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MANUFACTURING CONTROL SYSTEMS: "WHAT IT IS AND WHAT IT CAN DO FOR YOU"

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INTRODUCTION

Imagine what a process and machine control system would look like today with no more than vacuum tubes and machine tool relays to get the work done. Fortunately, we do not have to imagine what it would be like trying to compete in today's world with outdated technology. Much has happened in these individual disciplines to advance the state-of-the-art.

The application of solid state technology, the transistor and integrated circuit have changed the looks of process and machine control systems. These advances have provided for the development of better, more effective and less expensive controls. Many industries, including the pharmaceutical industry, have employed these technological advances in their manufacturing operations to produce more cost effective and improved products.

Manufacturing Control

The challenge at hand today is to integrate your process and machine control systems into a Manufacturing Control System, with the capability to transmit, present and record information. Manufacturing control is a larger multi-dimensional concept than process or machine control. It goes beyond the

level of their functions to integrate their operations with assembly, manufacturing, material handling, quality control and packaging functions.

Total manufacturing control is the key to a successful automation program. Certainly pressure, temperature, product level and automatic sequence controls will remain the fundamental building blocks of the manufacturing control system, but the communication systems will become the mortar which binds them together into a system. This communication capability is the means by which you can meet the operating needs of your manufacturing system now and in the future. The days of clipboard inventories, push buttons, dials and meters have given way to the keyboard and the cathode ray tube (CRT).

ROLE OF THE MANUFACTURING CONTROL SYSTEM

Machinery Needs

For years, process and machine control systems have met the needs of production machinery. They provided the immediate control or direction required to operate the machinery on a continuous basis. With the advent of process computers and programmable controllers, you are now able to collect a variety of operational data from the various machines in your pharmaceutical manufacturing operation.

One of the most overlooked, burdensome, yet essential areas is the gathering of machinery performance data. Details like motor running time, frequency of failure, fault occurrences and out-of-limit process conditions can be recorded and quickly retrieved.

The keeping of maintenance log books, manually recording running time meters or the cigar box full of maintenance tickets is obsolete. The application of computers and PLC's

