Introduction to Data Enablement for Manufacturing Operations

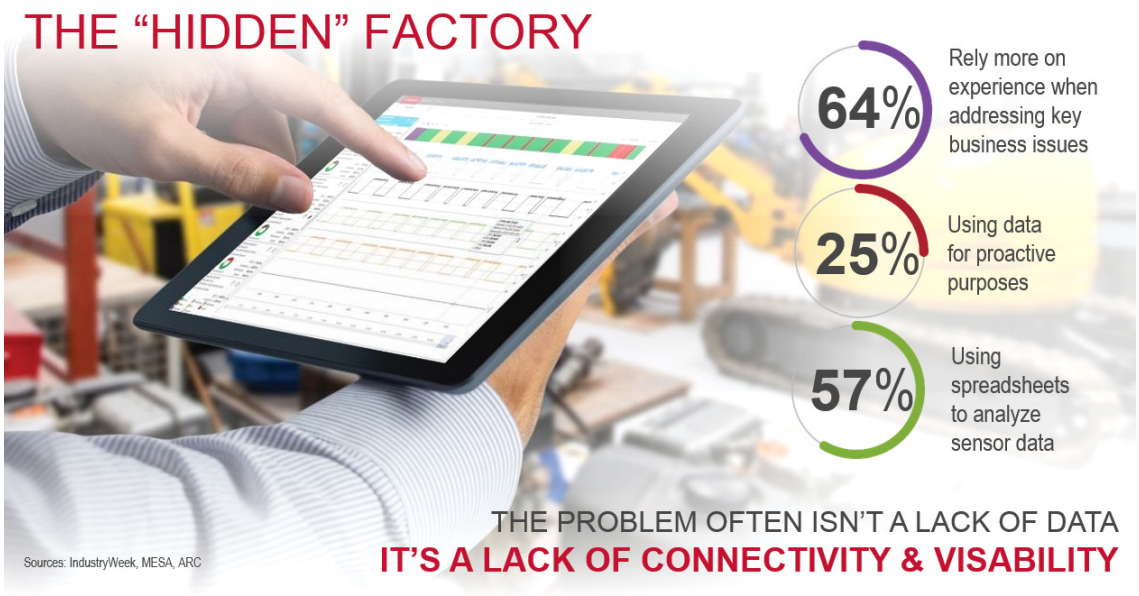
10 - 15 minute read

The content is based on article written by Tim Goecke is the Director of Enterprise Application Integration at Rockwell Automation's MAVERICK Technologies Group.

There is also a 12 minute video on the same topic by the same author/presenter (link below)
https://www.youtube.com/watch?v=UiOFp_WeecY

Data Enablement – Introduction

How to make manufacturing data more useful, more accessible and enabling your manufacturing data is at the very root of staying competitive. Data enablement ensures the right data, in the right form, is available to the right person at the right time.



If you are a manufacturing operations leader, the ability to make data-driven decisions in near real-time is most likely a very important goal of yours. If you are a business intelligence analyst focused on gleaning ways to improve the business across the entire supply chain, robust data sources are of great value, especially from the manufacturing operations, which is a critical link in the supply chain.

This paper defines data enablement for manufacturing operations and discusses the five basic elements for data enablement: structure / governance / contextualisation, analytics and socialisation.

Data Enablement – What is it?

A high level definition of data enablement for manufacturing operations; is getting the data from the various sources on the below left to the people on the below right who need the data to do their roles more effectively.

Data enablement must also include transformation of data from the various sources on the left into meaningful and usable format that various roles on the right need to make decisions on how to improve their aspect of the manufacturing operations.

Data Enablement – Scope

- **Data within manufacturing operations can be segmented into 2 data types:**
    - Process Data
        - Sources – sensors/instruments/control systems/manual data

      (This data includes temperatures, rates, speeds etc)
    - Transactional Data
        - Sources – typically various operational IT systems - eg MES, Quality database, LIMS etc.

