

Manufacturing Intelligence

By

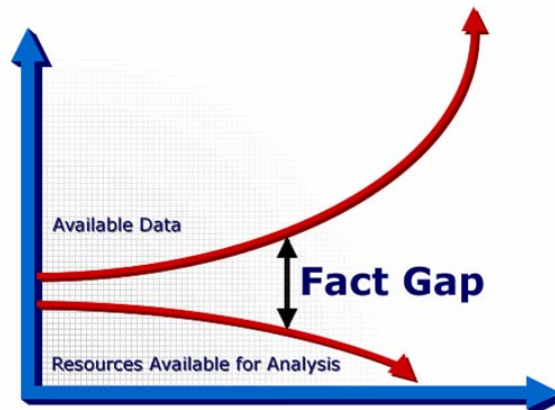
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Introduction

While factory floor automation has significantly improved all areas of processing for manufacturing companies, it has also created a staggering amount of data. Today, facilities with even a modest number of collection points can experience data storage rates that vary from 10 Megabytes per month to 30 Gigabytes per day.

IT departments have taken advantage of hardware improvements to economically store the increased data, however there never seems to be enough time or resources to meet the needs of factory managers who face the “fact gap” that exists between the data and the usable information required to make real business decisions.

The amount of information managers are dealing with each day is increasing exponentially but the resources available to sort, scrub, and analyze the data are decreasing.



This paper presents a variety of ways in which Business Intelligence (BI) technology, which has long benefited the financial areas of the enterprise, can be used to increase the flexibility and speed of operational reporting. Through real world examples, it explains how BI can be used to:

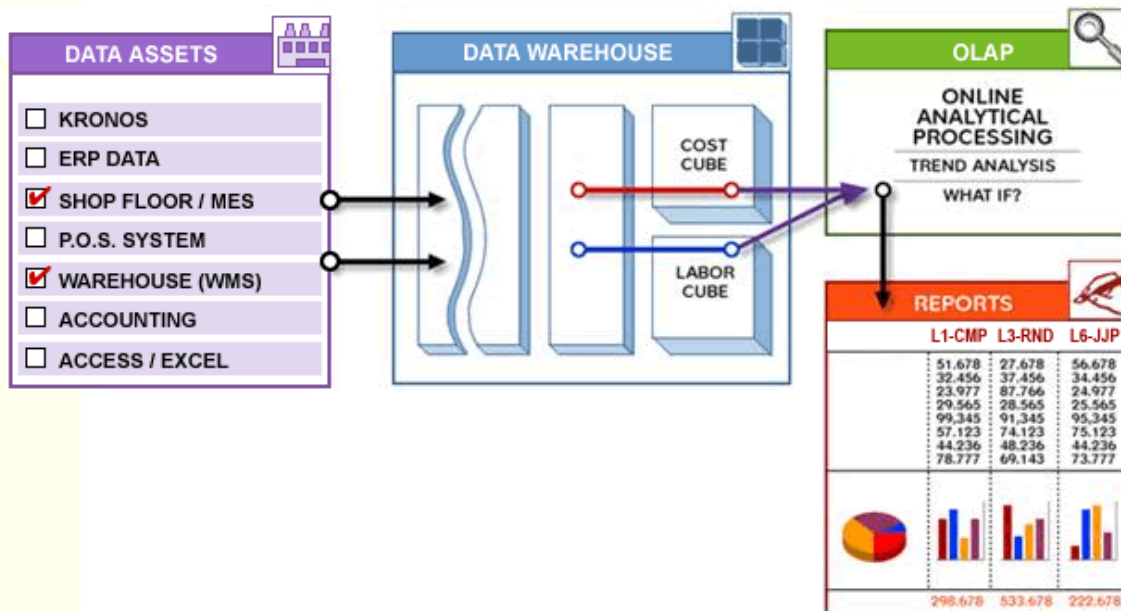
- Quickly generate established reports
- Easily create ad hoc reports
- Isolate specific problems
- Analyze data across multiple systems
- Integrate new data sources

Overview - BI technology for manufacturing

Reports generated in high data volume environments normally take a long time to run. To speed up report generation, many systems use tools that employ a summarization technique to reduce the amount of records by aggregating records together with common characteristics. Problems with this technique include an inherent inflexibility and an inability to cope with the constantly changing information needs of manufacturing.

