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CURRENT STATE IN THE IMPLEMENTATION OF THE QUALITY SYSTEM IN BATCH AUTOMATION COMMANDS

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Abstract: *This paper sets forth the current state of the implementation of the quality system in Batch automation, particularly aiming the differences between the Centum Batch systems, PCS7 and the DeltaV ones, operation graphics and testing methodologies. The currently used systems were observed in order to set an analysis of the methodology together and perfect these systems in regard with the ISO 9001 quality standard. All the examples mentioned below can be implemented in various factories, as: antibiotic and medicine production, chemical production (using batch systems), as well as an oil and gas extraction platform or in the production of food and drinks (using continuous systems).*
Key words: *Batch, automation systems, graphics, testing, quality, production.*

1. INTRODUCTION

The main subject of this article is a part of the research paper called: “Contributions to the quality insurance of sequential Batch commands of automation production lines”.

The theme aims the improvement of projects from the industrial automation field of production. The emphasis will be set on individual contributions within the signalizing and interventions interfering in the command scheme of certain quality management elements:

1. verification of purchased material: quantity, quality, certification supplier;
2. traceability of each batch of products, enabling unique identification: man, machine, methods, materials, environmental conditions;
3. calibration and periodic checks of inspection and measuring equipment;
4. identifying the causes of non-compliant products, including those raised by customer service;
5. verification of a representative sample from each batch, according to statistical techniques.

More specifically, not just the following along, "from the sidelines", of the quality assurance, but aiming to integrate elements in the control scheme. The comparison between the different systems used in automation (eg. Emerson DeltaV, Siemens PCS7, Yokogawa Centum) will be made. For all these examples, the draft may be adjusted to various requirements, such as:

- In a factory producing antibiotics and other drugs (controlled sequential process - Batch);
- On an Oil and Gas platform (continuous process);
- In factories that produce food or beverages (continuous process);
- Factories producing chemicals (controlled sequential process - Batch); and others.

2. OVERVIEW OF PROCESS CONTROL SEQUENCIAL BATCH

Batch processing is executing a series of instructions in a program, from a computer, without manual intervention (non-interactive). Strictly speaking, it is a way of processing: the execution of a series of programs, each on a set or "lot" of inputs, rather than one entry (which should instead be a personalized instruction). However, this distinction has been largely lost and the series of steps in a batch process is often called a "task" or "batch task".

Batch processing has the following benefits [1]:

- It can change during processing tasks when computing resources are less busy;
- It avoids idling the computing resources, the intervention every minute and manual supervision;
- By maintaining an overall high usage rate, the computer is worthily used, especially a costly one;
- It allows the system to use different work priorities - interactive and non-interactive;
- Rather than running a program several times to process a transaction once, the program will run the batch process only once for multiple transactions, reducing system load.

2.1 Modern Batch systems [2]

Batch applications are still critical in most organizations, largely because many common business processes can be subjected to batch processing. While online systems can also operate when manual intervention is not desirable, they are not typically optimized to perform high-volume, repetitive tasks. Therefore, even new systems usually contain one or more Batch applications to update the information at the end of the day, report, document printing and other basic non-interactive tasks, which should complement reliably in some business terms.

Some applications are subject to processing flow, namely those that only require a single input data at once (not totals, for example) to start the next step for each entry because it complements the previous step. In this case, the processing flow decreases latency for individual entries, allowing them to be completed without waiting for the entire batch to finish. However, many applications require the data from all records, in particular, calculations such as totals. In this case, the entire batch must be completed before obtaining a usable result: partial results are not usable. [17]

Modern Batch applications make use of modern lot settings like Jem the Bee, Lot spring or implementations of JSR 352, written for Java and other frameworks, for other programming languages, to provide fault tolerance and scalability needed in high-volume processing. In order to ensure a high-speed processing, Batch applications are often integrated with grid computing solutions to divide a Batch task to a

Fig. 1. A mixed Batch platform that produces asphalt [3]

large number of processors, although there are significant challenges programming in this regard [16]. The large volumes of Batch processing tasks are particularly heavy in the system requirements and in architecture applications as well. Architectures showing strong performance input/ output and vertical scalability, including modern mainframe computers, tend to provide better performance than Batch alternatives.

