vs Opex

2. Systems Commissioning risks in a Refinery

The efficiency of any Systems and Applications start at the very beginning from its design and deployment. The commissioning phase is the last chance to correct any deficiencies which may impact operation for years thereafter. From past experience in refineries commissioning, here are the main risks encountered which can impact quality and performance of automation and process control (refer to figure 2 for summary), and therefore capex and opex effectiveness:

- Vendor Package Integration including third party controllers and interfacing.
- Availability of process expertise in control system commissioning.
- Interpretation of functional specifications and other requirements into control system configuration.
- Lack of communication and co-operation between control systems vendors.
- Quality of commissioning procedures and documentation.
- Identification, ownership, resolution and close out of commissioning issues.
- Technical consistency and adherence to standards.
- Initial alarm and trip allocations and settings disrupting plant start-up and flooding operators with alarms.
- Historian not ready/setup leading to valuable commissioning data not being recorded.
- Not taking a “big picture” approach (eg. considering problems in isolation).

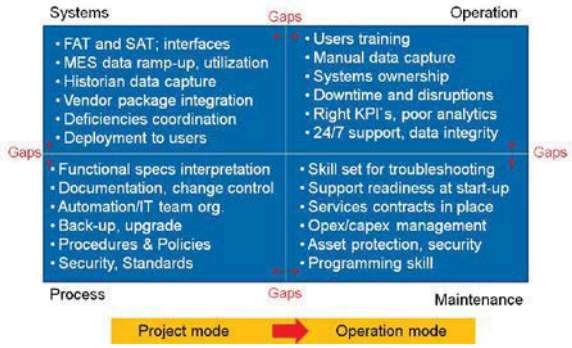

Figure 2 – Commissioning Systems risks

The role of the project team, Systems Integrators and the EPCM is to close all these gaps before start-up. Let`s see now the main factors to consider in order to mitigate all these risks

3. Integration success factors

3.1. Interoperability by design

Interoperability is the ability of diverse systems to work together (inter-operate). In a modern Refinery practically all applications implemented need to exchange information from one to the other, so it means that all associated interfaces must be completely understood. This can only be achieved if one single integrator manages the global Refinery systems landscape from the very beginning. Otherwise, this global landscape will be fragmented (done by several integrators) and integration test will be partially done, which will result in possible start-up problems, as described in section 1.2. From instrumentation to business systems, through all automation and process controls layers, all systems must be mapped and designed to use all the same data for effortless usage by the users.

3.2. Greenfield project dynamics: successful hand-over

The challenge of a Greenfield project is that as the Refinery has to be built from scratch, an operating organization must be created very quickly in order to do the plant commissioning and start making profit out of it. Information systems and process control are in fact the backbone of this new organization being developed. However, all Refineries systems are to be designed and implemented during the project phase, where often the alignment with the plant business processes is often neglected since the new operating team either has not the time or the knowledge to review all systems integrators functional specifications.

The value to have a single integrator, who can facilitate hand-over of all systems, is a great gain for future plant operation performance. As per figure 3, the key elements to manage are to

1. Move from Project to Operation mode
2. Keep Design & Build systems information to assist Operation & Maintenance
3. Plan the hand-over to really transfer a global set of integrated systems and not several isolated and fragmented systems

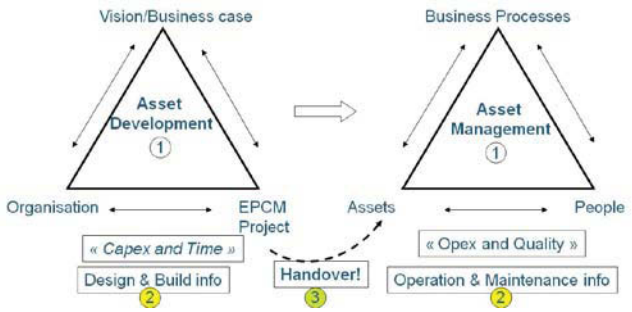

Figure 3 – Greenfield project dynamics

3.3. Team involvement

It is crucial for the Refinery operating team to be involved in the initial systems design and factory and site acceptance tests, during the construction period. Then to be fully ready to receive all systems during the start-up, to ensure all deficiencies are resolved. Finally be capable to operate and maintain all systems during the full operation period after complete ramp-up of production.