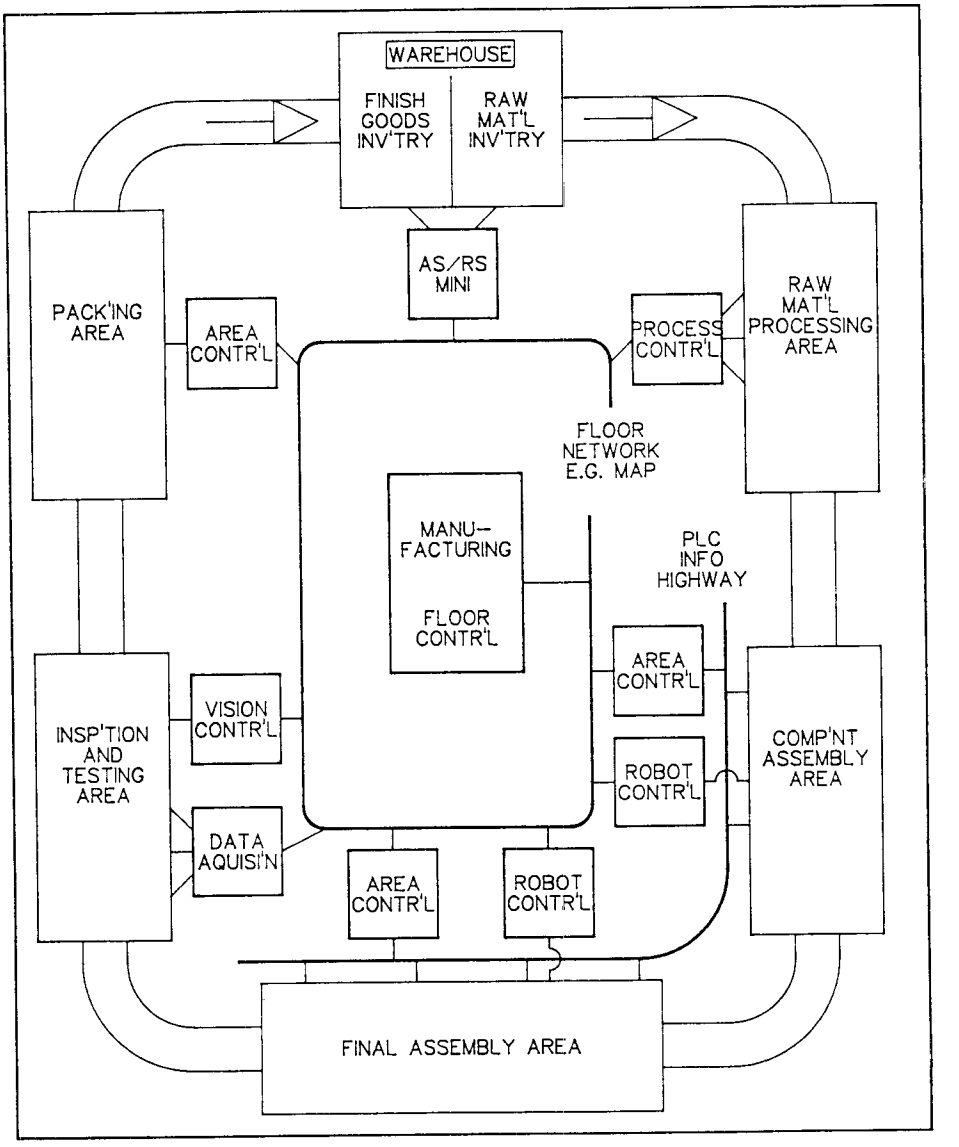

FIGURE 1. DIAGRAM OF A TOTAL MANUFACTURING CONTROL SYSTEM

make it easier and less expensive to obtain this information. You can use your control system to schedule routine maintenance operations, such as the lubrication of bearings, the replacement of belts or the cleaning of filters.

You also can use your system to keep maintenance records, record frequency of failures, overloads and out-of-limit conditions. Since the gathering of this information can be obtained with relatively low risk of interfering with production, this feature can be added anytime at a minimal cost. Recording this kind of machinery performance data can help justify machinery modifications or the purchase of new components and equipment.

The gathering of equipment performance data can be simplified by adding a communications network to your manufacturing control system. Some machine control systems do not have the intelligence to print or display reports. A communications network, linking the controllers, can be used to probe each controller for its information, then consolidate the data into a single report for viewing or printing.

Today's manufacturing control systems can do more than just report the needs of your machinery. Modern programmable controllers include a variety of intelligent input/output features, allowing for greater flexibility and expanding its data gathering and reporting capabilities. You can add more features to your manufacturing control system as your process data management needs increase.

Integrated Manufacturing

With stricter federal regulations and guidelines, and the need for greater product security and quality control measures, an integrated manufacturing control system can help meet the needs of your production operation. Your machine controls can monitor material flow, material input, product-in-process, and the completed product can be tracked.

Raw material levels are monitored and compared to production batch sizes, calling for material supplies only when needed. Material requirements for a product are provided based on the product selection. The control system can be programmed to identify what product is being run, and then provide the necessary specifications for that product. Product changeovers are monitored as they progress through the entire manufacturing system; and, if necessary mechanical adjustments can be made automatically.

Robots, vision systems or other quality assurance instruments can be integrated into the system so raw materials can be dimensionally gauged, inspected for flaws and selected parameters monitored. Unacceptable or foreign materials can be rejected or collected for analysis and return to suppliers.

Product-in-process can be checked for quality and quantity standards, and adjustments can be made automatically to insure an acceptable product.

The repetitive and tedious task of recording machine running time and comparing the number of good parts to bad parts previously required manpower and calculations to arrive at relevant data. Today, you can ask the control system to acquire this data and perform the tedious calculations to reduce the information to something meaningful.

Record keeping of process information and parameters like temperature, rates and concentrations are monitored as part of P.I.D. control or other automatic feedback systems. This data can be recorded and archived to comply with federal regulations.

Machinery statistics are calculated to arrive at meaningful quantities. Raw data, including counts, rates and time, are

used to calculate overall rates, the amount of time between failures and machine efficiency.

Machinery downtime is perhaps the most expensive item in production. A control system can be instrumental in minimizing downtime. It can monitor faults and annunciate their cause to the machine operator to expedite correction or repair. Fault monitoring takes the guesswork out of downtime, thus reducing the number and length of production delays. Specific problems can be identified and located to save time. The faults can be categorized, and the control system can tell the operator who to call for repair. This information can be recorded and counted for future analysis and long-range corrective action, planning and justification.

What this means to the pharmaceutical manufacturer is:

- Greater assurance of product quality and control.
- The ability to evaluate operator and machine efficiency.
- Increased productivity.
- Reduced manufacturing and labor costs.
- Reduced downtime and repair.

CONTROL SYSTEM REQUIREMENTS

With the development of any process or manufacturing operation, the control system must be included in the planning process from the beginning of the project. If your project is an improvement or replacement of an existing system, you must first define your present system.

The specifications of each production operation in your current system need to be defined, including:

- Infeed System
- Preceding Operations
- Outfeed System
- Material Handling System

Infeed System

Defining the specifications, dimensions and tolerances of all items being fed into your system is critical. Include this data on all raw materials, parts, labels and packaging materials entering your production system.

Preceding Operation

If the new process is an extension of your existing system, the nature of the material being supplied to the new process must be identified.

Is the material arriving in totes or trays, or by conveyor?

