# MAS vs MES

***Most mining houses have investigated Manufacturing Execution System (MES) implementations for several years, but now the new buzzword seems to be Metals Accounting, as if this is unique. But is it?***
***By Gerhard Greeff***

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In trying to define the difference between Metals Accounting Systems (MAS) and MES, I can't help reflecting on the difference between Six Sigma and TQM. Why is it that TQM failed to be accepted as widely as Six Sigma, especially in South Africa? It could be that our culture and management style were just not conducive to TQM, as it entails a change in company culture and the way things are done. It pushes decision making responsibility down the company hierarchy, something quite foreign to the South African way of thinking in the mid 1980's and 1990's. Did Six Sigma succeed because it came at the right time and TQM because it was premature?

As with TQM and Six Sigma, MES and MAS have the same basis and are essentially the same thing with a different focus. So the answer is yes, there is a difference - about the same amount of difference that exists between a Toyota Hilux and a Nissan Hardbody. They look different, they handle differently, they perform differently, but they are both trucks

Will MAS be as successful as Six Sigma? Only time will tell, but I believe that unless we learn from the mistakes of MES implementations, MAS will fail! Let me explain my reasoning and then you can decide.

MES consists of 11 modules, all contained within the ISA95 standard and grouped into four functions: Production, Inventory, Quality and Maintenance. Assessing these functions and their activities, one can establish that with the exception of Maintenance, all the others are needed for an integrated MAS solution. One may argue that Execution functionality is not required as MAS is only a reporting system, using process data to report certain data in a specific format, in actual fact a "Management Information System (MIS)". This is the first mistake! Continuing along this path will see MAS ending up like MES, something everyone has heard about but no-one is using.

A MIS system takes pre-recorded data and places it into a report in a certain format, irrespective of the source or accuracy of the base data. By comparison, a MES system has as its aim the collection of electronic data from the correct source, and the quality assurance of the data through built-in business and systems rules and checks. MAS, which is based on hand-recorded and MSExcel-manipulated data, is neither accurate nor integrated. The accounting may just as well be done in a spreadsheet (*often more trusted by users anyway*).
To put together an Integrated MAS, the following need to be resolved:

- Electronic measurement data such as weights and content is not always available at hand-over between processes;
- There is a combination of process types such as continuous, batch and discrete, each with different business rules;
- Measurement data is often derived from flow and density and instrumentation is often inaccurate or out of order;
- Sampling is inadequate or not done at the right time or place;
- Most solutions need to cover more than one site, and definitely more than one department.

These cannot be resolved by only reporting captured data. A change in work methods and additional data capturing is required throughout the production process. It requires a change in the way that instrumentation and systems are maintained, as inaccurate instruments result in inaccurate weight and content data. Additionally, business rules need to be defined and agreed upon. Business rules ensure that material only moves to permissible locations, metal content results are assigned to the correct batch or lot of material and that material is identified appropriately throughout the process. This is all Execution functionality.

MAS is in a sense a material tracking system. It tracks a specific metal element (or elements) through the production process and accounts for the overall yield (or recovery) of the metal at the end of the process. In order to do this it needs to know the material weight and the specific concentration (or content) of the specific element within that weight. This is required for each step of the process. For a discrete batch process and only one element this is reasonably simple, but for continuous processes it becomes more complex. For multiple product streams and a number of elements it is exponentially more complex.

Furthermore, to obtain element concentration in a load, lot or batch of material, one needs a chemical analysis of the material. For this one needs a sample. One thing often overlooked is that samples are not necessarily taken representatively or at the correct points required for Metals Accounting. For instance, waste streams are not always sampled and weighed.

Let us assume all material streams are sampled. The next complication is that chemical analyses are not instantaneous. Samples may only be transported to the laboratory at the end of the day and only tested the following day. Then there is a results approval or verification process and potentially a re-analysis. After a two to three day period, the results are available. These results must then be assigned to the specific load/lot that they relate to. This is the only way in which the mass and concentration can be used to calculate how much of the specific element moved into or out of the process.