Scripting languages have become popular because they have evolved with Batch processing. [1]

A batch window is "a period of less intensive online activity" if the computer system is able to run without Batch instructions - interference from on-line systems.

2.1 Batch Definitions

Procedural control model defines a hierarchy of necessary actions to complete the Batch process (sequentially).

It is part of the S88 standard. Its objectives are [2]:

- To provide a common and consistent model for the design and operation of batch manufacturing enterprises, and batch control systems;

- To improve control and efficiency in batch manufacturing processes.

Defined patterns belonging to the S88 standard (DeltaV) include [4]:

- The physical model: defines the hierarchy of the equipment used in the sequential batch;

- Procedural control model: it defines the control that sets the device to perform a process task;

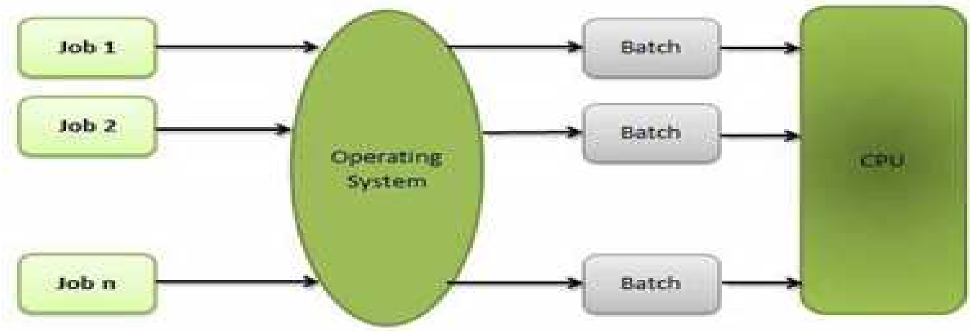

Fig. 2. Operating system with sequential order and requested executions [7]

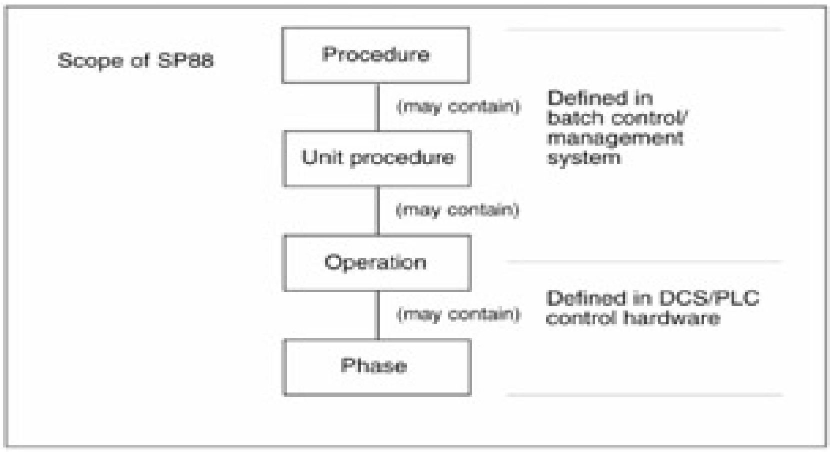

Fig. 3. Procedure control model [3]

- The control activity: it defines the relationship between various control activities that are required to perform batch processing;

- The process: it defines the performance results of procedural control over the process equipment.

<u>Class based objects</u>

DeltaV system allows creating a standard set of reusable logic that can be incorporated into recipes for multiple products.

If the production platform has multiple and similar units, configuration effort can be saved can save effort by implementing a class based design.