Use of an On-Line Analytical Processing (OLAP) database can significantly improve both the performance and power of manufacturing reporting. Performance is improved by applying essentially the same summarization technique, but the common characteristics (in OLAP referred to as a "dimensions") and indicator parameters (called "measures") can be quickly changed to answer new questions as they arise. The dimension and measure elements are combined into an OLAP "cube" for analysis. The OLAP cube is powerful in that it is specifically designed to do this without costly modifications to system architecture.

The diagram below shows how information from a variety of systems is integrated into an OLAP framework.



The tools available for OLAP analysis allow manufacturers to examine data spanning multiple systems and to compare data across a wide range of subsets including:

- Date/Time
- Shift/Crew/Employee
- Supervisor
- Product (Category/Sub-category)
- Lot/Batch
- Quality code
- Customer
- Machine/Class
- Area/Plant

OLAP databases are designed to provide meaningful answers to analytical business questions. A Data Warehouse is the product of an Extraction Translation and Loading (ETL) process that:

- Pulls data in from a complex array of Data Assets [Extraction]
- Cleans the collected data [Translation]
- Prepares the data for accurate reporting [Loading]

The resulting data, normalized during the ETL process of merging data sources, is now ready for analysis.

Cube building consists of processing measures saved in the BI system to pre-summarize or aggregate data based on the dimensional slicing configured for the reporting system. Measures can be of many formats:

- Length/Width/Thickness measurements
- Temperature and Pressure
- Laboratory values Color/Hardness/Uniformity
- Weight/Quantity
- Time to build/process

Computed values allow for more advanced analysis:

- Average/Range
- Ranking (top 10 worst quality)
- Standard Deviation
- Tolerance variance

The OLAP server performs aggregations with the level and number of aggregations determined by the size and desired performance of the OLAP system. For example, total quantities can be summarized by machine, by shift, and by day to give the best performance for the given server resources. To achieve optimum performance, the OLAP server automatically uses the best aggregation when querying the data set.

Quickly generate established reports

Without cube processing that performs summarization or the use of complex, custom applications that summarize data, reports can take hours to generate, to the point of becoming unusable.

Report performance – Real world example #1

A tire manufacturer used BI to better predict when to replace grinder stones used during a manufacturing process. Whenever tires are ground to correct non-uniformity, the grit on the stones wears down, eventually reducing effectiveness and increasing cycle time. A preventative maintenance (PM) crew checks the condition of each stone on a periodic basis, but since each stone's wearing characteristics vary according to the product mix ground and the amount of utilization, the use of calendar scheduling to check stone wear resulted in many stones that were either changed unnecessarily or not changed when they should have been.

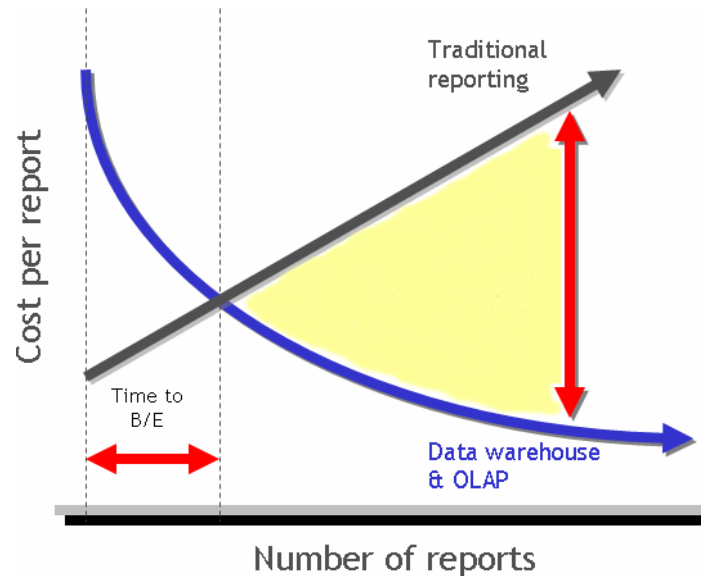
The attempted solution was to simply accumulate the grind time by machine and report this information to maintenance. The initial PM report—extremely slow, taking more than a half-hour to generate—was unacceptable.

