

KEY SUCCESS FACTORS DEPLOYING A MANUFACTURING EXCELLENCE SOLUTION (MESAL™) IN RIO TINTO ALCAN

Manuel Chareyre¹, Steve Boivin²

¹Rio Tinto Alcan – Smelter Technology, Centr'Alp, BP7, 38341 Voreppe Cedex, France

²Rio Tinto Alcan – Information System & Technology – 2028 Mellon – Saguenay – Québec – Canada

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Abstract

High capability information systems are now a mandatory enabler to achieve Operational Excellence in a modern smelter. Realizing full potential of new and existing assets, by reducing operating costs and increasing production capacity at low capital cost, is supported by the best practice use of a capable Manufacturing Execution System.

In order to realise this goal, Aluminium Pechiney, a company of Rio Tinto Alcan has developed MESAL™, a Manufacturing Excellence Solution for Aluminium to enhance management of all aspects of smelter operations.

This platform developed with a world leading IT company provides framework and dashboards for operation management, process quality follow-up, measurement and analysis of production performance and optimized inventory management.

This paper describes how Rio Tinto Alcan has launched the global deployment of MESAL™ based on a strategy that aims at standardizing and centralizing expertise in competencies centres.

Introduction

In Rio Tinto Alcan, the search for enablers to optimize our production activities is a constant Business Improvement goal. We have always tried to provide as much visibility into manufacturing processes as possible to help the production teams to make better informed decisions.

In the evolving lean manufacturing environment, the dependence on plant level information increases drastically. Rio Tinto Alcan is no exception. The need for effective decision making becomes more critical at all levels and across all the manufacturing processes. The rapid response to changing conditions, the focus on reducing less productive activities and effectively driving plant operations and processes requires current and accurate data to initiate, respond to, and report on plant activities as they occur. Rio Tinto Alcan has a MES platform providing this mission critical information about production activities across the enterprise.

MES? A Manufacturing Execution System (MES) measures, visualizes, analyzes and manages production operations, quality, inventories, etc. and finally production performance.

What answers does MES provide?

Is the morning team more efficient than that of the afternoon?

What was the exact dosage in the last batch?

What is the solution to see an issue in a workshop after 3 shifts and not after 3 weeks when receiving the monthly report? ...Etc.

In the Information System of a plant the MES is the third IT level, unifying automation and supervision levels with the business management level by supplying data to the Enterprise Resources Planning (ERP) (Figure 1).

Under the name of MESAL™ for "Manufacturing Excellence Solution" for Aluminium, we have implemented a joint approach, combining an Information System with a Lean Industrial Performance culture.

The main objective of MESAL™ in our plants is to reduce operating costs by providing tools to support Operational Excellence and Lean Manufacturing deployment.

This article will explain the role of our MES, who is using it and why, the leverages it gives to our smelters, and highlight the keys success factors of MESAL™ on-going deployment.

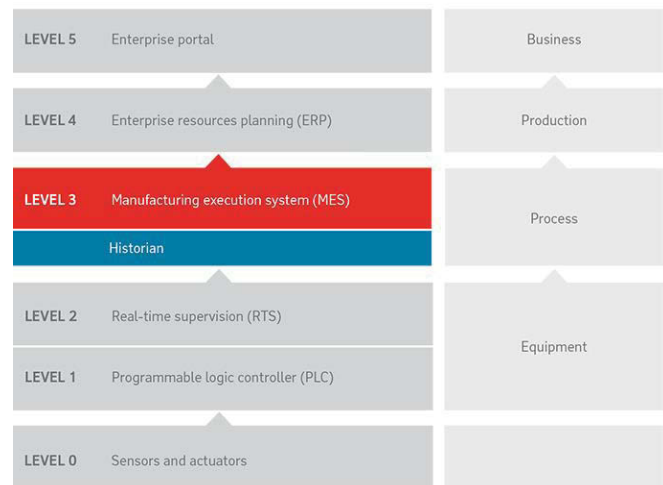


Figure 1 : MES location within Information system layers

What answers does MES Provide? Main advantages.

Production managers' questions

- What is the real production today? Can we produce more?
- How to access accurate and reliable plant data?
- What are the required skills and resources?
- At present, who makes what?
- Are we meeting the deadlines? What & where are the drifts?