- A class is a template from which objects can be created;

- Objects created from classes becomes an instance of the class. Each instance of a class has the same structure and properties as all other instances of the same class.

Cells process chain equipment, units, phases, equipment modules, and control modules are defined in the DeltaV system and class levels as well as those based on instances (individual). The class level defines common properties that apply to all instances of those equipment entity.

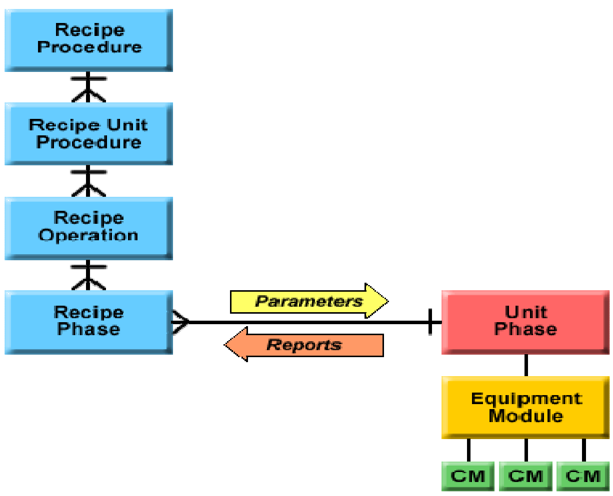

Fig. 4. Batch unit phase [6]

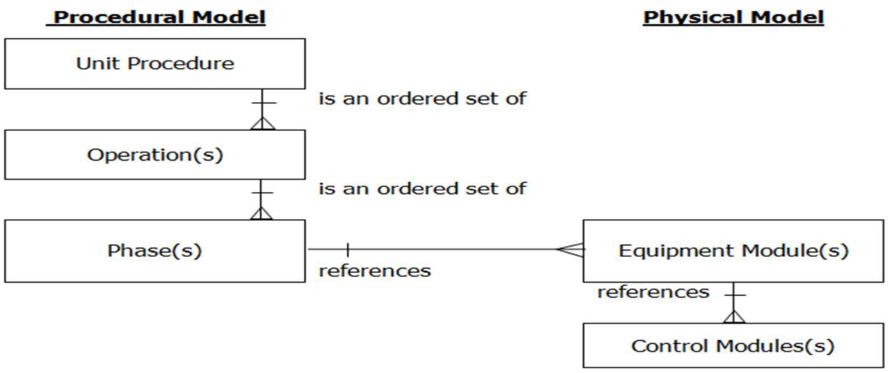

Fig. 5. The Batch action hierarchy [8]

