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Successfully Implementing Automated Work-in-Process Tracking and Materials Traceability Systems

Introduction

In this paper we are primarily concerned with tracking the flow of materials through organizations that transform materials from one form to another. These include manufacturing plants, food and pharmaceutical processors, biotechnology laboratories, engineering organization, and distributors that repack, kit or re-label products.

Many of these organizations still perform their work-in-process (WIP) tracking using paper forms with subsequent manual data entry into Excel spreadsheets or other computer programs, such as ERP systems. The reason that this data collection takes place is:

1. To know where customer orders are in the complex flow from raw material received from suppliers to finished goods shipped to customers. This is to ensure that customer orders are shipped on time.

2. To understand how much inventory is available for making products and how intermediate and finished product is available. Also to understand how much scrap and rework is taking place.

3. To ensure compliance with regulatory, standards and customer requirements to maintain records that enable tracing back from finished products to the materials that went into them so that the source of defects can be quickly determined and that all defective products that result from a defect can quickly be recalled.

4. To get accurate detailed job costing so that the actual versus estimated material, labor and machine costs can be compared and the source of problems quickly identified. This is essential for quick-turn, short-run manufacturers to be able to accurately predict the cost of new jobs they are quoting, based on the actual cost of prior jobs.

5. To capture process parameters, yields, test results and similar data at each step along the way so that it can be subsequently analyzed to determine the source of defects and to improve the efficiency of the process. This includes who worked on each job step and what equipment and materials were used.

Today, many of these organizations are facing pressures to transition from manual to automated collection of this information.

These pressures include:

1. The need for quick turnaround of customer orders in order to be competitive. In today's manufacturing environment, it is no longer satisfactory to know where customer orders were, or how much inventory you had in stock, yesterday.

2. To be able to rapidly determine the source and cause of defects and to be able to implement a rapid recall of affected materials in less than 4 hours and, in an increasing number of cases, less than one hour. Here we are seeing rapidly increasing pressures related to improving health and human safety.

3. To be able to quickly detect mistakes and defects and to rapidly take corrective action. Here the transition is from managers learning what went wrong yesterday by reading reports, to the managers and their people getting real-time alerts on mobile devices when they are about to make mistakes or things are starting to go wrong.

4. To minimize the number of people required in the manufacturing process. Automating the data collection process has been shown to eliminate the equivalent of one to three people involved in manual data collection and process expediting.

While implementing automated work-in-process tracking and materials traceability systems has many advantages for manufacturing organizations, these systems are difficult to implement because of the underlying complexity of the manufacturing processes. They are often an order of magnitude more complex than implementing a warehouse management system and more complex than implementing many ERP systems.

As a result, many attempts at implementing these systems have failed outright, have failed to live up to their expectations, or have suffered from major cost over-runs and delays in implementation.

The author and his team have implemented close to one hundred of these systems, most successful, but some not. This paper is an attempt to distill some of the lessons learned into a form that may be useful to other implementation teams.

Lessons Learned

In the following, we use the term WIP tracking to refer to work-in-process tracking and materials traceability systems.

1. There is no one-size fits all. These systems almost always need to be customized for the specific manufacturing processes involved. These customizations typically include:

    a. Custom data that needs to be collected manually or automatically from process control and test equipment.

    b. Custom reports, graphs, dashboards, shop floor digital displays and web-portals for viewing information.

    c. Custom warnings and alerts that need to be given to prevent mistakes or head off other problems

d. Integration with other systems to eliminate duplicate data entry.

2. Developing a custom solution "from-scratch" is something that most manufacturing plants cannot afford to do. We have invested over $2 Million and a decade of practical deployment experience into the BellHawk software platform that we and our partners use to implement these solutions. This provides over 90% of the needed software code needed for any WIP tracking implementation. It enables us to deliver solutions at a price point where the ROI from labor savings by automating the data collection process is less than a year.

3. Implementation is a process not an event. The most successful implementations are always incremental. They start by solving one problem in one area and then evolve over time to solve a whole range of problems. Attempting to solve all the data collection automation problems within a manufacturing plant at the same time is a recipe for disaster.

