Sharing Sepasoft MES Production Data

We are frequently asked to lay out our database tables so that the MES production data can be analyzed at a higher level. This makes sense because companies should do high-level analysis, whether it is machine learning, AI, or just manual analysis, to optimize their production processes. We were founded on the principle of openly sharing data, and customers have complete access to the raw MES production data. However, the MES production data is not very useful in its raw form. This article describes how we store the raw production data and best practices for pulling clean, useful MES production data.

When AI, data lakes, data warehouses, big data, and machine learning are mentioned, one commonly gets the idea that the first step is collecting all data that can be collected. The more, the better. Then, once you have a massive amount of data, the AI engine will start producing great results. In reality, it doesn't work like this. First of all, using millions or even hundreds of data points for training machine learning or AI requires an extensive amount of computing power. Second, the training is against a known result (like OEE). And third, the results are only as good as the data collected. Yes, this means garbage equals garbage out.
There is a term for this "Data Swamp" when your data gets messy and unmanageable.

The Sepasoft MES data is clean and has a context, which is a first good start to feeding data to a system to perform higher-level analysis.

Raw Production Data

The Sepasoft MES modules store production data in a raw format that typically includes the equipment UUID (Universally Unique Identifiers), timestamp, and the value. I say typically because in some cases, there are additional columns, as is the case for storing the equipment state. Operators can override and split downtime reasons, and these details are stored in additional columns associated with the automatically detected downtime reason.

Because we store this raw data and not calculated data such as OEE, downtime duration, etc., it is not very useful for higher-level analysis. Or, at a minimum, requires a significant amount of effort and computing power to derive meaningful data with context.

This is an example of how we store the raw data and how we use that raw data to calculate meaningful information.

EquipmentUUID	TimeStamp	State
b75fa5df-3117-4016-a293-71a9339841a6	2021-10-05 10:00:15	16
8dfdf1ba-9e6a-43a1-b2a0-509d36d6d9e2	2021-10-05 10:00:15	1
b75fa5df-3117-4016-a293-71a9339841a6	2021-10-05 10:00:25	1

Equipment UUIDs are used instead of the human-readable name. If the equipment is renamed and if there are millions of records of history in the database containing the human-readable name, then it would result in a whole bunch of updates.

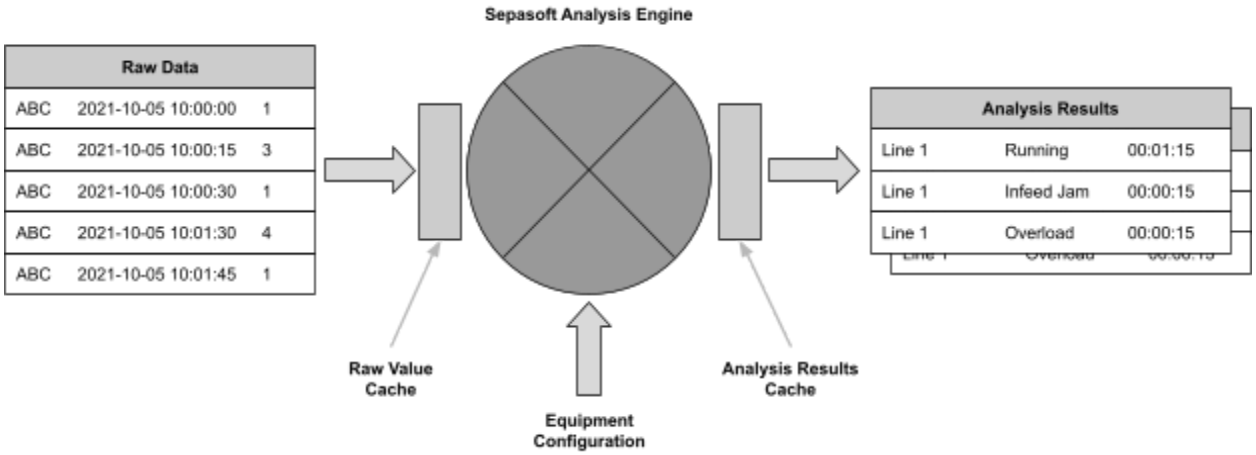
Notice that the state is just an integer and is not human-readable text. This is done for three reasons: the first being that it uses less database space; second, state names can be changed; And third, PLCs are like integers and not human-readable text.

