CHAPTER 2

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Why Use SAP MII in Manufacturing Industries

This chapter explains why you should use SAP MII in the manufacturing industry. It explains the challenges that are being faced in manufacturing and the role SAP MII plays in overcoming these challenges.

Why Use SAP MII?

The previous chapter explained what SAP MII is. One of the biggest questions these days in the manufacturing world is why use SAP MII? The benefits of using SAP MII need to be considered from multiple perspectives, such as its functional aspects, technical advantages, and business benefits, to justify its usage. SAP MII is a powerful integration platform, which means that SAP MII can work as middleware among different third-party or legacy systems. It's not only for integration. SAP MII has intelligence capabilities also, as it is used to develop various smart real-time analytical and monitoring reports with high-end visualization using 3D graphics. Recently, SAP MII has been introduced with another "I" factored in it, which refers to "innovation". This silent feature of SAP MII helps you leverage innovation by connecting with IIoT (Industrial Internet of Things) smart mobile devices.

■ **Note**　The term *innovation* refers to introducing a new idea to an existing method or modifying the existing method with a more enhanced solution. The new solution might be more user friendly or use new devices or technologies to achieve better results. For example, the smartphone was an innovation over the traditional cell phone and it was inspired by the market demand for more flexible communication.

IIoT refers to the Internet of Things technologies. The different technologies that are part of the IIoT include big data technology, machine learning mechanisms, methods controlling, and monitoring sensor data. How one machine communicates with another machine is also

called M2M (machine-to-machine) communication. Another factor behind the use of IIoT is that it can integrate with mobile devices so users can stay connected to near-to real-time data even when they aren't on-site.

Key Challenges and Solutions in Manufacturing

The manufacturing sector has been facing various challenges, including increased cost of production, lower quality of the products, finding qualified manpower, competitive markets, and more. All these challenges are interconnected. For example, inefficient manpower tends to increase the cost of manufacturing and adversely affect the quality of the products. The organization is left behind in the long run. To overcome these issues more easily, quickly, and efficiently, the company needs a robust solution. The following sections explain in detail the challenges and the solutions applied to the manufacturing industry.

Competitive Markets and Lower Manufacturing Costs

Manufacturing is a complex sector but is an essential part of any country's economy. There is stiff competition in the manufacturing industries these days. The competitiveness of a manufacturing firm can be determined based on various interdependent factors like quality, innovation, efficiency, customer satisfaction, employee satisfaction, etc. Further, how fast these functions communicate with each other adds to the competitiveness factor of a firm. Multiple factors are involved to determine the competitiveness in manufacturing. To handle this challenge more efficiently, you must identify the core competencies to manage with minimal cost and high quality. These days, innovation is also considered a factor that provides better performance, which in turn helps reduce the cost of manufacturing.

SAP MII provides all these functions in one place to the manufacturing firm with minimal costs. From the server perspective, as it has the following:

- Internal database and low maintenance cost

- Capability to integrate with ERP systems using connectors to get near-to real-time data from the shopfloor

- No manual costs involved in various processes

- Automation of the processes so to avoid human error

■ **Note**   ERP stands for *Enterprise Resource Planning*. This is the planning and management suite for the business, which helps manage the activities of planning for the production and product. This includes manufacturing costs, delivery, bill of lading, material management, shipping management, payment management, inventory management, sales management, etc. It helps you get an integrated view of the business from warehouse to production management and from planning to production management by providing control over various business processes in real-time using a strong RDBMS (relational database management system).

The *shopfloor* is the area of a factory or workshop where the operatives work; this term is used to distinguish the productive part of a factory from the administrative part.

Preference of Lean Supply Chain Strategy

Now a days, manufacturing industries prefer a lean supply chain strategy. This method promotes delivery of products quickly to the end customers with minimum waste. A lean supply chain helps deliver the customers a better solution while quickly predicting the customer's needs and easily delivering the product with great efficiency. This ultimately helps in superior financial performance. As SAP MII is a flexible platform, it is possible to develop customer-specific solutions as required. Further, SAP MII can connect to the shopfloor systems and ERP solutions and can automate the processes, so it is possible to design the solution in SAP MII in such a way that the production timeline will be reduced. SAP MII can further integrate with quality modules and monitor the production in real-time. It can put a check on production wastes more efficiently, which results in decision-making being reduced.

■ **Note**   The *supply chain* is one of the components of enterprise resource planning that provides a clear view of the inventory's movement from supplier to end customer. This provides a transparent view and better control over the raw material to the finished product, and finally delivered to the end customer.

Lean supply chain encourages producing only the amount required and considering when and where products are required. This helps reduce unnecessary production, which can cause waste and drive up cost. Fewer resources are used to produce more or more resources are used to produce the exact amount, as per the end consumer need. This can be successful only if each product is attended to individually to remove the unnecessary methods involved in the processes, which are considered waste. Thus, the Lean approach focuses not only on removing waste from processes but also considers the enhancement of the value stream.