In a subsequent OLAP solution, the grind stones were identified in a dimension, with a simple dimensional property that clipped out old grind stones as they were replaced by maintenance. Because the OLAP environment aggregates the grind time, the reporting was instantaneous. Maintenance received timely information that allowed them to concentrate their effort on the stones most likely requiring replacement (decreasing machine downtime), with the added benefit of extended grind stone life. This solution was implemented at a low cost since only a minor OLAP change was necessary to keep track of grind stone changes.

Easily create ad hoc reports

BI systems are not only designed differently than traditional On-Line Transactional Processing OLTP database designs, they are fundamentally easier to use.

There are many OLAP tools for analyzing and reporting. For example, ProClarity displays “drag and drop” report selections that allow the end user to make advanced queries without any programming knowledge. After just a few reports the break even (B/E) point for OLAP reporting can result in significant cost savings.



Ad hoc reporting made easy – Real world example #2

For one supervisor, an end of month task was to export production labor reports into a CSV (Comma Separated Value) file and import the data into an Excel spread sheet. From there it was the supervisor’s task to manipulate the data for monthly performance reports, make scheduling decisions, and generate other labor related reports. This was a high cost operation, not only because of the intense manual effort required but also the cost of lost opportunity—reporting that could have been done but was not due to the difficulty of assembly or the painful wait for an IT programmer to become available to implement any necessary changes.

OLAP installation eliminated the requirement for Excel as a reporting tool and significantly reduced reliance on IT for additional, specialized programming. Excel could still be utilized for some forms of analysis, albeit significantly improved by ProClarity’s ability to move data directly from the OLAP environment to an Excel sheet.

Isolate specific problems

The dimensional organization of BI systems allows for easy “drill down” analysis, where data can be sliced and diced to examine different data sets. In many cases manufacturers are looking to compare operations between set standards—machine to machine, shift vs. shift, etc. Using a graphical visualization tool for analysis can help to quickly identify production outliers.

Striking a balance – Real world issue #3

Downstream systems seemed to be starved for components again and again. Maintenance and production personal could not agree on where the problems originated. BI analysis of machine downtime and maintenance, production output by area, and other key metrics led to several discoveries, including:

- Maintenance staff imbalance. Some areas received too much coverage while other areas received too little, creating downtime ripples.
- Production bottlenecks. Production found that some of their mid-stream machines were not able to produce as expected, requiring expenditure for specific equipment.

Implementation of changes that focused on these discoveries resulted in factory output that increased by an astounding 40% over the next year.

BI systems allow end users to uncover facts that were previously unknown. Because it gives the end user the ability to drill down into fact tables and to examine, compare, and analyze data, BI is the effective bridge that overcomes the “fact gap.”

Examine issues across multiple systems

Often the data systems within an organization have such limited interaction that creating a report that interacts with two or more systems is complex at best. A major obstacle is that the data is still organized in an OLTP / transactional format. BI technology overcomes these types of problems by design.

QA clues – Real world issue #4

Intermittent quality problems were found during final assembly of a product. The problem did not appear to be associated with a machine or a raw material lot. The OLAP system was originally designed only to investigate upstream machine calibration issues which might not show up until final assembly. BI allowed the

easy addition to the OLAP database of time card information from a Kronos scheduling system. The additional time card information analyzed against the backdrop of the original OLAP data helped management determine that a float operator followed the quality problems downstream.

Integrate new data sources

As with most information systems, the only constant is that the systems will be changing. The architecture in a BI system is generally organized to meet the business needs of end users, rather than the technical needs of the computers. The addition of new data collection points, new dimensional information, or even completely new data systems can be handled by applying BI technology.

New equipment – Real world issue #5

A sophisticated set of reports already existed, so when they learned that a new product would require an additional manufacturing step, the production team worried about acquiring the new process data and changing the operational reports. Fortunately, that system was already an OLAP system, and integration would add only two dimensional records and extend the fact table. Most of the reporting was already in an online format, so after revising a few reports to reflect the new equipment, the systems were ready for production. Careful design of the OLAP database in advance made the ongoing maintenance simple and very cost effective.

Conclusion

The technologies of Business Intelligence (BI) and On-Line Analytical Processing are very effective for manufacturing. BI can close the “fact gap” by improving the availability and delivery of actionable data with minimal IT involvement. Manufacturers should carefully consider using BI as a cost effective way to improve operations.