3.4. Standardization

Finally, standardization is the key to speed-up implementation and save in opex cost after start-up. Ideally, one system product brand could be selected for each of the 4 information systems level, as per figure 4. This will not only save in the project budget for systems implementation, but will enhance data accuracy, reliability and get timely and contextualized information, highly needed to operate and improve plant performance. The level 3, processing and managing production and process information is often a neglected area. When properly integrated and deployed, it is a powerful tool to support cost savings and plant performance improvement. Section 4 will expand more on the value of this information system layer, often minimized and often poorly integrated between the automation and ERP layers.

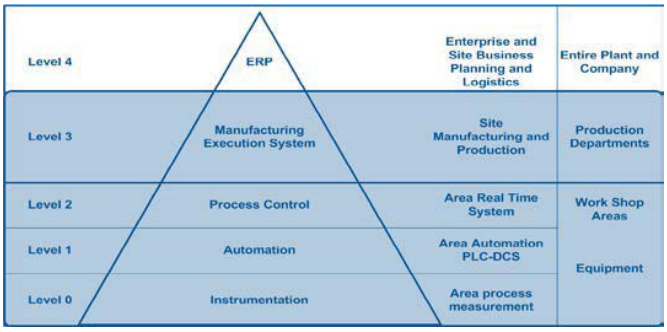

Figure 4 – Refinery information system levels

4. Value of Production Systems

4.1. Overview

As introduced in the previous section, the production layer (represented in purple and in the frame in figure 5) is the set of applications processing and giving sense and meaning to raw process control data and feeding, with contextualized events and alerts, the cost and people oriented Business Systems for value added transactions and decisions.

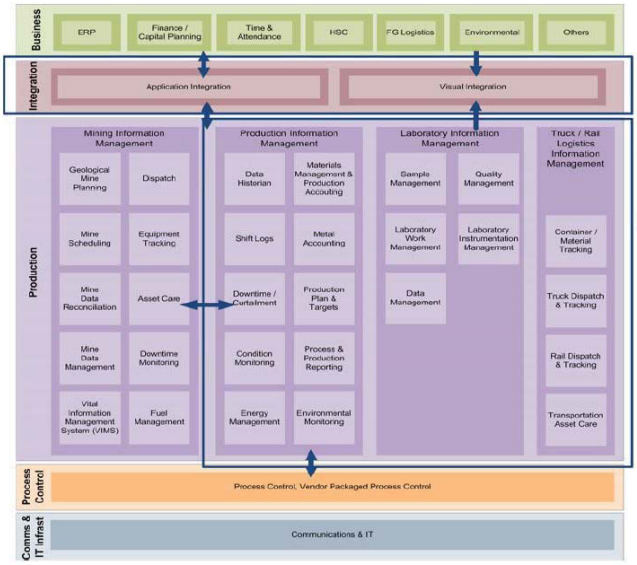

Figure 5 – Operational Systems landscape

The production layer included systems that support the day to day management activities of the operation in the refinery. It can be divided into 3 sections (apart from the Mining information Systems which are specialized for Mines only), namely:

Production Information Management: for the monitoring, scheduling, reporting, analysis of operational data, shift logs, data historian, equipment performance, etc.

Laboratory Information Management: all sampling analysis, quality management, laboratory equipments data processing, test results, reporting, historical information access.

Logistics Management: for transportations logistics (rail, trucks, containers...) between facilities and asset care and tracking of associated equipment.

In order to get the full value of such applications, the following aspects need to be considered:

- Design/development: the functional specifications, prior to programming, need to be reviewed by process experts and aligned with other applications, with all KPI's well defined.
- Integration with Automation: data historian and associate architecture for optimize data extraction and retention.
- Programming: one team supervising all aspects, for clear standards, robust testing and stable and bug free deployment to users.
- Integration with ERP: clear functional specifications of value added interfaces (maintenance, end of month, HR, procurement, etc.).
- Deployment to users: involvement in testing and effective training program, with systems ownership accountability for master data maintenance.
- Alignment with the Refinery Improvement program: ensure the production systems is a strategic platform and a recognized business enabler, and not just for data processing and storage.

4.2. Getting the most out of existing assets

Of course, the earlier the Production Systems (sometime call Manufacturing Execution Systems – MES) can be commissioned in a Greenfield project, the more aligned it will be with the users and their business processes, and higher will be their benefits: bring plant performance visibility with accurate information to users adopting the applications in their daily routine. For existing facilities, a business case will drive the way the future Production systems should be implemented. Often, a simple operational dashboard can bring a lot of value by mainly drawing data from diverse set of applications, contextualizing information together and simplifying the visual display on key metrics with high pictorial fashion to drive fast understanding. Figure 6 shows an example of dashboard, tracking key performance indicators.