Disparate Manufacturing Plant Systems

Manufacturing plants involve multiple automation systems, machines, factories, headquarters, and securities of different manufacturing-related departments. In a larger manufacturing system it is very common for production plants to be scattered in multiple locations, regions, or geographies. These various units are disconnected and don't communicate with each other very well. Generally, ERP is implemented centrally at the headquarters or regional office and not at each plant. As there is no direct connection of the ERP systems with these units, it can be more time-consuming to fetch information from various sites and units. Also, as this information is handled manually, there is a very good chance of human error. If ERP is connected to MII locally, regionally, or globally, management will always be able to get near-to real-time data. As the process becomes automated with SAP MII, the data will always be accurate. Along with that, MII has guaranteed delivery of data and thus, if any plant or unit gets disconnected, MII can push queued data to ERP immediately on reconnection, without any data loss.

Business and Financial Impact of Production Issues

The business and financial impact of production issues or discrepancies is very difficult to monitor or control manually in manufacturing units. As an example, if the scenario arises where there is demand for 100 parts to be produced as the final product but, due to a fault in the line, 20 are scrapped and only 80 are produced, this is considered good production. If 80 were scrapped and 20 were good, the line or machine needs to be replaced or corrected, as number of scraps is higher than the good product. SAP MII can connect to ERP to monitor and raise plant maintenance notifications from both MII and ERP. These notifications tell the maintenance supervisors about such business losses in time so they can replace or rectify the machines or lines quickly.

Financial loss can also be curbed by having good performance line or machines that produce good products with minimal waste. MII can also connect to the quality module of ERP so whatever good quantity is being produced as a final product, MII can connect to ERP quality modules. SAP MII also has a plant maintenance schedule monitoring feature. This feature can be utilized by management and supervising teams. These teams can use the score card reports developed in MII to see why and when the lines went through states like scheduled downtime, unscheduled downtime, scheduled stop, malfunctions, and so on. These issues could happen because of labor error, material unavailability, deviation from planned production, utility of equipment in excess, improper logistics, and unavoidable incidents.

Lack of Control and Monitoring Mechanism for Production

Many times, manufacturing industries face problems because they cannot control and monitor the line running in production. Suppose there is a situation where they need to keep track of the temperature controllers used in large ovens in production, when it crosses a particular threshold and then manually track the exact time of this incident. This information may be erroneous if it's left to human intervention.

Another situation that could occur is that the boiler or tank valve needs to be closed, as it is exceeding its capacity. But again, due to the lack of a proper mechanism, the boiler/tank overflows and bursts. Human lives could even be lost due to such plant incidents. SAP MII provides a foolproof solution to avoid such incidents. It constantly checks for the threshold and sets alarms to automatically track such problems in production occurring in real-time. SAP MII can also trigger emails to the supervisors to let them know about such incidents. If the shopfloor machine is connected to SAP MII, then MII can stop the machine whenever it detects a malfunction or an abnormality in the machine.

■ **Note**   The temperature controller controls the temperature without needing human intervention. This intelligent tool gets input from thermal sensors like RTD (resistance temperature detectors) or thermocouples and continuously compares that information with the set-point, which is the safe desired temperature. It provides output to the control element, such as valves that control the temperature.

Lack in Decision-Making Process to Meet Production-Level Targets

Often, there is lack in the decision support information by the production personnel to meet production target goals. These goals are defined and measured by various KPIs (key performance indicators) differing from plant to plant. As there is no direct connection of the shopfloor to ERP, production operators and even sometimes supervisors can take advantage of this disconnection and can stop the machine or manipulate the data manually to meet the production targets, thus ignoring actual readings.

These human discrepancies can be avoided by completely automating the machines involved on the shopfloor using SAP MII and connecting to ERP. Once SAP MII is connected directly to both the shopfloor machines and ERP, it can use the real-time data available from the shopfloor and ERP to display valuable OEE (Overall Equipment Efficiency) reports and custom reports, such as machine reports, downtime analysis reports, yield overview reports, etc. SAP MII is capable of fully automating such situations very efficiently.

■ **Note**   *OEE* stands for Overall Equipment Effectiveness. It is one of the metrics for ISO and considered in the best solution practices to identify the percentage of planned production time, which is truly productive. GMP (Good Manufacturing Practices) suggests having practically no downtime in the plants while manufacturing only good parts. So, if the OEE comes out to 100%, that is considered perfect production. If over time, a very good result of OEE is reached, then it is used as a benchmark for other assets in the same setup or as an industry standard for other production assets. Similarly, it can be also used as a baseline to detect overtime, the progress of eliminating waste from a particular production asset.

Copies of Master Data Leading to Quality and Compliance Issues

If ERP is not connected to the shopfloor directly, the only way to transfer the master data to the shopfloor is by downloading and exporting it from ERP into Excel. In this case, there is sufficient time loss during the transfer of data, as it is human dependent and open to error. There is also a good chance of data manipulation. To fill this gap, MII can connect directly to ERP systems and load the master data automatically when it is pushed from ERP.

Functional Aspects of SAP MII

SAP MII is the one-stop solution for not only integration but also for intelligence. It establishes a direct connection to the shopfloor and business processes and operations. It ensures that the integration between the enterprise systems and plants is near-to real-time data and displays the integrated data to the users.

When you're considering SAP MII as a solution for integration and intelligence, consider the following functional aspects.

Availability of the SAP MII Product

Currently, it is easily available and one of the most trusted solutions from SAP labs and it now comes with manufacturing suites along with some other manufacturing products. Licensing is required for SAP MII, but if the manufacturing suite licensing is already incurred by the plant then it automatically includes SAP MII in it.

