The Ultimate Automation Machine

In an effort to improve productivity and efficiency at their production facility in Greer, SC, BMW enlisted the services of RSSql transaction manager software and RSView32 HMI software.

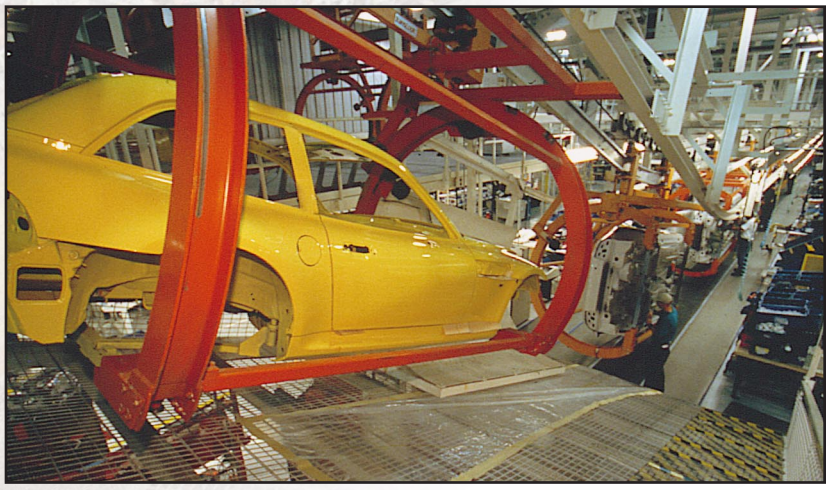
The automobile manufacturing process requires following a precise assembly schedule and tracking the production of the car from beginning to end. By installing a new control system and connecting it to a plant-level database, BMW Manufacturing Corporation achieved these goals while improving productivity and efficiency at their roadster assembly facility in Greer, South Carolina. BMW's experience demonstrates how a new class of database tools, called transaction managers, can help companies more easily integrate their control systems with the rest of the enterprise.

BMW Manufacturing, a subsidiary of BMW, the internationally known automobile and motorcycle producer, is BMW's only U.S.-based manufacturing facility. The upstate South Carolina plant produces the Z3 Roadster, the M-roadster, the Z3 coupe and the M coupe, and will begin production of the BMW SAV (Sports Activity Vehicle) in 1999. In operation for just over four years, the Greer facility has 2,100 employees and produces more than 50,000 cars annually.

The Birth of a Bimmer

BMW has an automated manufacturing process based on just-in-time manufacturing. It is a full manufacturing facility – receiving the necessary components (engines, tires, body components, etc.) from various suppliers on an as-needed basis.

The manufacturing process begins at BMW headquarters in Germany, where a corporate ERP system downloads instructions on the number and type of cars needed to the plant-level database in Greer. The order information is stored in the BMW Production Control System (PCS) database, and



order reports are generated to receive parts from various suppliers. The building of each car begins in the body shop. From here, cars move through the paint shop and continue through the final assembly process.

Between the paint and assembly process, BMW stores in-process bodies in an Automatic Storage and Retrieval System (ASRS) or "stacker." In the Paint Shop, vehicles are batched by color and put

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in a manufacturing sequence before reaching assembly. The ASRS prevents cars from going into assembly if they cannot be built right away, and moves cars that are ready to be built to the head of the line. Additionally, the ASRS can "model-mix" the cars into the assembly process. Model mixing allows certain cars, which are hard to build, to be selected and plugged into the sequence between easier-to-build cars. Model mixing prevents the ASRS from pulling purely by sequence, so sequencing the stacker must take into account model mixing as well. After the final assembly process, the cars are ready to be sent to the dealership, or direct to the customer.

Stacking the Deck

Adding production lines to manufacture the new SAV required BMW to double production capacity and add a second stacker system. With two stackers, BMW determined that the company would need one master ASRS controller which could communicate with both the stacker systems and the central plant database. This would allow BMW to communicate with all systems from one central location, as well as communicate to controllers on the conveyor systems. However, having one master controller would require changing the current software control interface to work with the existing systems. To do this, the company could either re-program the existing interface software or purchase new software and start from the ground up.