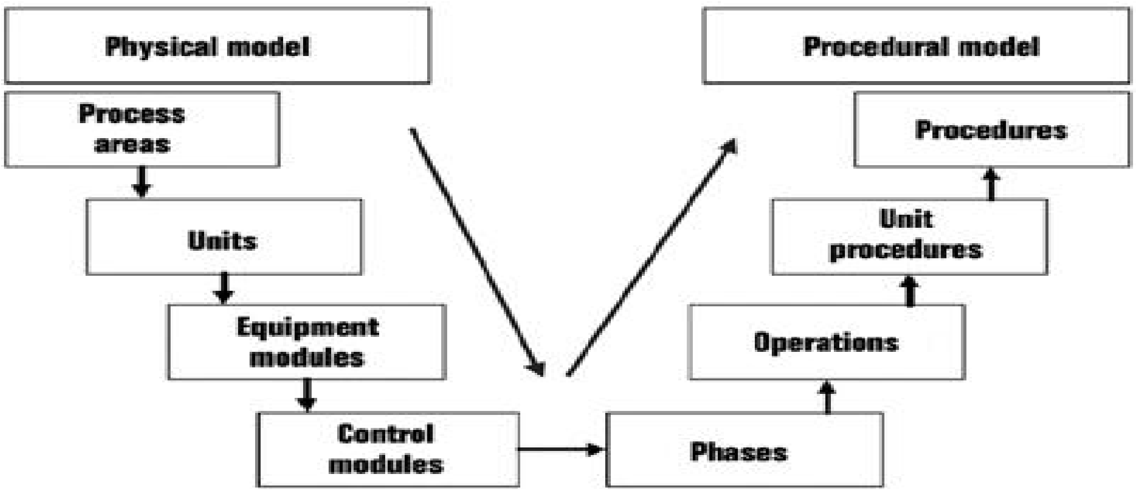

Fig. 6. The Batch physical model [5]

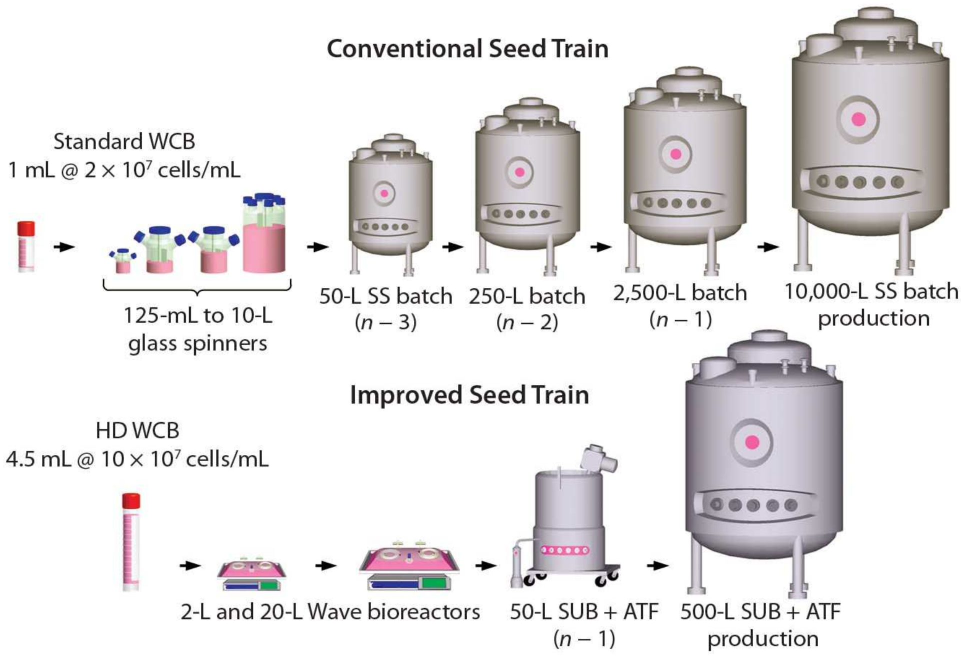

Fig. 7. Cellular process classes [6]

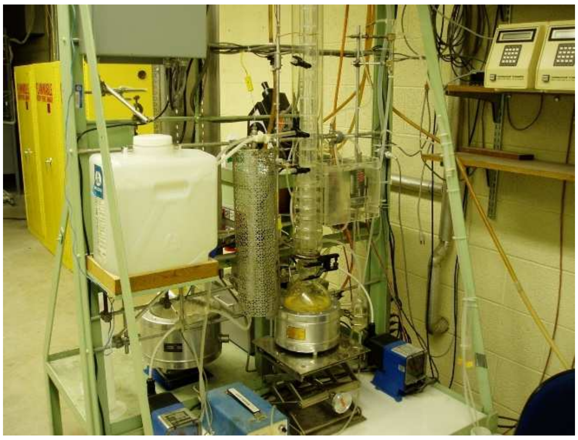

Fig. 8. The devices of a factory with ongoing Batch processes [5]

3. OVERVIEW OF THE SOFTWARE USED IN PROCESS AUTOMATION – DELTA V VERSUS CENTUM

Within this chapter, the parallel description of two systems used in industrial automation is intended, DeltaV and Centum, implemented by the companies Emerson, and Yokogawa respectively.