Integration Benefits

SAP MII has many default connectors, which makes it very easy for SAP MII to connect to any Level 4, Level 3, Level 2, or Level 1 systems. SAP MII can fill the gap between Level 3 and Level 4 and if any plant has no MES, then MII can be placed in Level 3 too. Further, MII using a SAP PCo or OPC connector can connect to Level 2 and Level 1 as well. See Figure 2-1.
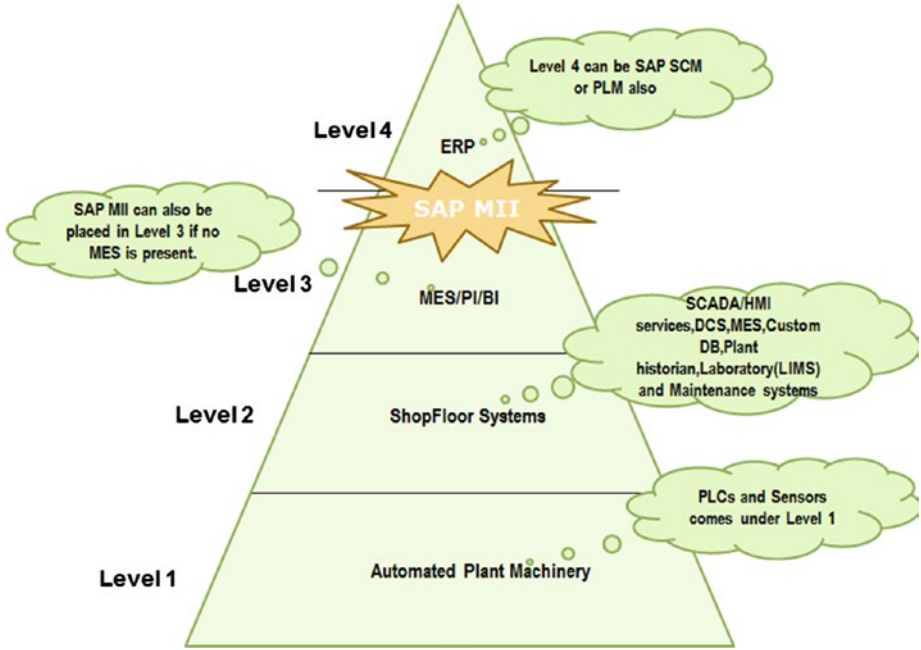
Figure 2-1. *Placement of SAP MII in industrial leveling*

■ **Note**   *Product Lifecycle Management (PLM)* is the concept of managing the products involved in any process or system by integrating the business data in a people-oriented extended enterprise environment.

Manufacturing Execution System (MES) is a computerized system that is used in the manufacturing industries to monitor and capture the transformation of raw materials to finished products. It shows real-time happenings from the shopfloor to the authorized personals involved in decision-making. It captures the input, the output, any critical failure or error of machines, the operator's activity, and other support services.

Supervisory Control and Data Acquisition (SCADA) is software integrated with an application program to control the manufacturing process. In modern manufacturing, the automated systems mainly work with SCADA. It collects data from sensors and PLC devices and provides a sophisticated control to all those devices based on the real-time data acquired.

Historian can pull data from complex systems across multiple variables to paint a complete picture of the manufacturing environment. *Wonderware historians* can store large volumes of plant historical data by processing and storing high-speed data using a traditional RDBMS. It provides a secure, high-performance database to consolidate disparate data sources and provides rapid retrieval techniques to make sense of the increasing amount of industrial data.

A *Distributed Control System (DCS)* refers to the control system of the industrial processes of the production plant where the controllers are distributed across the plant's process control points. A centralized control is also in place in the central control room. DCS mainly follows the distributed hierarchical control philosophy to control processes in plant automation.

A *Programmable Logic Controller (PLC)* is a solid-state industrial computer control system that can continuously monitor the input state of the device and make a logical decision for the automated process or machines. PLC is a good replacement of industrial relay and provides more functionalities than relay. As PLC is modular, it can be placed in any setup to define the logic and can resist any kind of tough manufacturing environment like high heat, dust, extreme cold, or high moisture. Relay, on the other hand, can't correctly operate under these environments. PLC consists of a 16-bit or 32-bit microprocessor, which can be connected to a CPU. Any kind of executable control logic can be designed in the CPU and can be transferred to the PLC by a routine run.

Laboratory Information Management System (LIMS) or Laboratory Information System (LIS) takes into account all the laboratory apparatus and equipment involved in a laboratory operation. This system enables the laboratory to be completely automated with workflows defined by integrating the instruments or apparatus and managing the associated information of the sample readings automatically. This automation enhances performance and reduces the time needed to meet the customer's needs.

SAP MII has multiple standard connectors for smooth integration, as explained here:

- *Aggregate connector*: Can be used when you create an *aggregate query*. It combines multiple datasets into a single one. It's a default connector provided by SAP.

- *ECC connector*: SAP Java Connector (SAP JCo) and SAP Java Resource Adapter (SAP JRA) can be used to connect to SAP ECC.

- *Database connector (IDBC)*: This can be used with any JDBC (Java Database Connectivity)-(Oracle, SQL or any database), or ODBC (Open Database Connectivity) data source that is defined in SAP NetWeaver.

- *PCO connector*: This can be used to support the query capabilities of SAP PCo. It's a default connector provided by SAP.