4. The needs of accounting and production are often at odds. This is why it is a good idea to keep your WIP tracking system separated from your accounting/ERP system. In a WIP tracking system it is critical to instantly record changes in inventory, so this data is immediately available to all production personnel. But, from an accounting viewpoint, it is important to delay recording these changes until the true cost can be determined, which is typically when a job is closed or when an invoice is received from a supplier.

5. Different members of the senior management team within a manufacturing plant have different goals for a WIP tracking system, depending on their respective management "silos". It is important to initially pick the most important problem to solve, so the organization can learn and gain confidence from implementing and deploying a WIP tracking system in one area, before deploying it incrementally to other areas. In the long-run a WIP tracking system serves to break down management silos by enabling automated sharing of data. But scope-creep in the initial deployment phases, to incorporate everyone's needs, can prove deadly by driving the cost to budget-busting proportions and making the initial deployment process very difficult.

6. It is important for the organization to appoint a project manager, who will be the internal point-of-contact and champion for the implementation, and who is given the responsibility and the authority to carry out the system's implementation. This project manager may be supported by other members of the implementation team but putting a committee in charge, with no clear leadership is a recipe for disaster.

7. All members of the senior management team in a manufacturing plant are already very busy. While implementing a WIP tracking system will ultimately make their jobs quicker and easier by giving them the real-time information they need, when they need it, implementing these systems takes a lot of time and energy from the senior management teams. It is important to allow plenty of time for the initial pre-deployment setup and testing phase so that managers still have time to live a normal life with their families.

8. Operators and materials handlers will push back against the implementation of the new system. This is the FUD (fear uncertainty and doubt) factor. Employees will get very nervous because they believe that this system will give management the tools to more closely monitor what they do. They are correct, it will. But managers and supervisors will need to overcome this by explaining that automated data capture is part of each employee's job. Please do not

tell your operators or material handlers that automating data capture will make their jobs easier because it won't. It will make the managers' jobs easier and the company more profitable but it won't make the production employees' jobs any easier.

9. There is no "silver-bullet" best technology to use for capturing data. In some cases a low-cost barcode scanner attached to a PC will work great. In other situations, you may need an explosion, dust and moisture proof wireless mobile data collection device. In yet other situations RFID or video data capture will work best. Also data capture technology is evolving rapidly. As such, it is important to use a data capture software platform that can integrate with a wide range of devices and is adaptable to integrate new technologies as they come along.

10. Wherever possible, start out by using preprinted tracking barcodes for tracking containers of material and individually barcoded items. This will save the cost, complexity, and operator training needed to deploy barcode printers in the production area. The only reason to print tracking labels as part of the materials receiving and production process is to have human readable information on the tracking labels. As this information is often already on other labels on the containers of material, printing this information on the tracking barcode labels only adds complexity and cost.

11. Wherever possible start out by running your WIP tracking system stand-alone and exchange data with other systems using Excel spreadsheets. This will enable you to make sure that the data being exchanged is correct. Then, when the needed data exchange is well understood, an automated data exchange interface can be implemented.

12. Implementing reliable automated data exchange interfaces between systems can be a very time consuming, complex and expensive process. It is important to use a software framework/toolset that will provide most of the needed code pre-coded or automatically generated to minimize the time and cost needed to implement the interface.

13. There is no such thing as a "standard" interface between a WIP tracking system and an ERP or accounting system. At the lowest technology levels there are standards that ensure that different systems can "talk" to each other in a uniform manner but the information that needs to be exchanged is typically very idiosyncratic to the manufacturing process and how the organization chooses to do its accounting.

14. It is critical to make the user interface very simple for operators and material handlers to use. The system should limit the data they can enter, at any one time, to the data that is needed at that instant in time. Then that data should be immediately checked and real-time point-of-action warnings delivered to the user. This is essential to prevent data collection and operational mistakes. This is the opposite to what happens with most accounting and ERP systems where office users are presented with many data entry boxes on a screen that they can fill-in to record the data that the users determines is necessary.