3.1 Emerson DeltaV [4]

A distributed control system (DCS) is a control system for a process or installation, where the controls are distributed throughout the whole system. This is in contrast to systems that are not distributed, using a single controller in a central location. In a DCS, a hierarchy of controllers is connected via communication network control and monitoring. – see Fig. 9 and Fig. 10.

Emerson Electric Company is an American multinational corporation headquartered in Ferguson, Missouri, USA. This Fortune 500 company manufactures and provides engineering services for a wide range of industrial, commercial and consumer markets. Emerson has approximately 115,000 employees and 220 manufacturing locations worldwide. DeltaV is its own software for industrial automation. [16]

DeltaV system architecture consists of multiple nodes. There is an example of 8 knots below. The maximum permissible limits are: 120 knots, 100 controllers (simple or redundant pairs), 65 operator stations and 1 server.

3.2 Yokogawa Centum

The Japanese company Yokogawa´s profile is the industrial automation and the testing and measurement of hardware and software. [12]

Some of its main hardware products are: pressure transducers, flow meters, controllers, recorders and data acquisition. – see Fig. 11 and Fig. 12.

The products are used in various industries that require process control systems. Depending on the project size and requirements, Yokogawa offers various control systems: DCS, PLC, SCADA and ESD (emergency shutdown). In collaboration with Shell Global Solutions, Yokogawa also offers solutions for advanced process control (APC) for refineries, petrochemical plants, and chemical platforms. [18]

Centum, the DCS software of Yokogawa, has the largest capacity of DCS's (signals), supporting up to 1 million tags per device. [16]

This system consists of an engineering station server with a HIS functionality (= Human Interface Station), an operating station, a station process (FCU = Field Control Unit) type AFF50D and expansion of multiple shelves for the inclusion of additional modules.

The engineering station, the operating station and the process station are connected by a redundant runtime system - (v-net).

The local extension racks are connected here through an ESB bus and a master interface - SB401 module. [12]

3.3 Operation Graphics

This subchapter emphasizes some examples of operation Graphics in two different process automation software (PCS7 and Centum) – see Fig. 13 and Fig. 14.

4. QUALITY MANAGEMENT IN INDUSTRIAL PROCESS AUTOMATION

In this chapter the issue of quality management in automation will be addressed, in order to achieve a comprehensive study in this regard.

In a project, everyone involved makes some commitments [9]:

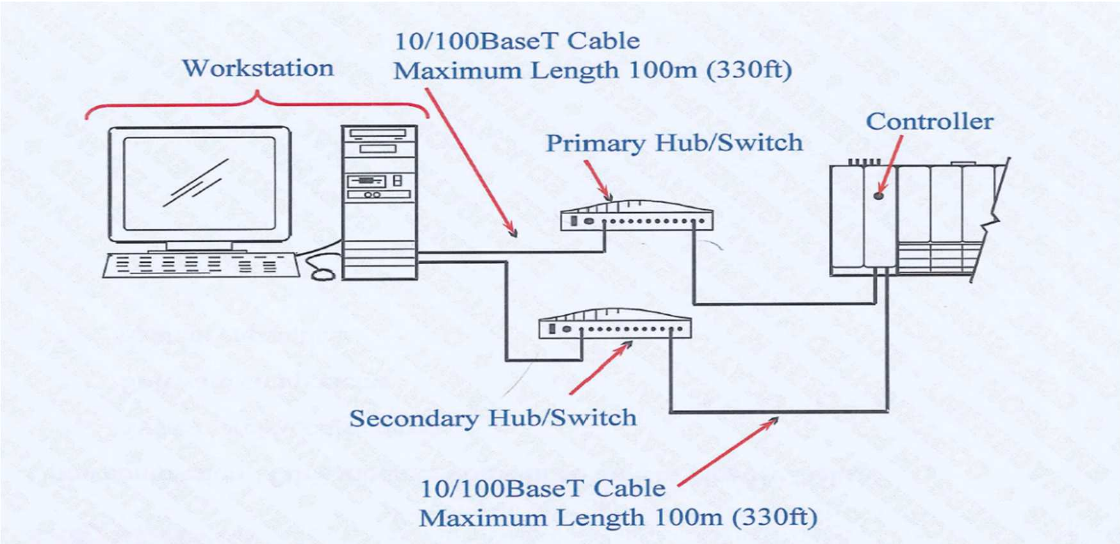

Fig. 9. The DeltaV system architecture [8]

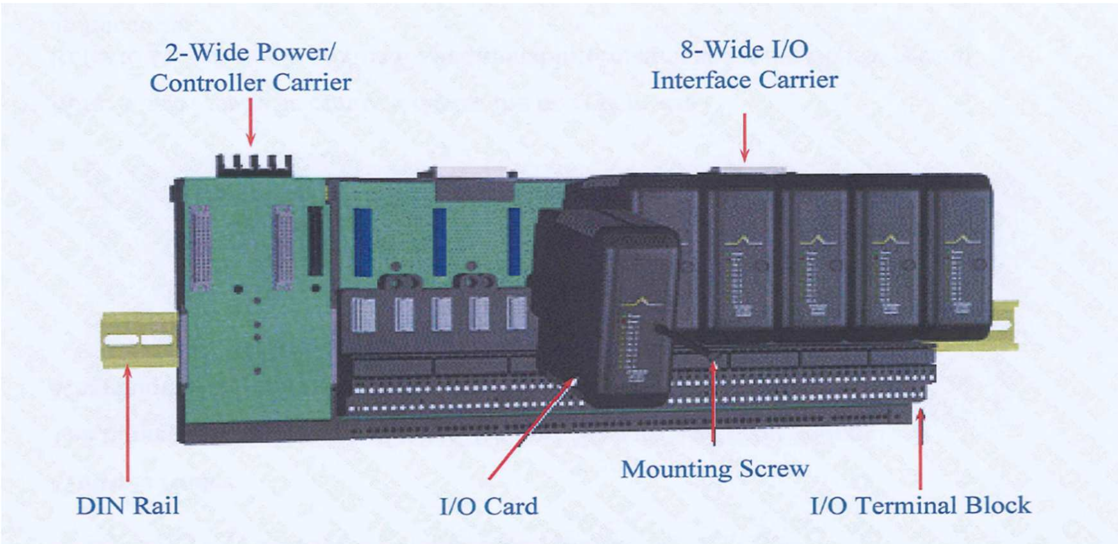

Fig. 10. The DeltaV interface [7]