- *Xml connector*: This connector allows connecting to and querying any XML returnable data source and is included in the system by default.

- *Alarm suite connector*: This connector is basically for alarm mechanism data source and enables you to connect to the Wonderware Alarm advisor software.

- *MDO connector*: This connector is specifically used with MDO queries and can have only one active MDO connector. It's a default connector provided by SAP.

- *Open connector*: The Open connector browses historical data in a relational database. One can create tag queries by browsing tag names and descriptions and using time periods instead of writing SQL queries.

- *Universal data connector (OLEDB)*: The UDC allows remote data access when the data source does not. The UDC communicates with remote universal data servers (UDS) using TCP/IP sockets. The OLEDB connector is a UDC that allows access to OLE DB data sources.

- *Xacute connector*: This connector is used to connect to a transaction through Xacute Query. It's a default connector provided by SAP.

- *KPI connector*: This connector is used with KPI queries. By default, only one active KPI connector is allowed. It's a default connector provided by SAP.

- *OLAP connector*: This connector allows connecting and querying multi-dimensional data sources that support the XML for Analysis (XMLA) specification. It is generally used to integrate BI queries.

- *Virtual connector*: This connector helps to query and connect virtually to other SAP MII instances without directly connecting to the data source server. It's a default connector provided by SAP.

- *IP21 and IP21OLEDB connectors*: The IP21 connectors connect SAP Manufacturing Integration and Intelligence (SAP MII) to AspenTech InfoPlus.21 (IP21) data sources.

- *HANA SDA connector*: This connector allows SAP MII to connect to HANA studio.

■ **Note**   *SAP Java Connector* is known as SAP JCo in short. It can leverage the development of the components and applications in Java, which are SAP compatible. SAP JCo communication is bidirectional with SAP ECC (i.e., it supports inbound and outbound calls). For an inbound call, Java calls ABAP and vice versa for the outbound call.

SAP JRA is the SAP Java Resource Adapter. It is the Java Enterprise edition connector that's used for connection with SAP systems. It allows you to integrate AS ABAP with remote Java application servers like AS JAVA and thus simplifies the communication among different distributable SAP JAVA applications along with AS ABAP (Application Server for ABAP).

Java Database Connectivity, known as *JDBC,* acts as an API for Java and defines the accessibility protocol for a client with database. It is a part of the Java Edition platform and is property of Oracle Corporation. It is based on relational database rules and provides functions and methods to query and update the data in the database.

ODBC stands for Open Database Connectivity and is another API for querying the database, but is an open source standard application. By using ODBC, you can access different databases like Access DB, Excel, DB2, Dbase, and Text. Other than the ODBC software, a Microsoft ODBC connector is needed for each database to connect and access the data using the ODBC software.

PCo is the freely distributable component with SAP MII. It is a .Net based application that can integrate with shopfloor and SPC systems. PCo can also host custom designed web services. SAP MII has a default connector to connect with SAP PCo. SAP Plant connectivity is called SAP PCo.

Manufacturing data object (MDO) is available to define object models and data structures and to persist data.

Aspen InfoPlus.21 is a kind of process historian that's highly flexible and can be involved with single processes to enterprise wide global deployments across multiple locations. This flexibility ultimately reduces the consumption of tags that generally happens and thus provides a better management of the metadata involved.

The *Plant Information Catalog (PIC)* contains the hierarchy of tags and groups created from the working version after approval. The hierarchical structure is created in order to provide business context to the tags and their data by interfacing to the tag data servers in a generic way.

SAP HANA has a built-in database memory, whereby all the data is stored in the RAM. As data is always in-memory, the data processing is faster. This is the recommended best approach to process real-time analytics and applications. It uses row based and column based technologies. It can process massive real-time data in a short time.

Infrastructure Benefits

MII can be installed on top of SAP NetWeaver and it is easily deployable. The solutions developed on SAP MII are more flexible than other middleware tools. MII can be integrated with NWDI, CTS+, and SAP Solution Manager and can be easily tracked for all changes. As SAP MII deployment is not time-consuming due to its simplicity, very little downtime is required to deploy a SAP MII solution.

Intelligence Benefits

SAP MII can provide performance management on the shopfloors through dashboards, scorecards, and rich analytics. SAP MII is also a powerful reporting platform that can provide enterprise reporting, ad hoc query/reporting, and advanced analysis in enterprise data warehousing and BI. It can execute reports from executive to plant to line levels on the shopfloor. SPC/SQC (Six Sigma) analyses are also possible using SAP MII.

Innovation Benefits

SAP MII can provide compatibility with IIOT, including mobile and tablet devices such as iPhone, iPad, etc. These kinds of innovations make SAP MII solutions user friendly and efficient. SAP MII can integrate with Google Maps and can communicate via platforms like SMS and e-mail.

Flexibility Across Plant-Level Machineries

As SAP MII is equipped with Open, UDC, and PCo connectors, it provides more flexibility to connect to systems like SCADA, DCS, PLCs (IFIX), Wonderware systems, etc., as most of the shopfloor system use standard OPC connectors. SAP PCo, which is a freely distributable component of SAP MII, has a built-in OPC connector so that it can connect directly.