Is the material coming from an interruptible assembly, filling or capping process? Or, is it arriving from a continuous process like an oven or an extruder?

This information will tell you what the nature of your new system has to be in order to handle the material. Will you need to accumulate or recycle the material, if it is not interruptible? Will you need an inspection system for the infeed materials before introducing them to the new process? These are all questions that need to be answered.

Outfeed System

The next area of consideration is how the material will be exiting the system.

Will the material go to a warehouse, a distributor or to the store shelf?

Will the material be carried on pallets, trays, totes, in bulk or conveyed?

Will your new process supply a subsequent operation, and will that operation tolerate interruptions or infeed material flaws?

Material Handling

The final area to define, when planning your control system, is the kind of material handling system that will be needed. If it is a new process, take advantage of the flexibility a new system allows. You can define the parameters to make the system more efficient and effective. You can take advantage of the latest technology to improve your production and material handling system.

Define Goals

On the other hand, if you are developing a manufacturing system for a new product line, then your first phase would be to establish and define the goals of the new system. This can begin as simply as: To produce 10,000 liters of product per month. However, this fundamental objective must be expanded to include the following parameters:

- Production costs
- Equipment and production speeds
- Manpower requirements
- Technical support required
- Quality production standards

Identify Information Needs

You also must identify the kinds of process information to collect for data management purposes. Be discriminatory between essential information and what would be nice to know. If you can separate these categories, it will help justify the cost of the system.

Frequently in the pharmaceutical industry, the kind of process information needed is determined by the Quality Control Department or federal regulations.

In a pilot or research operation, considerable process and production data is required. However, in a strictly production

situation, the gathering of too much information can be burdensome, costly and even slow production.

Departments receiving data should identify how they plan to use the information. After you have identified the kinds of process data required, you need to determine how frequently the information will be needed. Frequency depends on the types of information required. Production and machinery speeds may be needed in real time (as it occurs). The amount of product produced or the number of rejects may be needed at the end of each production shift. Other information may not be needed until the end of the week or month.

Data Management

Once you have determined the types of information required, how much and how frequent it is needed, you then need to determine who will manage the information. Will there be a central data processing department or will the plant engineering and maintenance department handle the data?

Identifying and specifying these aspects of your manufacturing control system in conjunction with development of the production system will help assure a successful project.

SYSTEM HOUSES

Considerable planning and preparation is necessary to achieve the goals of a new manufacturing or production system. Since this type of project requires so much time and manpower, you may decide to use an outside control systems house to help design, develop and implement a total manufacturing control system.

If you are not currently working with a systems house, there are several items to consider to help choose the right

systems house. First, communication is essential. Take the time to get to know the personnel with whom you will be working. This can and should be done before you ever start a project. Two-way, open communications must occur before the systems house can understand your needs.

Next, involve the systems house from the beginning of the project. The requirements for designing a control system, previously outlined, must be provided to the systems house. They may be able to offer suggestions or alternatives on ways to accomplish your objectives.

Total involvement is another key ingredient to working with a systems house. Expect and demand complete involvement from them and expect to remain totally involved yourself.

Regular reviews of all system specifications should be conducted with all participants to keep the project on target. Problems that arise during the project can be dealt with expeditiously and effectively, if total communication and involvement is maintained.

Expect your control systems house to become your complete partner - knowledgeable of your industry, and sensitive to your way of doing things, your project objectives and your need for confidentiality.

Advantages

Working with a control systems house can offer several advantages to a pharmaceutical manufacturer in developing a manufacturing control system. They include in-depth expertise in state-of-the-art control system design, objectivity and a pool of people with whom to brainstorm a system configuration. A systems house also provides manpower resources to help meet short-term commitments and deadlines without adding overhead.

Disadvantages

On the downside, there will be a learning period for a systems house to learn your processes and operation. As previously stated, communication is essential, and, if not addressed up front, may be a problem later. Using a systems house also presents a new entity for project management. Finally, confidentiality could pose a problem, if you consider your product or process proprietary. Confidentiality agreements should be established from the beginning of a relationship with any systems house.

There are always advantages and disadvantages to any arrangement. The question to ask yourself is, "How can I best achieve the goals of this project?"

CONCLUSION

Technology has changed the way we define process or machine control. What we knew as process control, the capability to regulate pressure, temperature, product levels, color, etc. has been expanded to incorporate the assembly, manufacturing, quality control and packaging operations.

You can take advantage of this state-of-the-art technology and control capability. If you are planning to update your current system or develop a new production operation, be sure to include your control system planning as part of your manufacturing system development.

Identify each area of your process and production operation, as well as the kinds of process information you need. Establish your goals and objectives and work closely with your control system designers from the very beginning of the project.

A well designed manufacturing control system can result in greater productivity and efficiency, improved product quality and reduced manufacturing costs. A well designed control system can be the key to a successful manufacturing automation project.