**Integration**
Then one is faced with the integration issues. When implementing an integrated MAS, one needs to integrate with the laboratory system (or LIMS) for concentration results and with the weigh-bridge system or scales for weights. The system will be of little use if not integrated with the company ERP system, therefore the processes in the MAS must map directly with those in the ERP system.

This may change the way in which material weights are captured and identified at the point of handover between processes. Batch or lot numbering conventions may change to avoid double-accounting. Provision must be made to weigh, sample and analyse additional material streams. The way in which this is done is based on production or business rules, - not just reporting functionality, but actual MES functionality. All this involves changes to current systems and the interfacing between them.

It is even more difficult to track material between continuous processes. Here weights are normally quantified using mass-flow meters with flow and material density being used to calculate material mass. Automated samplers may be used to ensure consistent and representative samples. In terms of the MAS itself, these weights and samples are no different to a discrete batch weight and sample. From a technical and maintenance point of view however, this may require a culture change.

These instruments are no longer only used to control the process, but now directly contribute to the financial accounting of the company. If the instrument is out of calibration, the incorrect weight will be reported and if the automated sampler sticks or breaks, the sample will not be representative and may lead to inflated or deflated metal content results. So without a proper instrument calibration regime, one cannot even begin to consider integrated MAS!

The amount of work-in-process or “lock-up” is normally calculated using some business rules, but these can be manipulated to inflate actual performance. Lock-up is a great place to hide process inefficiencies and low yields. If metal recovery is a bit low, increase the lock-up quantity slightly and yield is within an acceptable range again. With SOX and other regulations, performance reporting is in the limelight. Auditors want to see defined reporting and calculation rules enforced to eliminate “artificial good performance”. Implementing an integrated MAS will reduce the potential of “hiding” inefficiencies, making it extremely unpopular with production and inventory people. So be prepared for a palace revolt!

**Metal Balance**
The next step is Metal Balance. Metal balance works on the principle that matter cannot be destroyed. So if you feed 100 tons of Metal X into a process, 100 tons of X should come out of the process or remain inside the process. Where Metals

Accounting is only concerned with the tracking and quantification of the metal through the process, Metal Balancing adds the dimension of enforcing the balance.

If to a process with 50 tons of work-in-process X, we add 100 tons of X and we take 100 tons of X out of the process, there should be 50 tons of work-in-process X remaining at the end of the period. If, however, the process equipment was on a loadcell that indicated that only 49 tons of X remains in the process, we lost 1 ton of X. The process is thus not balanced. Metal Accounting Systems disregard this situation, but Metals Balancing systems do not.

As matter cannot be destroyed, metal could not have been "lost". It had to go somewhere. A Metal Balancing system will force a balance over the process. It will consider the probability of accuracy of each of the incoming and outgoing streams of the process. Rules can be built for instance that weighbridge data is more accurate than scale data and that in turn is more accurate than mass flowmeter data. Based on these rules, the system will determine for instance that 99.5 tons of X came into the process, 49.2 tons remain in the process and that 100.3 tons came out of the process. Now try informing the manager upstream that his actual output from his process was only 99.5 tons and not 100 tons as reported!

The above sounds reasonably simple, but it is for only one process. Try to picture this over multiple processes running in series over multiple sites and you will start to get the picture.

Any company considering implementing a MAS or Metals Balancing System needs to ask itself the following before even planning to embark on this journey (because it is a journey, not an event):

- Do we have sampling, weighing and measuring infrastructure in place at the appropriate places to measure each material stream within the different processes?
- Do we have the appropriate maintenance culture?
- Do we have the employees with the right skills to maintain the instruments, systems and interfaces?
- Do we have a company culture that accepts change easily (probably the most important question)?
- Are we ready for an initiative that spans and touches each production and material inventory movement and storage department in the company?

Personally I believe that only companies who put tremendous effort into a MAS will be successful. It is not 'just' an IT system; it is a company system. It is not only IT that will have to put in the effort to make it work – in fact it will take a lot more effort from Production than from IT. The MAS will ultimately determine how the company works and produces product/s.

In the final analysis it is my personal conclusion that a Metals Accounting System is in fact nothing less than a Manufacturing Execution System for the metals industry.

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