■ **Note** SAP Manufacturing Execution is called SAP ME. *SAP ME* is one of the MES products of SAP used for discrete manufacturing. This solution helps manufacturers manage manufacturing on the shopfloor in an automated and granular way at each operations level. It can also connect to the ERP as well as to the shopfloor using SAP MII. SAP ME uses the integration component called SAPMEINT to connect to other systems.

Easy to Use with Other SAP Manufacturing Products

As SAP ECC is an enterprise solution of SAP and similarly SAP OEE and SAP ME are developed and maintained by SAP as a MES solution, connecting SAP MII to these three is very efficient, easily configurable, and reliable from the connection and integration perspectives. Manufacturing products like SAP OEE and SAP ME are also developed on top of the SAP MII platform.

Integration Per Industry Standards

ISA-95 is the international standard for integrating enterprise and control systems. B2MML is the Business to Manufacturing Markup Language. It is actually used to implement the data models of the ISA-95 standards and is a superset of XML schemas written using the World Wide Web Consortium's XML Schema language (XSD). SAP MII can integrate with the ISA-95 standard following B2MML.

Statistical and Other Mathematical Analyses

SAP MII can do mathematical and customer-specific statistical calculations. Standard functions for max, mean, average, standard deviation, and so on, are available by default in the SAP MII package. SAP MII can provide SPC/SQC analytics through logic as well as visualization.

Predictive Analyses Capability

It is possible to develop solutions of SAP MII, which are capable of providing predictive alerting as to when a machine should stop working based on certain parameters. SAP MII can analyze and create a predictive alert from all the historic values to determine when the machine will have downtime.

Technical Advantages of SAP MII

Due to the flexibility across the shopfloor execution, ERP systems and other legacy systems, easy development methodology and standardized coding techniques in SAP MII, it becomes a robust manufacturing solution development platform. The following are the technical advantages that you can leverage from SAP MII.

Easy Coding Standard

Unlike other technologies, where most of the coding needs to be done manually by writing and remembering the functions and keywords to be used to write the code, SAP MII provides very easy and standard coding standards in the form of a drag-and-drop tool. It is an easy-to-use software application platform for manipulating, transforming, and distributing the plant and production information via XMLs. Using SAP MII, you can just drag and drop the required action block and you don't have to worry about remembering the coding functions, expressions, and operators as they are built into the action blocks by default. The only thing the developer needs to think about is the logic behind handling the business cases using the built-in features of SAP MII.

Flexibility with the XML Language

SAP MII lets the developers store and use XML (Extensible Markup Language) robustly and efficiently in a structured way. As MII is a web based application, XML is used to transport and provide the data across the Internet and applications. Developers can use

the XML data files to generate the dynamic content by applying different style sheets. XML provides easy parsing through data contents. In fact, it can represent any kind of data structure, including databases and other business information. XML is very easy to handle and transform as it is always a structured dataset. XSLT is one of the XML technologies that converts XML and is further compatible with SAP MII. Thus, using XML gives you flexibility in moving and translating data based on the customer's needs.

High-End Advanced Business Logic Services

SAP MII enables developers to encode the real-world business rules that can determine how data can be created, displayed, stored, manipulated, and changed as per the need of the business. In simple terms, SAP MII can handle any kind of customer-specific logic with its standard logic services. Business logic define the flow of logic from one business object to another and so on in the business landscape to interact with one another. The routes and methods by which the business object communicates should be defined in the Business Logic Services, commonly termed as BLS.

BLS basically defines the process or procedure by which data should be transformed or calculated, as well as the method by which it will be routed to other system. SAP MII provides many action blocks that can be used in the BLS to define the business process actions ranging from data input and output, web input and output, transformations, data calculations, e-mail communications, and process flow control.

Compliant with International Standards for Integration

The manufacturing industry follows certain standards for manufacturing. As per the current industrial automation, ISA-95 is one of the most acceptable standards used in manufacturing industries. ISA-95 generally follows the B2MML structure in order to interact with other systems. SAP MII can integrate with the ISA-95 standard and can handle B2MML restructuring with minimal (simple) coding and accept B2MML and generate B2MML as per ISA-95 standard.

UI5 Integrated SSCE

Self Service Composition Environment (SSCE) is extended to integrate UI elements and allow end users to create their own frontend views in the dashboard. The dashboard can be created by adding suitable UI controls from the selection panel, called UI elements. To integrate the UI elements with the backend data, query templates of the same MII instance can be selected from the MII content pane. Similarly, display templates can be selected and added by configuring visualization parameters. For UI controls, different events can be selected, including select, press, etc., just by the drop-down selection in the Properties tab. Suitable layouts can also be selected as per the dashboard design requirement.

SSCE creates the code in the backend, which can be seen and modified from the Source Code tab. Modification can be done in a specific area. The code that gets generated does not follow the MVC pattern but rather generates an HTML file at the backend. This is an additional functionality that can help to create a dashboard within minutes by just dragging and dropping with minimum effort.

An Easy-to-Configure and Flexible Solution

SAP MII comes with a very friendly frontend for developers. SAP MII is flexible enough to customize any of the customer-specific solution and can also be extended, if required. SAP MII has very strong illuminator services; i.e., it is possible to create a full plug-and-play kind of solution using it. SAP MII provides features like scheduler, connector, and message services to configure jobs as BLS or queries, and to connect and configure easily with other systems like SCADA, ERP, etc.