To answer these questions, a MES centralizes production information, coordinates with ERP, enables resource management, reduces the number of manual entries and the wretched paperwork and provides indicators.

With the MES, Management controls the production cost (material balance), the production capacity, the reactivity of the production process, the performance indicators and controls energy savings and waste management.

Production managers can also guarantee adequate skills allocation, effective tasks assignment, team organization, use real time dashboards, follow-up on performance indicator, manages misses and lack of resources, control of material consumption, deadlines, to ultimately fluidize the production process.

Quality manager questions

- Are the specifications of the client respected?
- How to improve the quality? Minimize waste?
- Are all the procedures respected? And the rules?
- Can you find and isolate the off-spec batch?

A MES provides production data and allows the quality manager to analyze dysfunction, to participate in the elaboration of the processes and to follow their real time use and to work "hand in hand" with the maintenance team. With a MES the quality manager will guarantee client specifications, the traceability of products and raw materials, and optimization of the quality process and will be able to limit waste or minimize raw material consumption.

Operators' questions

- What do I have to make now?
- What is my next production order? What is its recipe?
- Where are the documents which I need? Are they up to date?
- Did I reach the objectives of my working shift?

A MES provides production documents and is adapted to each part of the plant; it allows operators to avoid dedicating time to distribute information, see in real-time the evolution of indicators and react when necessary with all the useful information. With the MES, operators have a list of clear and updated tasks, targets are followed in real time, data entry time is reduced, gain a better knowledge of the process and make better use of their skills allowing them to master their work.

Maintenance manager questions

- What is the rate of breakdown of each equipment?
- How may I avoid them? Have we the replacement part?
- When did they plan the next stop of production?

A MES gives the downtime by cause for each equipment, alerts of the drift and critical parameters, informs on production and maintenance planning and allows management and scheduling of the interventions of maintenance and to work "hand in hand" with the production. With the MES, maintenance has the analysis by correlation of dysfunction (types of products, temperature, etc.), the follow-up of performance indicators, the understanding of failures, the support for the equipment reliability, the planning of maintenance tasks, and maintenance will be able to prevent breakdowns and downtimes and increase the availability of production tools.

Sales and Supply chain manager questions

- Where is my order? Do I have to warn the client of a delay?
- When will production provide me the right information?
- Where are the stock levels? Why did we fall out of stock?
- Is the quality of the last shipment in specification?

A MES informs about the progress of each order, informs about the production planning in real time and allows all to share the same information. A MES also informs about stock levels, manages

materials flows, informs about quality controls for raw materials and products and allows an effective dialogue with the purchasing management. With the MES, Sales team informs the client of the progress of orders, the supply chain team has the real-time levels of stock: quantity, material movements (updated ERP) between storage and plant and analysis of results at all stages of manufacture. The supply chain will be able to do just in time orders and avoid shortages while optimizing work in progress (inventory).

MES main advantages:

- Increase the real time responsiveness of the company
- Transforms constraints (legislation, customer specifications, quality) into competitive advantage
- Ensure reliability of information
- Improves the dialogue between plants
- Is a tool for continuous improvement

Main MES benefits according to various industries feedback

- *Responsiveness:* + 45%
- *Data management time:* (-) 60%
- *Paperwork:* (-) 50%
- *Scrap & rework:* (-) 15%

Operational Excellence to support production cost cutting and creeping projects

Due to the ever growing global competition, all producers of primary aluminium have to face stronger cost pressure. In this context, optimizing each smelter is vital: increasing the production of a smelter and/or cutting the production cost.

On one hand, the lowest capital cost lever used to increase the metal production of a smelter is basically current increase through a creeping project. On the other hand, production cost decrease is done mainly with technology improvement (design, process control...). In both cases Operational Excellence with performance improvement is the key to reach full asset potential by decreasing operating costs or managing the additional constraints introduced by a creeping project.

An example: Operational Excellence in the Potlines

Operational Excellence in potline always prioritizes safe operating conditions with a particular emphasis on tapping, anode changing and beam raising operations and on coactivity between Pot Tending Assemblies (PTA), heavy load transport and pedestrians.

Secondly the principal technical objective is maintaining cell productivity (t/pot) and performance (specific power consumption and Current Efficiency) with minimum environmental impact working on:

- Minimize Green House Gases emissions (low Anode Effect frequency / duration / overvoltage)
- Minimize Fluoride and Dust emissions
- Reduce specific raw material consumptions

Key drivers to achieve these goals are operation regularity and quality.