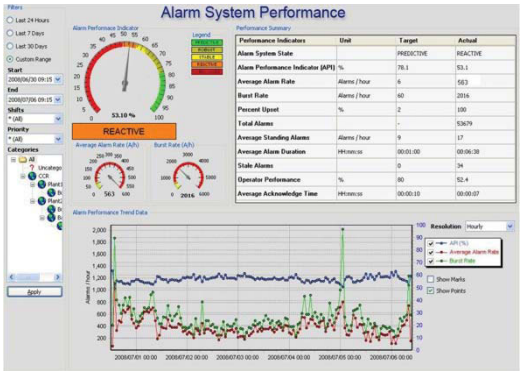

Figure 6 – Operational Dashboard example

This will provide a better control and monitoring of the refinery processes variability and assets utilization, therefore being more predictive about equipment breakdowns and more proactive in production planning and improvement. A direct impact of this will be the improvement of alumina production rates and reductions of raw materials consumption, increasing the cash flow margins, so the plant profitability.

Production plan/targets, shift logs, condition monitoring, materials management, energy management and environmental monitoring, are key functionality which brings meaningful insights to people. However, they are tools and their value resides in the right

integration of these applications and the right utilization by the users.

5. Automation and Production Systems as Operational Improvement enabler

Apart from Capex, the main element of cost for a refinery resides in the Opex. Often neglected when the commodities prices are high, it is not the same when we see these prices going down and getting close to profit breakeven. Opex costs are more difficult to fully grip and to reduce as such. A lot has to do with workforce competencies and how aligned they are with the operating procedures and the use of the plant`s assets. However, process control and production systems are key since they provide a source of information about what, where and how to improve, for the existing equipments, plant lay-out, technology used, support contracts and much more. Then they are required to track progress and report on performance results.

Operational improvement is mainly about enhancing the performance of production and maintenance activities in the plant with the use of Systems, as presented in section 4. Production Systems are great tools to bring contextualized information to employees, but they need be designed and implemented with the aim to provide such information. The main value comes from cost avoidance and value engineering outcomes. To ensure the best results automation, process control and production systems need to:

- Be aligned with the refinery business and processes and be well integrated to a clearly defined and fully supported continuous improvement program.
- Provide Data Accuracy and Contextualized Information: *from sound initial design, testing and data ramp-up.*
- Generate Information to the right person, at the right time: *from an agile systems landscape*
- Be used the right way by competent users: *from effective training and change management program.*
- Be aligned with an Equipment condition monitoring and asset management program (ex: OEE, reliability).

Then, with Information systems providing the right analytics and data to the right person to generate valuable insights and input to decision-making processes, operational gaps can be quickly found and improvements measured and safely implemented. From this base, Hatch has developed the following methodology to guide the improvement process initiative that is to be taken by an Operations Improvement team in the Refinery:

1. Define the improvement to be achieved: options, costs, savings, risks, effort, HSE, etc. Then detail the gaps comparing “as-is” (Present State) and the “to be” situations (Future State). *Now we know WHAT is happening and WHAT to improve.*
2. Select the right option and define the project according to a priority list, by identifying the top ten issues for each project.
3. Conduct workshop to analyze and identify root causes and assign action to address these root causes. *Now we know WHY it is happening.*
4. Refine these actions into the asset strategy and other tactical improvements.
5. Execute the implementation plan, and institutionalize new common practice. *Now we know HOW to improve.*
6. Monitor the refinery and process performance through defined KPI`s (key performance indicator s) which will be used to review and update the plant operation goals in the future. *Now the efforts are MEASURED for its intended outcomes.*
7. Configured/adjust Production Systems to track these KPI`s, generate alerts before any deviations and inform the right persons for each key events.

6. Conclusion

Today, successful Greenfield and expansion projects need to ensure a clear systems integration plan to properly start and operate at low cost afterward. Globally, system integration success ties not only to the technologies but also largely to the systems integration strategy. The multiple vendor sources, the heterogeneous technologies and the complex EPCM project schedule can easily bring cost overrun. The multiple-vendor approach has to be strategically unified and standardized.

Experience shows that one global integration team will reduce the systems gaps and will bring substantial savings during commissioning in term of quicker ramp-up, better users adoption, greater equipment performance and uptime. Moreover, getting adequate Production Systems applications will help to improve plant performance through higher asset optimization and better process status visibility for the employees.

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