Flexibility to Communicate with Legacy Systems

SAP MII can easily connect via UDS or PCo connectors to legacy systems like SCADA/HMI, DCS, MES, plant historians, custom database, laboratory and maintenance systems, and SPC/SQC systems. It can fetch data accurately near-to real-time.

■ **Note**   Statistical Process Control is known as *SPC* and Statistical Quality Control is known as *SQC*. Both of these controls use statistical tools. While SQC is more focused on the analysis of the variations occurring in the processes involved in manufacturing industries, SPC focuses on minimizing waste during production by predicting the problems in production processes and controlling them. Thus, SPC is kind of a SQC where it checks the flaws leading to low-quality production, whereas SQC is completely dedicated to checking the quality of the product by checking each sample. The samples undergo inspection and acceptability testing to finally introduce the product into the market.

Flexibility to Communicate with Plant-Level Devices

Even if the legacy systems are not present in the plant landscape, if machines like PLCs are compatible with the UDC/PCo connector then via tag recognition, data can be fetched to the SAP MII platform.

Compatibility of Connection to Files in Shared Network

PCo can easily be configured to connect to any files linked with SharePoint, which is stored in the shared drive via the Microsoft OLEDB connector to get data in the SAP MII platform. Using the OLEDB connector, SAP MII can fetch the data from any of the file systems.

■ **Note**   *OLE DB* (Object Linking and Embedding, Database, sometimes written as OLEDB or OLE-DB), an API designed by Microsoft, allows you to access data from a variety of sources in a uniform manner.

Service Exposure to NetWeaver Stack

MII services are by default exposed to all elements of the enterprise as services via NetWeaver. All these services can be utilized by other NetWeaver components like PI, Portal, etc., for data exchange, advance reporting, and visualization.

High-End Visualization Capability

SAP MII supports integration with crystal reports so that these reports can be accessed by multiple reporting tools. MII can integrate with an enterprise portal for better visualization and integrate with the ERP users directly to access those reports. SAP MII has a lightweight portal to host the specialized visualization service developed by SAP MI. SAP recently introduced SSCE to create and host special visualization using SAP UI5.

Capability to Support Web Service

Web services can connect businesses to one another by using XML, SOAP, WSDL, and UDDI. Web services allow applications to communicate with one another without worrying about hardware, OSs, and programming languages. Web services can also be customized to meet user requirements. SAP MII can connect to other web services directly to access the data from other systems in a very secure way, because MII supports multiple encryption methodologies. Similarly, if any third-party systems do not have standard web services to invoke their data, MII can expose its BLS transactions as web services so that the third-party systems can use that to pass the data to MII in a more secure manner. MII also supports most of the REST and SOAP services to receive and pass data.

■ **Note**   *Simple Object Access Protocol (SOAP)* is a universal messaging protocol that's operating system independent. It can run in all OSs, such as Windows, Linux, etc. SOAP communicates through HTTP and its base language is XML.

Web Services Description Language's (WSDL) interface is based on an XML defined language. The XML is used to define the methods with various functionalities that the web service is supposed to provide. Business users can easily call these services.

Universal Description, Discovery, and Integration (UDDI) is a registry based on XML. It helps developers publish the business services on the Internet. WSDL is the language behind this.

Provision of Flexibility for Language Support

SAP MII removes the language barrier for an application to be used by end users with simple configuration and minimal coding. It provides language support flexibility through web page localization and project localization features. For any business requirement that demands various cross-locational designs with different respective languages, it is possible to maintain the web page frontend application with the user's defined language through HTML or SAP UI5. This provides an end application that's globally standardized but is specific to local regions while adapting their regional language.

Support for Analytics with Graphical Representation

SAP MII features the graphics generation using iSPCC chart applets that can be used to create static image references. SAP MII is the only available middleware that can support SPC/SQC charts. SPC charts can enable label alarming points and custom levels and comments for different alarms. MII can show animated objects or vector images for the reporting designed in MII.

Easy Debugging Techniques

In terms of debugging, SAP MII provides breakpoints, watchpoints, color-coding of action success/failure/not executed items, ability to modify values at breakpoint, and the flexibility to copy and paste to analyze the output from various actions in another editor.

■ **Note**   A *breakpoint* is forcefully putting a stop or pause in the program during code debugging. It helps the developers check if the coding is done correctly while inspecting each step of the code used in the program.

A *watchpoint* is a kind of breakpoint that can be placed on a particular expression to be debugged. Whenever the value of a variable in that expression changes, it stops the execution flow of the program at the applied watchpoint. Moreover, the value change can be more than one variable. It can use operators such as $a * b$ where a and b are variables with certain values and $*$ is the operator between the two variables. This is sometimes also referred as a *data breakpoint*.

Alert and KPI Framework

SAP MII comes with standard alert and KPI mechanisms. This feature helps developers as well as customers in many ways. It reduces the effort needed to create an alert mechanism for every solution hosted on SAP MII server and is easily configurable. It is now possible to create the alert threshold and handle certain alerts. Apart from that, it is also possible to set acknowledgements for any alert recognized. It is possible to query

these alerts too. In the latest version, it is possible to expose the KPI and Alert queries in HANA using OData services. It can also use the analytics engine of HANA to provide rich analytics and predictive analytics.