Additional smelter objectives led to increased constraints for potline operations; For example, decreasing energy consumption through Anode-Cathode Distance decreases. Today Energy cost leads also naturally to focus on Energy consumption decrease.

Pot productivity increase (amperage increase / creeping projects) with existing equipment puts additional strain on equipment (over used) and a higher pressure on operations (cycle times reduces).

Note that the metal market context of each smelter could also add specific constraints on potline operations (high purity metal market, particular value added products in Casthouse, hot metal delivery to downstream customers, etc.)

Improve operation quality to improve pot performance:

- Increase Current efficiency & pot productivity
- Reduce energy consumption

But also to reduce operating costs:

- Reduce stem/brackets repair costs
- Reduce PTA breakdowns and optimize PTA usage
- Improve Crustbreaker Feeding Device (CFD) reliability

Main levers and KPI for pot operation quality improvement

Performance Indicators based on PTA information:

- Anode Changing (AC): grab passes/anode, breaker shots/anode, duration of sub-operations, gauging performance
- Anode covering: duration, quantity, number of recovering
- Tapping: cycle per crucible, ejector activation duration
- Anode beam raising: duration, incidents

Performance Indicators based on Process Control (ALPSYS data)

- Pot performance: Anode Effect (AE) during AC, tracking duration after AC
- Tapped mass versus target mass

Performance Indicators based on inspection (visual audits)

- Anode change: sweeping, stem verticality
- Anode covering: quality (number/quantity of recovering)
- Tapping: quality of hole opening, crucible cleanliness
- Hoods: number of pots with open hoods, tightness

Operating costs improvement

Optimize PTA usage:

- Follow global PTA availability and availability per operation
- Follow Tools/functions reliability
- Decision making : PTA position, available functions
- PTA transfers (number and reasons)

Reduce stem/brackets repair costs

- Anode change and Covering quality
- Bath height control

Improve CFD reliability:

- Follow number of CFD changed (and multiple)
- Pareto of components failures
- Follow CFD reliability (MTBF)

MESAL™ Operational Excellence Platform for Reduction

Principle is to provide tools to support Operational Excellence:

- Collect information from various sources (PTA, ALPSYS, audits, other MESAL™ modules, MESAL™ plant infocentre),
- Generate the relevant KPI (operation & equipment),
- Exploit information with a real time Dashboard [1] and data analysis tools (cross analysis, trouble shooting, process)

With three main focuses:

- Improve decision process
- Increase operators involvement and responsibility
- Develop proactive management

MESAL™ PTA MANAGEMENT views giving information regarding PTA location, PTA available functions (combination of tools availability) and PTA transfers (transfers for operation reasons, for preventive maintenance or breakdowns).

MESAL™ INFOCENTRE (access to smelter's data) with dashboard and analysis tool is the ideal platform for Business Improvement.

MESAL™ DASHBOARD views to help operation teams to ensure production performance targets are met and supervisors are working to Rio Tinto Alcan best practices guidelines (figure 2).



Figure 2: MESAL™ Reduction dashboard views

MESAL™ SHIFT PORTAL empowers supervisors by providing support to help them focus on the activities that truly impact their results and so increasing management on the shopfloor (figure 3).

It gives functions & information throughout the shift:

- Help supervisors optimize their own time allocations
- KPI calculation (to focus on analysis and correction)
- Management instructions display (avoiding multiple emails)
- Ease communication between teams (log book)

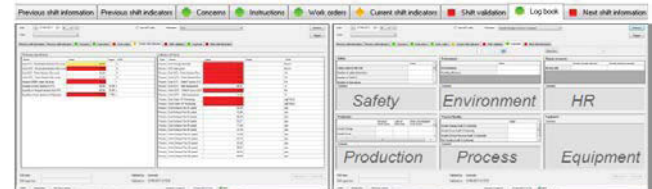


Figure 3: MESAL™ Shift Portal views

Main features of the MESAL™ solution

MESAL™ lies at the centre of our smelters, providing real-time visibility into the entire operation. This means immediate and customizable access to the information we need to maximize performance and proactively address issues.