15. To make the user interface simple and easy to use for machine operators and material handlers, it is essential that the WIP Tracking system have a large and extensive knowledge-base that is setup by knowledgeable operations managers and manufacturing engineers. This

takes a lot of time and thinking through of operational needs by the project implementation team and should not be rushed.

16. Despite all the best efforts of the data collection system, operators and material handlers will make mistakes. It is essential that the data collection system support mechanisms to enable supervisors to correct labor hours and machine time recorded and quantities of material consumed and produced before "signing off" that a job is complete. This is especially essential when this data is being used for job costing and being fed to an accounting or ERP system.

17. In many instances, it is critical that the system log all data entry made by employees, and corrections made by supervisors, so that this data can be available for audit purposes, as required by certain standards and Government regulations. It is also critical that it is not possible for any data in the database be able to be made without the change, and the person making the change, being logged.

18. These systems implementations are most successful where the organization providing the equipment and performing all the systems integration and implementation for the manufacturing plant have people located within a 2 hour drive. While much of the software support services can be provided remotely, significant on-site presence is typically required for successful systems implementation. If this on-site work has to be done on a fly-in, fly-out basis then this gets very expensive.

Recommended Implementation Process

1. Choose an area to start in. This typically is one of the following:
    a. Receiving and put-away of raw materials
    b. Production area – tracking the transformation of materials
    c. Picking, packing and shipping finished goods.

    If there are multiple production areas, choose one to start with.

2. Choose the "low-hanging fruit". Select an initial deployment that has well defined goals and immediate benefits to the organization. Also avoid scope-creep. Ultimately this system will solve lots of problems but plan to do those in subsequent phases.

3. Start with a training room pilot project. This is used to:
    a. Train the project management team
    b. Setup the knowledge base for the initial systems roll-out
    c. Try out one of each data collection device to be used in the roll-out
    d. Try out the system using actual production data in a simulated environment
    e. Train all the material handlers and operators who will use the initial system
    f. Determine whether there are any changes needed to the system before deployment

4. Then, once everyone is happy with the training room pilot operation, deploy the system. Initially retain whatever manual data collection is in place in case you need to move back to the training room to make adjustments. Then, when the tracking system is working satisfactorily, stop doing manual data collection.

5. When implementing subsequent roll out phases, always start with the training room pilot and test out the system there before deployment. This is essential to finding and correcting problems before roll-out.

For initial deployment, a training room pilot phase will typically take about 3 months. In subsequent deployments of upgrades to the WIP tracking system, the training room pilot phase will typically last about a month.

The initial use of a training room pilot has great risk-mitigation benefits. During this phase, the organization will learn how to use the WIP tracking software and get to know the systems integrator assisting them with systems deployment. At the end of this phase, the organization will know whether the software and equipment and the solution integrator will work for them in the longer term.

As software can now be used on a subscription basis and much of the equipment is available on a demonstrator-loan basis, the initial training room pilot phase can be completed at a modest cost. In fact, the cost is often less than what it would have cost to send the project team to an off-site training course for a week, and the lessons learned are so much more powerful.

Deployment, with its need to purchase data collection equipment, possibly install industrial wireless networking, and subscribe to additional software licenses is more expensive. But, by this time, the organization's project team will have had the opportunity to thoroughly test out the system and ensure that it meets the organization's needs. And, if it does not, then the organization can simply "walk-away" with their senior management team having been provided with important "hands-on" learning as to what works and what does not.

Commentary

Manufacturing plants are not static entities. They continually change and evolve their manufacturing processes to meet the demand of new and existing customers. It is essential to choose a WIP tracking software platform that can be easily modified over time so that it mirrors the changing needs of the manufacturing plant.

Author

The author of this white paper is Dr. Peter Green who has been implementing industrial work-in-process and materials traceability solutions for over a decade. Dr. Green is a domain expert in industrial automated data collection. His team at BellHawk Systems has implemented nearly 100 systems for clients including manufacturers, food and pharmaceutical processors, biotech labs, and defense contractors, as well as systems for the US Navy and Air Force.

Today, Dr. Green spends most of his time coaching, training and assisting implementation teams to enable them to successfully deploy work-in-process tracking and materials traceability solutions.