      (This data is the lot/batch numbers, order numbers, production and quality events, Downtime events etc.)
- **Data Enablement entails five basic elements:**
    1. Collection
    2. Structure
    3. Contextualisation
    4. Analyse
    5. Socialisation

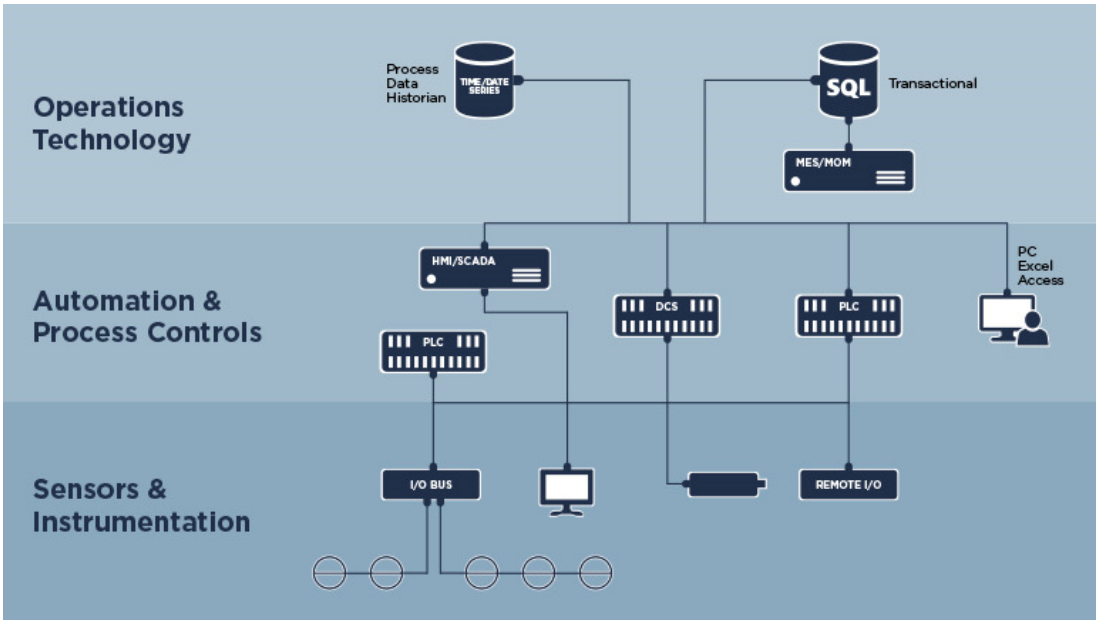
For discussion purposes, let's use the term *data enablement*, which in this context is defined as the process that translates all the bits, bytes and strings of data that the manufacturing operations generate into accessible, readable information. The general data stakeholder community (i.e., the operations team, quality team, product engineering / R&D, maintenance, business intelligence analyst, etc.) can then leverage this information without reliance on the process engineering group or IT team to retrieve and translate it.

5 Elements of Data Enablement

Data enablement done right requires some fundamental elements, such as collection, structure / governance / contextualisation, analytics and socialisation. Let's delve into each of these elements beginning with *collection*.

1. ***Data Collection***

This element may sound basic, but it is a critical foundational element. It needs to be done correctly, starting with the process data, which is the time series data that the sensors and instrumentation generate, along with the calculated values generated within the process systems. This data is captured within the automation controls layer, which is mission critical data. You should not have anyone, except the automation control experts, accessing it. Therefore, this data needs to be extracted into a repository that puts it into a different layer and keeps the automation controls layer isolated and secure. The preferred way of doing this is via a process data historian.