MESAL™ main differentiating factors:

- Embed a strong Aluminium smelter know how
- Robust, scalable and flexible
- Supported by a world leader IT Company

Based on Aluminium Pechiney (AP) experience

MESAL™ has a strong Aluminium business content with more than 300 screens and dashboard views covering all smelter areas (figure 4) and specified through 5 000 man days of AP operation and technology experts during development with close to 30 000 IT man days to commercialize the product.

At AP, we've been designing, building, running and supporting smelters worldwide for more than a century. The MESAL™ solution incorporates this knowledge and experience.

Continuous involvement of Operation, Technology and R&D experts is part of our MESAL™ development governance model.

MESAL™ is based on a stretchable and customizable platform giving a high level of autonomy to each smelter to improve parameterization (equipment, KPI), and develop views or reports.

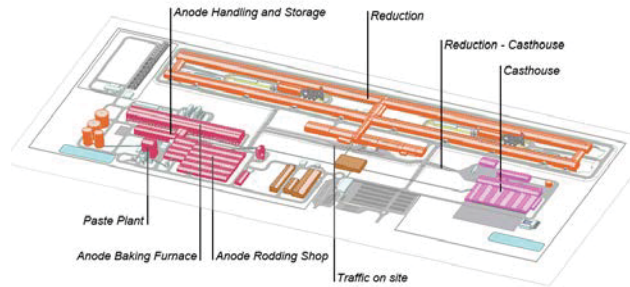


Figure 4: Areas covered by MESAL™ solution

MESAL™ can be cost effectively customized to any of our plants (also carbon plants). It uses standardized processes and reusable templates named “common functions” applicable to each workshop (Material Management, Shift Portal, Equipment Performance, etc.) and “specific functions” (PTA management, metal flow, casting units, anode baking furnaces, etc.) (figure 5).

To summarize, a MESAL™ solution for a smelter could be thought of as a “Lego” construction of common and specific functions:

- 1 function = 1 module + a set of parameters
- 1 application = a “Lego” construct of functions

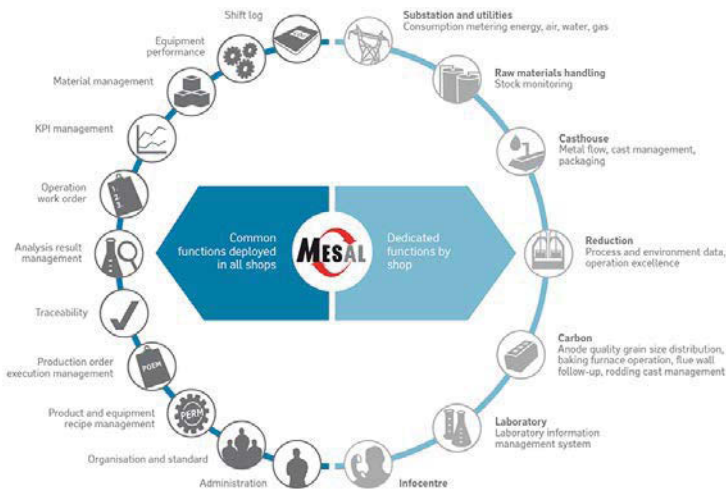


Figure 5: MESAL™ main functions

Final objective is managing operations and production, including monitoring technical performance with accuracy, certainty and efficiency.

For Greenfield projects, it simplifies smelter start-up and operations by standardizing parameterization, operation, use and increasing integration between the various systems implemented [2].

A robust, flexible and scalable IT platform

Integration with others systems is fundamental with interfaces with Enterprise Resource Planning (ERP), Pot Process Control (ALPSYS) and all systems managing data acquisition.

MESAL™ integrates Service Oriented Architecture (SOA) communication and collaboration applications into traditional manufacturing practices and processes.

With its modular SOA, MESAL™ simplifies solution integration into the information system, application deployment, external systems interfaces, solution maintenance and upgradability.

The main advantage of this flexibility is illustrated during revamping projects with the need to interface to old and heterogeneous existing systems.

MESAL™ is compliant with the ISA 95 market standard [3].

A world leader IT company for partner

One of the key success factors is having a strong worldwide IT company as a partner for development, integration and deployment all over the world.

Our MESAL™ modular product approach associated with strong IT skills ensures a maximum reuse of functions and thus the allowing deployments for a fraction of the new development cost.