BMW evaluated both its existing software operating system as well as requirements for the new system before making a decision on how to proceed. The interface that BMW was currently using ran on a computer running the OS/2 operating system, a system no longer supported by the company IT group. As a result, BMW decided to purchase a new software program that would run on the Windows NT® operating system – BMW's corporate standard. "The OS/2 system was put in place when the facility opened," said Ken Blackman, Equipment/Project Planner for BMW. "While OS/2 worked with the old system, BMW has since decided to standardize on the Microsoft Windows platform for all future developments," he added.

For the new software system, BMW needed to be able to control the programming of the software. The company was interested in transaction manager software – a new class of database tools that link multiple data sources together so they act as one. Many industrial transaction managers are bi-directional, meaning they can send data both up to a database and down to the plant floor. Finally, BMW wanted to work with a local, reliable support staff, in case there were complications with installation.

BMW evaluated a number of software products that would allow an interface to both stacker systems, but determined that many did not offer complete programming control. BMW was using an Allen-Bradley PLC-5® controller, SLC 500™ controllers and several Allen-Bradley PanelView™ operator interface terminals. Because of these systems already in place, BMW evaluated the transaction manager software from Rockwell Software. The company found that Rockwell Software products ran on the Microsoft® Windows NT operating system, and according to Blackman, the company was familiar with Rockwell Automation and felt confident that Rockwell Software products would work well with the current operating system and the controllers already in place.

"The main reason we chose to go with Rockwell Software was the full-control aspect," said Blackman. "We wanted software that we could truly develop in-house, but having the support of our local Allen-Bradley representative also was very important."

Car 54 – Where Are You?

All communications between the PCS and the controllers takes place over the plant Ethernet® network. Because the HP-9000 UNIX® server where the PCS sits cannot talk directly to the controller, BMW developed an interface between the two systems. A Pentium® computer running the Windows NT 4.0 operating system acts as the interface, running the Rockwell Software RSSql™ transaction

manager software, SQL*NET and the RSView32™ human-machine interface software program.

The Rockwell Software RSSql transaction server provides a direct connection between the PCS database and the controller. By configuring RSSql to do certain database actions when a value in a memory location changes on the controller, it is possible to communicate bi-directionally between the database and the controller. SQL*NET provides the interface between RSSql and the PCS Oracle Developer/2000 database. Under this method, the database effectively becomes a communication area where messages between PCS and the controller can be read and written.

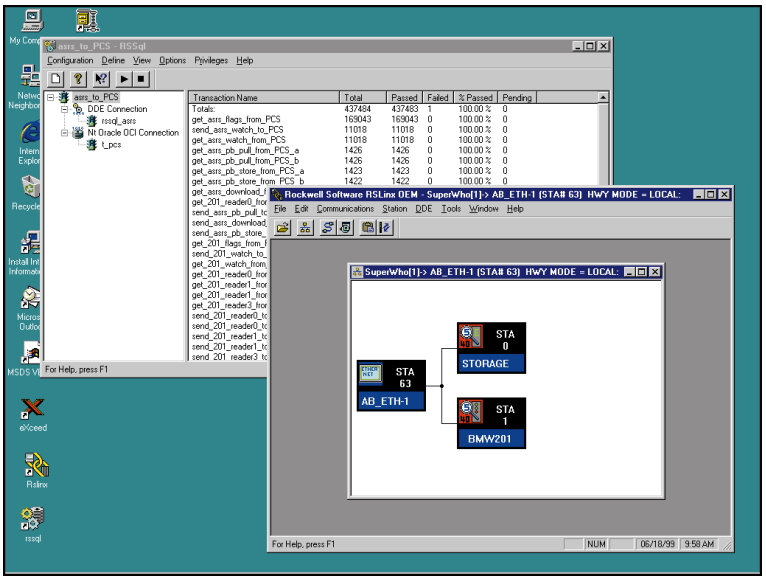
When a car exits the Paint process it travels down a conveyor. As the car reaches the first sensor on the conveyor, a SmartEye Reader checks the girder number (a number between 1 and 9999 located on a barcode) and sends the number, via the transaction manager to the PCS database. When the PCS receives an event, the system makes a decision on what to do with the car. Four options are available: hold, store, bypass and error.