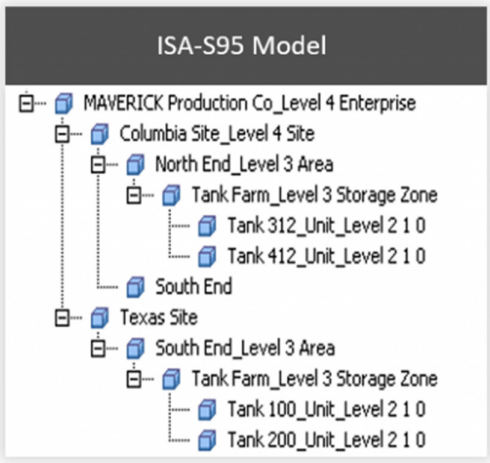


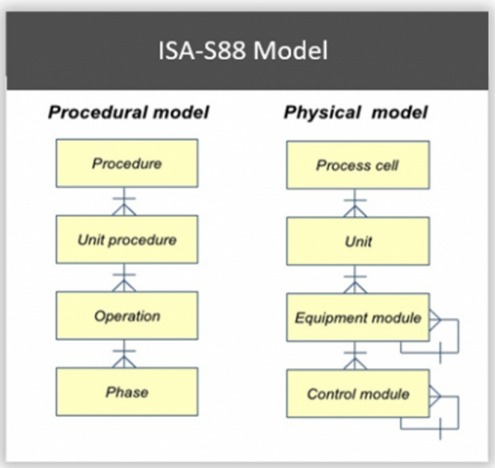
Process data is only half of the collection element; the other half is the transactional data. This is the all-important operation event header type records (i.e., batch numbers, lot numbers, order numbers, quality samples, downtime events, work orders, etc.) To be useful and manageable, this data needs to be kept in a relational database format, like a SQL-based database. Common system platforms for the collection, generation, organisation and management of this data are manufacturing execution system (MES), manufacturing operations management (MOM), quality management system / laboratory information system (QMS / LIMS), enterprise asset management / computerised maintenance management system (EAM / CMMS) and of course, enterprise resource planning (ERP).

2. *Data Structure*

Process data collection by itself does little good other than ensure there is a historical record. Left as is, this valuable operational insight data is highly cryptic to the general data stakeholder community. To make this data useful, the data needs to be structured and contextualised to enable an easy and intuitive way to find, access and read the data. The best way to structure the data is via a data model. A data model facilitates common terminology and structure for data governance, ease of access and optimal integration between systems. Examples of common data models are the ISA-S95 model for hierarchical structures, and the ISA-S88 model for batch-based processes.

Here are a couple macro visuals of these structures:



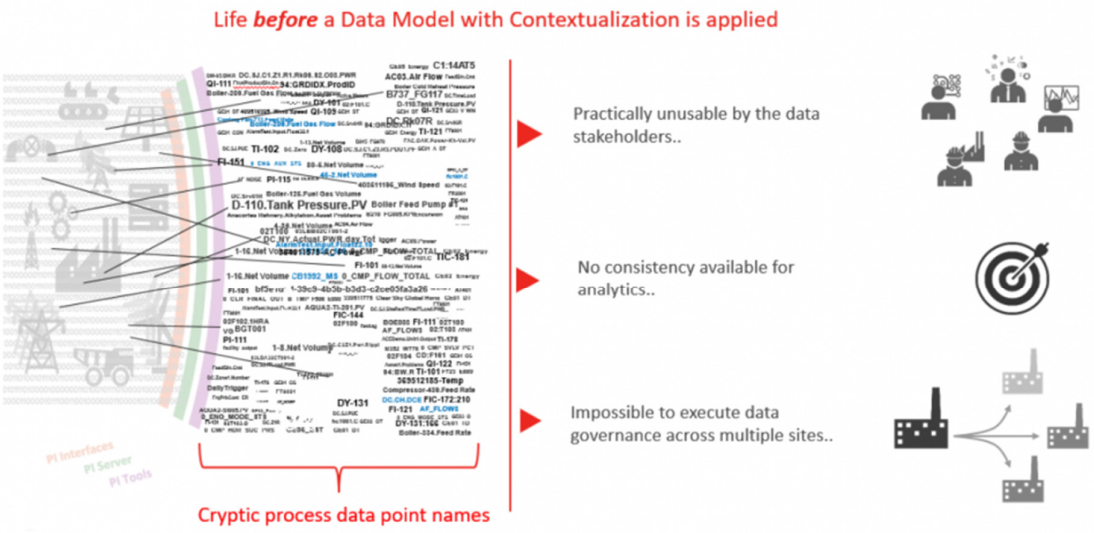


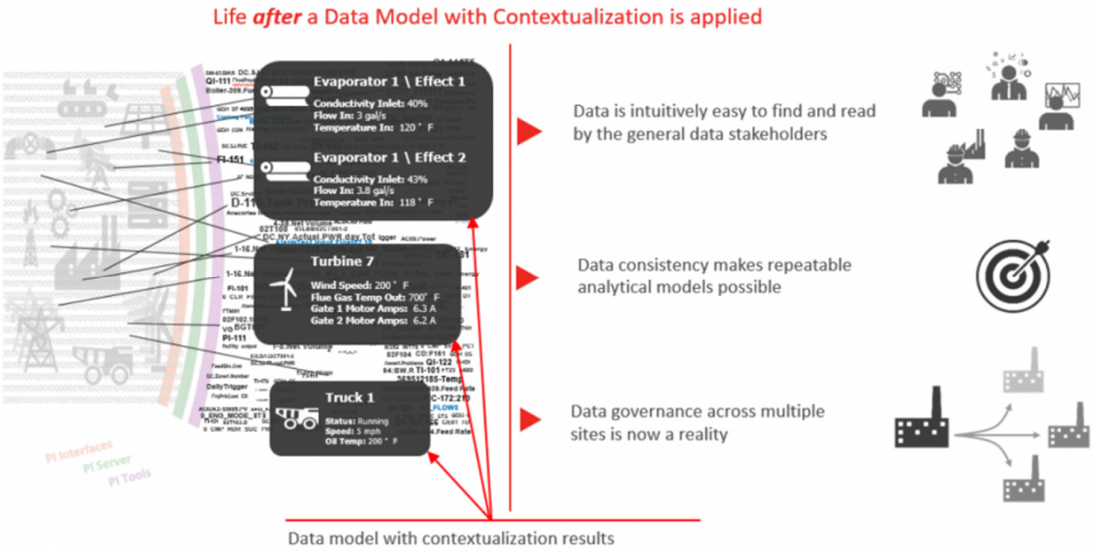
3. *Data Contextulisation*

Once a data model has been selected, now it's time for the Midas touch — organising the data within this model and adding the correct contextualisation. For the general data stakeholder community, this is the key between your process data being usable or not. The structure organises the data in a way that makes it intuitively easy to find. The contextualisation allows the relabeling of this native cryptic data into a language that is familiar to the general data stakeholder. This relabeling is done without ever changing the original tag and data point names down in the automation controls layer. Relabeling maps the new name to the original tag or data point name that is returning the actual value. This is at the heart of data enablement in the context of this article.

Most of the contemporary data historians and operations technology systems, like MES and enterprise manufacturing intelligence (EMI) solutions, incorporate tools that facilitate these data structures. Rockwell Automation's FactoryTalk Historian Asset Framework takes the tags registered within the data historian and organises them in an intelligent, hierarchical manner. Helping manufacturers to make sense of that data and facilitate performance improvements. The key here is to make sure a "common" data model approach is used across all systems to ensure proper governance and help maximise interoperability between systems.

The following two illustrations demonstrate life for the data stakeholder community before and after data modeling with contextualisation:





Having data that the general data stakeholder community can intuitively find and easily read reduces the operational friction that exists without it. For example, your process engineering staff will not have to burn valuable time doing data mining for people interested in data analysis that requires process data. The operations team can now quickly locate data for key performance indicator (KPI) generation, performance reports and root-cause analysis to operational issues.

This leads to our next element of data enablement — analysing the data now that you have it accessible and readable.

4. ***Analytics***

Basic Analytics - Basic analysis of process data is accomplished with native Microsoft Excel connectivity tools or the historical trending tools found in many human-machine interface / supervisory control and data acquisition (HMI / SCADA) platforms. Typical examples of analysis are:

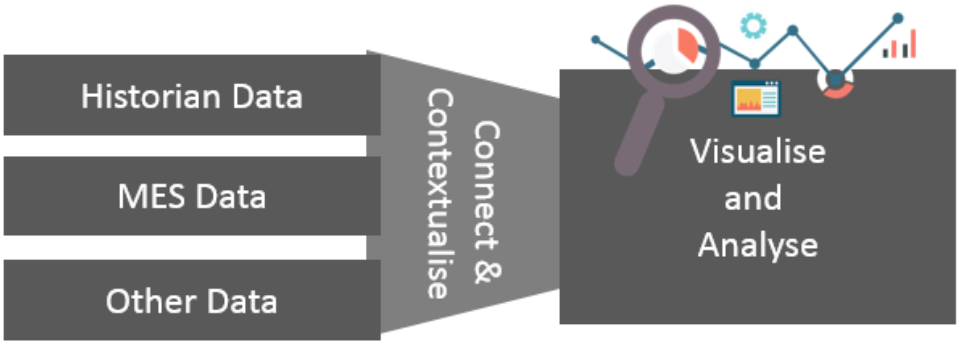
- Trending of rates, flows and temperatures over time
- Threshold determination
- Auto population of Excel-based reports

We have seen some amazing reports and analysis accomplished using these Excel add-in tools. As the old adage goes, with enough time and money, you can accomplish anything. However, who has that kind of time? The time it takes to formulate, manage and execute long-term support with this approach for anything other than the basics quickly becomes unsustainable.