Also, notice that there is no duration column. The duration is determined by many factors, such as the downtime detection method. For example, just because the state of a filler represents a downtime reason doesn't mean there is a loss of production on the line. If it eventually causes a loss of production on the line, then the downtime event begins, and it doesn't necessarily match the timestamp that the filler state changed. Another vital reason for not storing the duration is to allow backfilling or modifications to the data.
Calculated values such as total downtime, OEE, counts, etc. are automatically adjusted. In other words, if we stored the total downtime, OEE, counts, etc. in the database tables, all the rows after the adjusted row would also have to be updated. Our OEE 1.0 product was this way and was not very user-friendly for our customers, and we shifted to this approach which has worked out significantly better.

Analysis Engine

The analysis engine transforms the raw data into meaningful data with context. It accounts for the downtime detection method, handles backfilling from MQTT store-and-forward, and much more.

Analysis can result in a high volume of database queries and number crunching.
For this reason, we have built-in caching of the raw production data so that the same SQL queries can feed data to multiple analysis requests. In addition, there are caches to reuse the calculated values.



Cost of Direct DB Access

It seems simple enough to query the raw MES database tables. However, there are substantial hours to reinvent the wheel to get the same results our analysis engine already provides.

From time to time, we change the schema of the MES database tables to accommodate new features. When we change the schema, we guarantee that the analysis engine will function properly and produce the correct results. However, we don't guarantee the schema or format of the data stored in the MES database tables will not change. This can cause the higher level analysis to break or, worse yet, provide inaccurate results.

The schema of the MES database tables was organized to accommodate two goals of supporting ISA standards and performance. This includes indexes that are optimized for our internal use. This means indexes were not created to optimize your queries. If additional indexes are added to accommodate outside queries, it will slow down our insert and update performance. Likewise, performing outside queries without correct indexes can cause table scans which also degrades the performance of the overall MES system.

Best Practices

The ideal situation is that higher-level analysis has clean data in enough detail and with the correct context that efficient, meaningful high-level analysis can be done.

Depending on the high-level analysis system, we support multiple methods to provide data. All of these achieve the ideal situation and result in lower TCO compared to querying your production data directly from the MES database tables.

RESTful Web Service API

If the higher-level analysis system supports making RESTful API calls, this is a great option. Optionally, data can be pushed on a periodic or event basis to the higher-level analysis system.

For the scenario where the higher-level analysis system requests data using an API call, a minimal amount of scripting is used to collect the data from the analysis engine and include it in the response. This supports passing parameters that can give the higher-level analysis system control over what data is returned.

For the periodic or event-driven scenario, a minimal amount of scripting is used to collect the data when a time interval has passed, or an event has occurred in the Ignition system (button click, production run completed, etc.). It initiates sending it to the higher-level analysis system. This method assumes that the higher-level analysis system will store the data sent.

Pros:

- If changes are made to past production data (like changing an unplanned downtime reason to a planned downtime reason), the change is reflected in the results.
- Data storage at the higher level analysis system is optional.
- More secure because a database is not exposed to the Internet. The push method is even more secure because ports are not exposed to the firewall.

Cons:

- Requires some scripting compared to the Live Analysis and SQL Bridge options.
- Not as performant as Live Analysis. However, we support a feature that offloads the analysis to an Ignition server separate from your server(s) handling your production on the plant floor.

Live Analysis and SQL Bridge Combination

More than likely, your MES implementation already utilizes Live Analysis, which calculates results as production occurs.

It is based on a configurable time period. It is highly optimized so that SQL queries and calculations only happen for the new data as changes in the production environment occur or every minute, whichever is less. Multiple Live Analyses can be configured with different time periods. For example, one can be configured to return the results for a shift, and another can be configured to return the results for the production run.

The data values included in the Live Analysis can be selected from hundreds of data point options and can include as much detail as is desired for your use case.

The Live Analysis results are exposed into Ignition tags so the SQL Bridge module can be used to add a new row to a custom dedicated database table. The system doing the higher level analysis can read to time history of production information directly from the dedicated database table without any worry of impacting the performance of the MES functions.

Pros:

- Simple, quick configuration
- No scripting required
- Very performant

Cons:

- If changes are made to pass production data (like changing an unplanned downtime reason to a planned downtime reason), the results in the dedicated database table are not corrected.

Summary

There is so much hype about AI and machine learning, but I encourage you to focus on just the successful case studies.

The ultimate goal is to perform higher-level analysis reliably with minimal implementation hours and no degradation of the performance of the MES systems. We provided multiple options to accommodate this, but if there is functionality that this article doesn't address, please contact us and educate us on your use case.