The PCS holds the car if there is no space to do a store or a bypass. As soon as space is available, the hold will be released and the car will be allowed to be stored or bypassed.

If PCS decides to store the car at reader 0, it sends a message to the ASRS controller to tell it to pick up the car and move it to storage. The girder number of the car also is sent since the crane that moves the car has no other way of knowing which car it is to pick up. The controller moves the car along the conveyor to the pick up point. The crane then picks the car up and moves it to the storage bay. Communication occurs between the conveyor and controller to determine when it is safe to move the car and when the car can be picked up.

A car will be bypassed if it is next in line for assembly. Rather than putting the car in storage and then picking it up, it is quicker to send the car along the conveyor, bypassing the ASRS.

When space is available in Assembly, a car can be pulled. The pull decision is made by the PCS and is based on sequence number and model mixing. When it is determined that there is space to pull a car, the car with the lowest sequence number is looked at first, a message is sent to the ASRS controller to pull a girder number, and the crane is sent to the storage bay to pull the car.



All Systems Go

BMW was able to develop the entire ASRS software system without any training, which allowed the company to develop a system based on their own needs, and gives operators complete control of the system. BMW tested RSSql with each part of the new production line system and were able to install all of the software during the development of the SAV production line. Even using multiple software programs and the Oracle Development 2000 database, BMW was able to install the entire system in approximately four hours due to the inherent interoperability within the Rockwell Software programs, Oracle Developer/2000 database and Windows® platform.

"The ease-of-use and ability to link together multiple software products makes Rockwell Software one of the best, in my mind," said Blackman. "We were able to save time on installation by using products that work together, and develop a system that does exactly what we need it to."

With the resulting installation, BMW can track the location and status of cars, and move each one individually according to a manufacturing schedule. This system saves time and resources by automatically scheduling and moving cars to the right location at the right time, and allows BMW to model mix hard-to-assemble cars in between ones that are easier to assemble.

Configuring RSSql

There are two basic steps for configuring RSSql. In Step 1, the controller memory locations and stored database procedures are defined in RSSql. Each memory location and procedure are given names. The name given to a memory location is referred to as a tag, and the name given to a stored procedure is a data view. The memory locations can be defined as solicited or unsolicited. A solicited memory location is one that is read by RSSql when needed. An unsolicited memory location is read by RSSql when an event happens, for example the value in the location changes. Typically, a combination of solicited and unsolicited are used.

Step 2 shows the memory location and stored procedure tied together using a transaction. The transaction is triggered by a specified event – for example, the change of a value in a memory location. When this value changes, the transaction will run, and call the specified stored procedure. Memory addresses can be used as inputs or outputs to the stored procedure, which allows values to be read or written from the controller to the database.

It's easy to configure RSSql to take data from the controller and write it to the database. Going the other way, from the database to the controller, is more complicated because RSSql does not monitor the database for changes. Instead, in the BMW application, RSSql has been configured to poll the PCS database. Rather than reading in the whole message every time, a binary word containing flags is used. Each flag represents a particular event, when the flag goes to 1, a message is waiting. This flagging process greatly reduces the amount of programming on the controller. The user simply creates rungs on the controller which act as the "blinker" function, turning a high and low at a predetermined rate, and reserves a binary word for the flags that RSSql uses.

For additional information about Rockwell Software products and services, point your Web browser to http://www.software.rockwell.com

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