A better approach is to use the fit-for-purpose analysis tools offered by historian OEMs. These platforms offer ad-hoc style analysis tools complete with navigational tools that allow the data stakeholders to leverage the data model and contextualisation efforts. Use case examples for these tools would be:

- Asset performance profiles
- Current batch vs. golden batch performance
- Threshold detection and determination for condition-based maintenance
- Pre-event vs. post-event pattern analysis
- KPI performance dashboarding

The above yields some very valuable intelligence. However, the **value equation goes up even further when we associate the process data with the transactional data** mentioned earlier. Now you can make things interesting and insightful for the wider data community. Using universal EMI tools like Rockwell Automation's VantagePoint or PTCs ThingWorx, are examples. These tools are designed to connect to data sources in the manufacturing operations technology space, mainly, OPC, most historians and SQL, that leverage and/or facilitate the common data models.



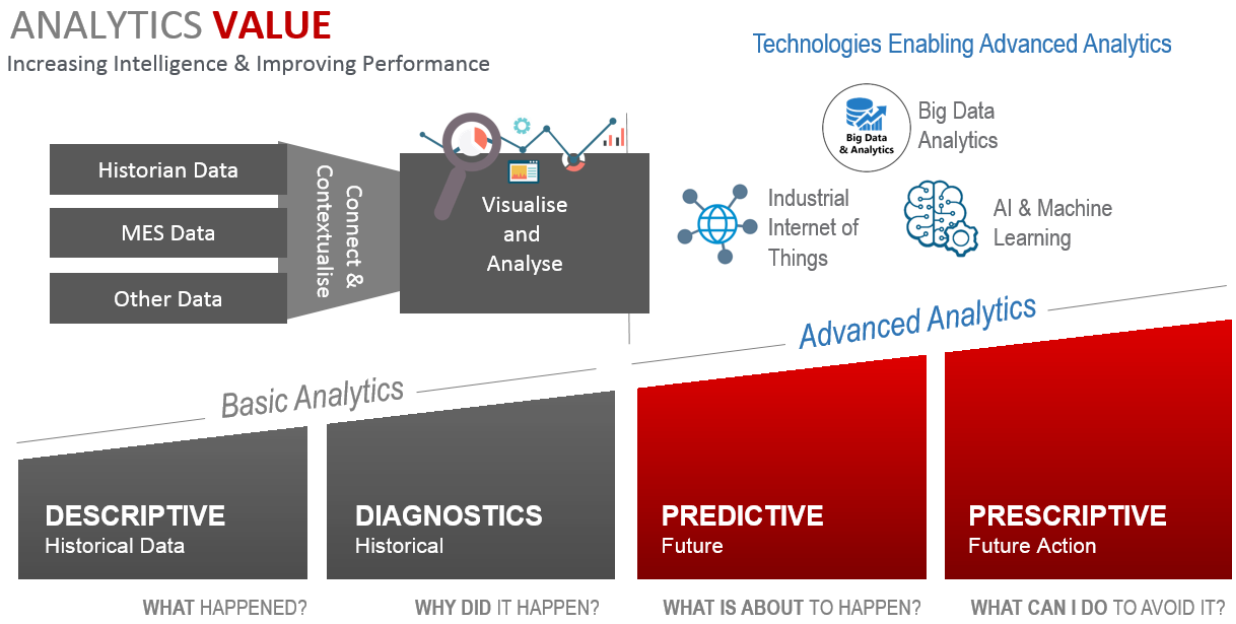
These tools enable the data stakeholders to cast a wider data analysis net across the multiple data silos. For example, they can now analyse process data in the data historian against the transactional data in one or many relational databases natively.