Internal Data Storage Capability

SAP MII has NetWeaver stack DB available by default, which is called MDO (Manufacturing Data Object). MDO is an internal data storage of SAP MII where customers can store the data for small volume purposes. As SAP is now integrating HANA with MII, in the future it may be possible to store large volumes of data in MDOs.

■ **Note** *SAP NetWeaver* is a technology platform from SAP that can host most of the SAP business suite products. It's possible to run these products in its web application server called NetWeaver WEBAS (Web Application server).

SAP MII from the Business Perspective

Its scalability, flexibility, low maintenance cost, and multilayered security make SAP MII the most preferred and suitable platform for automation in manufacturing. The following sections explain why SAP MII is best for such business requirements.

Lower Cost for Server Setup and Installation

SAP MII needs to be hosted on NetWeaver and the latest version can be hosted on SAP HANA. If your customer already has NetWeaver, only the SAP MII installation is required. SAP MII does not need to install databases separately for its own standard component because it uses the application database of NetWeaver or HANA. Patch upgrades are possible for free and it's easily installable and available for SAP MII. Overall installation, setup, and maintenance costs are lower than with any other middleware tool.

Low Risk to Business

As SAP MII is compatible and can easily integrate with other SAP ERP modules, standardization with SAP solutions has brought reliability and peace of mind to all the organizations involved in the integration process. The risks and cost of obsolete software and custom integration are no longer concerns to these organizations.

Provision of Vast Scalability Throughout Applications

SAP MII provides the flexibility to expand, integrate, combine, bundle, and layer different functionalities of many applications, as required. The visualization and the user interface development feature of SAP MII can provide a wide range of flexible scalable

interfaces to the end user. With the integration feature, SAP MII can connect to many kinds of shopfloor systems. SAP MII is flexible enough to be implemented on large-scale manufacturing systems, rapid manufacturing systems, and small-scale manufacturing systems.

Improved Efficiency

Regardless of the vendors of different systems or software available on the shopfloor layer and ERP layer, it can connect SAP MII to any of them. Thus, implementing it in any scenario makes the process very efficient and reliable. The vendors can leverage the bidirectional integration to all the shopfloor systems supported by SAP MII and can support homegrown solutions on the shopfloor.

Low Total Cost of Ownership

SAP MII can be globally, regionally, and locally implemented. Due to this flexibility in SAP MII, based on customer requirements and budgets, SAP MII can be implemented in the landscape and will still work in the same efficient way.

Customization

As SAP MII is a platform, it is possible to create customer-specific solutions and generate customer-specific reports and frontend applications as per customer requirements.

Smaller Project Teams

Due to its easy code standards, strong logical enhancement, and the flexibility and scalability of the SAP MII application, it can be handled with smaller development teams and project teams, as opposed to any other middleware or reporting tool.

Unified User Maintenance in NetWeaver

No separate user maintenance needed in SAP MII, as it is built on NetWeaver. A single user role can access the SAP MII development platform.

Multilayer Security as Per Customer Requirement

SAP MII can provide multilayer security to any solution. The first layer of security is through project-specific roles, which can be controlled from the NetWeaver User Admin. Apart from that, it is also possible to set strong encryption logic to keep the entire configuration and the data encrypted. SAP MII has custom attributes that can restrict the user interface to a certain user or group. For ECC integration, it is possible to set customer specific encryption to the Java Resource Connector. Another way of securing the solution in SAP MII is to use encoding and decoding while sending the information from MII.

Better Utilization of Human Resources

As SAP MII provides stepwise processing and control at any step or process making direct connection to ERP or shopfloor systems, need for human resources is reduced and the same person can be utilized in more processes. Effort can be channeled to provide greater utilization of manpower.

Guaranteed Message Delivery

One of the more critical risks of the manufacturing industry is production data loss. To prevent this, manufacturing industries are always looking for solutions that can provide guaranteed delivery of data even if the connection is down/interrupted. It is possible to develop a high-scalable solution with SAP MII, which can provide guaranteed delivery.

Provision of Local Survivability

In real manufacturing industries, there may be incidents when the shopfloor is running fine but connectivity is lost with ERP. In such a case, the shopfloor needs to be shut down, which will cause a financial loss to the company. In this case, if SAP MII is working as middleware, SAP MII can buffer the data either in an internal queue or an internal database and keep the shopfloor automation up and running even though the ERP connectivity is down. When the connectivity is re-established, MII can push the data to ERP following the FIFO method.

■ **Note** *FIFO* stands for first in first out, which means products that come in first go out first.

Single User Interface for Manufacturing Employees

SAP MII promotes a single user login facility. When users log on to the SAP MII system, they don't need to separately log on to ECC or the shopfloor. SAP MII maintains a generic user in the backend so that SAP MII can connect to SAP ECC to schedule or confirm orders in ECC.

BI/BW versus MII versus PI

As mentioned, the major requirement of manufacturing is to have a good middleware product that can integrate with any system varying from the shopfloor to ERP. Another requirement is to have a very good reporting solution where the vast reporting needs of the manufacturing system are fulfilled easily.

SAP has a middleware product called SAP PI that integrates ERP with the shopfloor and a reporting product called SAP BI to provide configurable vast reporting. SAP MII can handle both requirements. Sometimes it is not clear which product is best to use. The following section explains when and why to use each particular product.

What Is SAP BI/BW?