For example, as order of magnitude, for a module development and first implementation a workload of 1 000 man days is typical, whereas the second deployment will require only 100 man days. 10 times cheaper than if it had been necessary to redevelop these functions or alternatively a product development approach that involves a minimum of 90% reuse of available functions. The remaining cost is linked to adjustment and parameterization due to local constraints or existing technology particularities.

Major MESAL™ deployments

Implemented:

First implemented in 2006, MESAL™ is now a mature solution.

In 2006 the MESAL™ solution was implemented at the Sohar Aluminium smelter in Oman and in 2012 we deployed MESAL 2.0 version with add-on to support the on-going creeping project.

In 2009 all MESAL™ common functions were implemented at Aluchemie, a Rio Tinto Alcan joint venture anode plant in the Netherlands. In 2010 and 2011 specific functions were deployed for all anode processes from raw material to final delivery.

From 2011 to 2012 Casthouse specific functions were deployed at the Dunkirk smelter in France to replace the legacy Casthouse system managing all operations to deliver value-added products.

Despite, the high pressure on production costs in our plants in Europe, the MESAL™ deployment is on-going on most of our sites and planned for the others.

In 2013 these Casthouse specific functions, plus new ones for management of other value added products, were deployed at the Alma and Laterrière smelters in Quebec.

These two deployments were the first step to build our new MESAL™ Competencies and Delivery centre in North America.

In project:

Early in 2014, MESAL™ Operational Excellence for Reduction platform will be deployed at our new AP60 smelter in Quebec.

In 2014, the next major MESAL™ release (built in 2013), will be deployed at our Kitimat replacement smelter project in British Columbia, Canada. It will incorporate operational excellence enhancements and cover all plants at the smelter.

In parallel, the MESAL™ Carbon Solution is currently under evaluation for brownfield projects at the Grande-Baie and Alma smelters in Quebec. Our objective is to quickly increase competencies of our MESAL™ Canadian Competencies centre and having a large pool of users in several smelters to ease the future MESAL™ deployment in Canada.

MESAL™ community

No doubt that building a strong user and expert community is perhaps the most important key success factor for successful deployment of an IT solution within a large worldwide aluminium producer like Rio Tinto Alcan or any large company.

Best practices for community development and management:

- Have a Community Manager to interact with the users, facilitate sharing and syndicate MESAL™
- Maintain a close relation with the Technology and Operation experts to bring some sustainable new business opportunities in sync with the evolution of the aluminium business
- Develop tools which encourages contributions
- Follow and participate in the user forum and analyze and respond to discussions
- Support the active members of the community
- Make a contribution to other communities

Continuous MESAL™ solution improvement:

The high pressure on our smelters' production costs led us to focus on catching innovative projects with immediate payback. We are continuously developing evolutions on the MESAL™ solution to support these projects and accelerate R&D prototype validation and operating solution deployment.

The lever of the MESAL™ platform give us agility to deploy immediately at minimal cost the new MESAL™ functions supporting innovation and thus catching value on all of our production sites that could benefit from these innovations.

The MESAL™ solution is an enabler to accelerate value capture for our smelters and it drastically reduces our IT cost.

Of course we have a strategic roadmap on a mid and long terms basis of solution enhancements and upgrades.

We are also continuously deploying IT improvement. For example the user experience of any IT application became the immediate priority and a fantastic lever of productivity enhancement for the companies using the product. The ergonomics is also a major source of innovation and ergonomic quality becomes a key business differentiator.

In the case of MESAL™ we are developing with our IT partner agile user interfaces required to have MESAL™ on smartphones, tablets for operation manager on the floor, laptops for back-office management, Personal Computers tailor-made to fit particular needs of production teams and big screens in control rooms.

Conclusion

Access to reliable, real-time information is crucial to our smelter's success. Our industry leading Manufacturing Excellence Solution provides us with the real-time data we need to run our smelters, from A to Z, with optimal efficiency. Definitely, MESAL™ is a key enabler to increase productivity & quality by deploying best practices and bringing processes under control & standardizing them.

The rollout of a MES could be a fantastic success but it is not without its challenges [2][4]. A strong top-down commitment is fundamental for solution acceptance.

Do not forget that deploying such IT solutions are above all, an enabler for Change Management and successfully implementing change in an organization requires change agents to guide individuals through the changes and to own the process.

Finally, taking a product approach that uses Centres of Excellence is one of the most efficient ways to manage such large-scale Manufacturing Excellence Solution implementations.

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