Some use cases for of process data in the data historian against the transactional data in one or many relational databases would be:

- Yield, efficiency and energy consumption by:
  - Product
  - Lot, order or batch
  - Shift, day or time of year
  - Asset

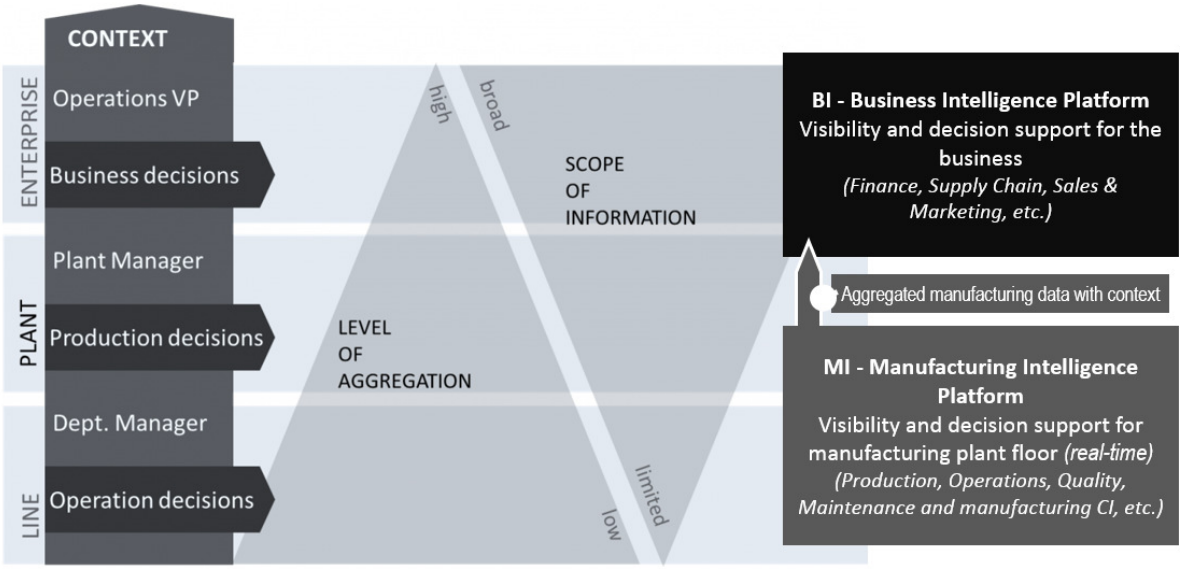
- Impact to yield, efficiency and energy consumption when a change in a quality spec, material or a process has been made
  - Material performance by vendor, product type or asset
  - KPI performance automation and dashboarding

Advanced Analytics - To go a step further, data enablement can be a great accelerator for the predictive analysis tools that are now mainstream thanks to machine learning (ML), artificial intelligence (AI) and pattern recognition. These technologies work best when there is historical time / date alignment between the process data and the event data, like maintenance work orders or downtime events. Data enablement, done correctly, will expose this data to the stakeholders.



5. *Socialisation*

Now that you have the data stakeholder community empowered with structured, accessible, readable data and the analytical tools to use it, it is time to socialise the results, which leads to our last element of data enablement, *socialisation*. It is important to note that there are varying degrees of interest across a given enterprise. MESA International refers to this as the divergent perspective (see the graphic).



Source: MESA International

Basically, the interest of leadership from a corporate perspective is going to be vastly different than the interest at a line or department level at a site. The interest at a plant management level is going to be a mixture of both high and low, which is natural. The data types, granularity and real-time nature differ for what is required on the plant floor to what is required at the business level.

A good socialisation solution needs to address all these interests and also have access to the data to support these divergent interests. When selecting a specific technology, consider the data sources the system needs to source, the existing enterprise analysis and visualisation tools already in place, the entire user community needs, and the client hardware platforms that will require support.

Closing Comments

So, where do you start the data enablement journey? What are the incremental steps that align best with your existing infrastructure and organisational needs? How do you select the correct technology to fill the gaps that exist? How do you build a business justification? To answer these questions, you must first understand that data enablement is all about making data accessible and useable to your wider enterprise to enable a deeper and timelier understanding of your operations.

For more information please visit Manufacturing Production Analytics page via the below link

https://www.rockwellautomation.com/en_NA/products/analytics/overview.page