BI (Business Intelligence) is an application that provides intelligence based on the series of raw data. BI can provide flexible configurable reporting to the business user and helps you make better business decisions. BI can handle huge volumes of historical data and provide analytics with its high-capacity data processing engine. BI has another component called *Business Warehouse* (BW), which persists all the historical data and helps BI do the analytics based on that**.**

When Should You Use BI/BW?

- BI is used for cross-functional reporting whereas MII is related to manufacturing domains.

- SAP BI has native connectors to SAP systems, but when it comes to the shopfloor layer, it struggles to extract data due to the special data models. SAP MII overcomes all these problems through its extraction technology specifically designed for the major shopfloor systems, historians, and it follows ISA 95.

- Unlike SAP MII, SAP BI/BW is not capable of easily replicating the SPC/SQC charts, which makes it unsuitable in a manufacturing-specific capability.

- SAP BI/BW cannot provide plant-level value-added metric data at runtime like machine availability, downtime, yields, cycle times, and energy analyses. It cannot integrate directly with production processes like production posting, and goods movement from the shopfloor, which SAP MII can easily provide. Thus, SAP MII also reduces the redundancy in human effort that may happen while entering values in SAP.

- BI is modeled and framed for huge volumes of data whereas MII cannot handle huge volumes of data in a single shot. For MII to handle huge volumes of data, it needs to be scheduled in batches.

- BI can handle Excel files (.xls,.xlsx, and .xlsm) to extract data, whereas MII can't. MII needs custom Java code to extract data from Excel files. If the filename is constant, SAP MII can handle Excel files via the PCo connector.

- BI can generate reports with huge volumes of data very quickly compared to the time SAP MII needs to generate reports with same volume of data. In the future, if HANA integration matures with SAP MII, this execution time constraint will become moot.

- SAP BI is standard reporting tool, so reports and templates are easily customized per customer standards, with no additional coding needed. As SAP MII is a platform, this kind of customizable template needs to be developed from scratch to provide similar functionality to the customer.

What Is SAP PI?

SAP PI enables you to integrate backend systems and applications via the A2A and B2B connector framework. It supports stateful and long-running business logic with a business process engine.

It can only provide integration with ERP to any other multiple legacy system. It follows point-to-point or point-to-many integration. It has no flexibility to integrate with user interfaces.

When Do You Use SAP PI?

- When an enterprise follows a service-oriented architecture and the integration of processes is found to be necessary.

- When a repository is required to store the services, datatypes, or the metadata involved for enterprise services and business processes in the customer landscape.

- When you need to support additional web service standards through UDDI, web service interoperability profiles, addressing, security, reliable messaging, and coordination.

- Whenever there is possibility to have high data volume and critical scenarios of integration to be established between business applications.

What Is SAP MII?

As explained in Chapter 1, SAP MII is a flexible, robust manufacturing platform for developing integration solutions from Level 4 (ERP) to Level 0 (Shopfloor machines). It includes high-end visualization and a browser-independent user interface.

When Do You Use MII?

- You need to analyze and organize datasets from different sources of data.

- You need global operational access across the manufacturing sites.

- You need intelligent applications with drill-down options to view very minute levels of analysis of the datasets across different data points.

- You need to connect the shopfloor or plant machineries to ERP to have real-time data availability using standard SAP connectors.

- Plant personnel need to be able to perform reporting duties (standard, mobile, and ad hoc) along with basic execution duties.

- Plant operations, production, and management users need reports that can be standardized, customized, or mobile-compatible for analyses and monitoring of the different KPIs involved in the manufacturing industry.

BI or PI or MII: Which One to Use

When a customer has the option to use BI, PI, or MII, it can be a difficult decision. This section provides some perspective on which one is better in the manufacturing sector. This section compares BI, PI, and SAP MII.

- To transfer messages and information from the shopfloor to ERP, SAP PI needs to be placed in the local plant. But SAP MII can be placed in the local, regional, or even in global headquarters. SAP MII is more flexible than SAP PI.

- SAP PI is famous for its data routing design and for its guaranteed delivery. You can also develop a similar kind of design in SAP MII easily.

- As SAP PI has a limitation on the shopfloor connectors, there can be inconsistency in message processing. SAP MII has a standard OPC compliance shopfloor connector and SAP PCo for plant connectivity, which means message processing in SAP MII is faster and more consistent.

- Manufacturing shopfloors can vary from site to site and variation is also possible based on the line used at each plant. To process similar data with PI, customization is required on the shopfloor to make the data as per the PI structure. In SAP MII, XML is the backbone of the solution, which means variation in data structure doesn't impact SAP MII very much.

- SAP MII can easily handle all the functionality SAP PI has. SAP MII has a few more features of visualization and data handling over SAP PI. It's best to use BI if the customer data volume is very high and the customer needs a solution where a huge volume of data needs to be transferred from one system to another system. If the customer requires integration and intelligence with a normal volume of data, SAP MII is recommended, as it can provide integration and intelligence with high-end visualization and many other manufacturing benefits.

Summary

This chapter discussed the key challenges in the manufacturing industry and why you should use SAP MII from functional, technical, and business perspectives. You learned when MII is preferred over SAP BI/BW and vice versa. The chapter also explained what PI is, including its advantages and disadvantages and discussed when to choose MII over PI.

In the next chapter, you will learn about some basic building features of SAP MII, including BLS, query templates, visualization, and commonly used action blocks.