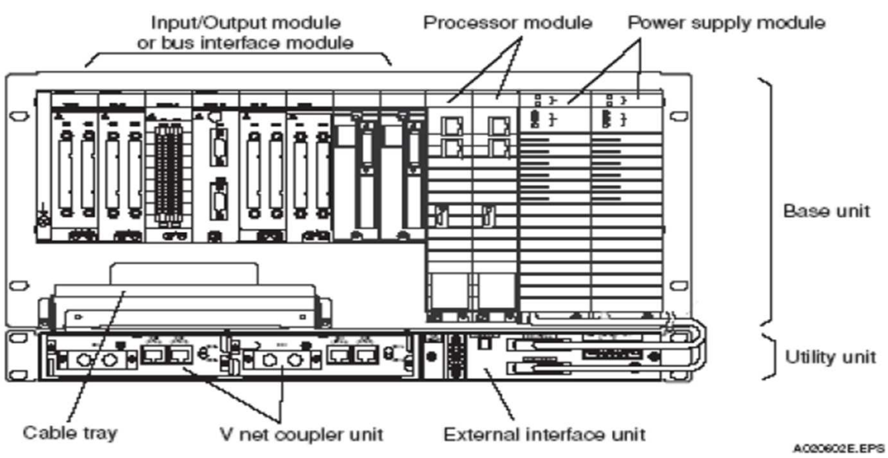

Fig. 11. The CENTUM interface

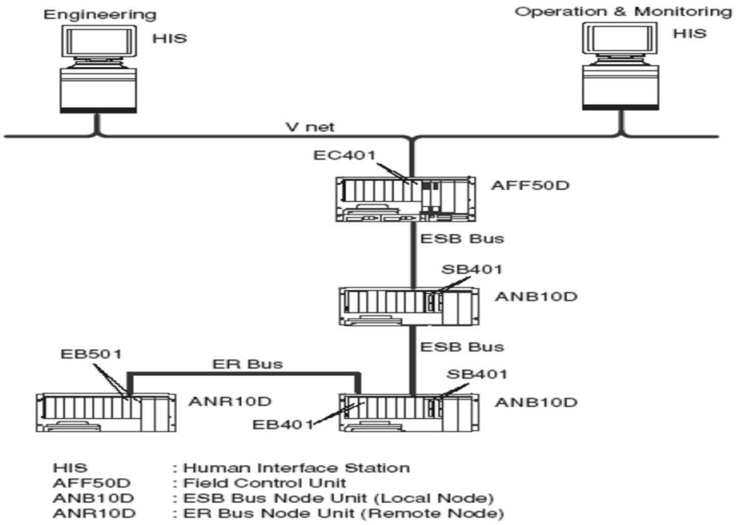

Fig. 12. The CENTUM system architecture [12]

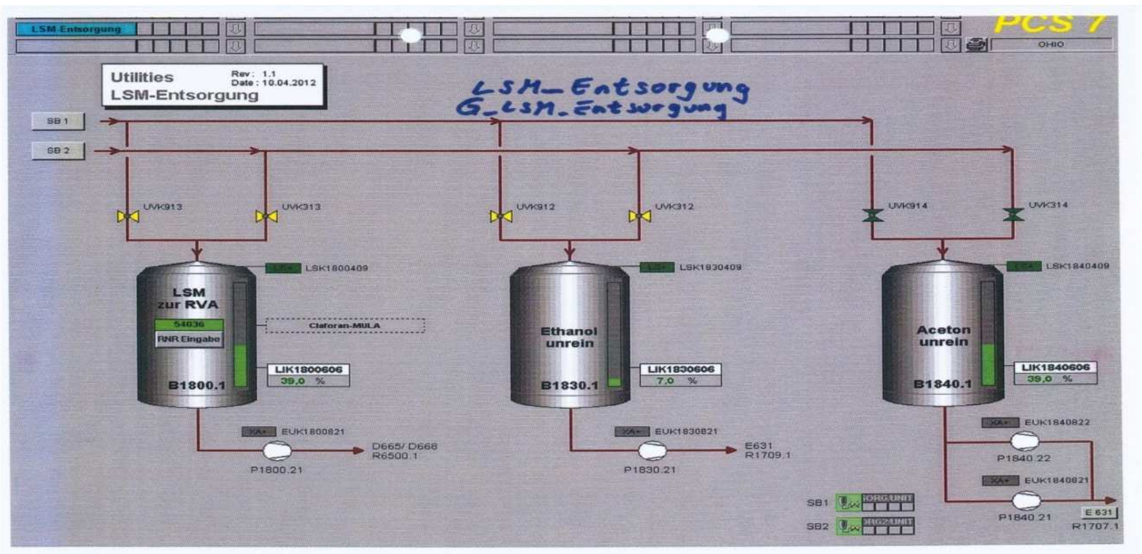

Fig. 13. A graphic example of motor operation, valves, alarms etc, created in the Siemens PCS7 system

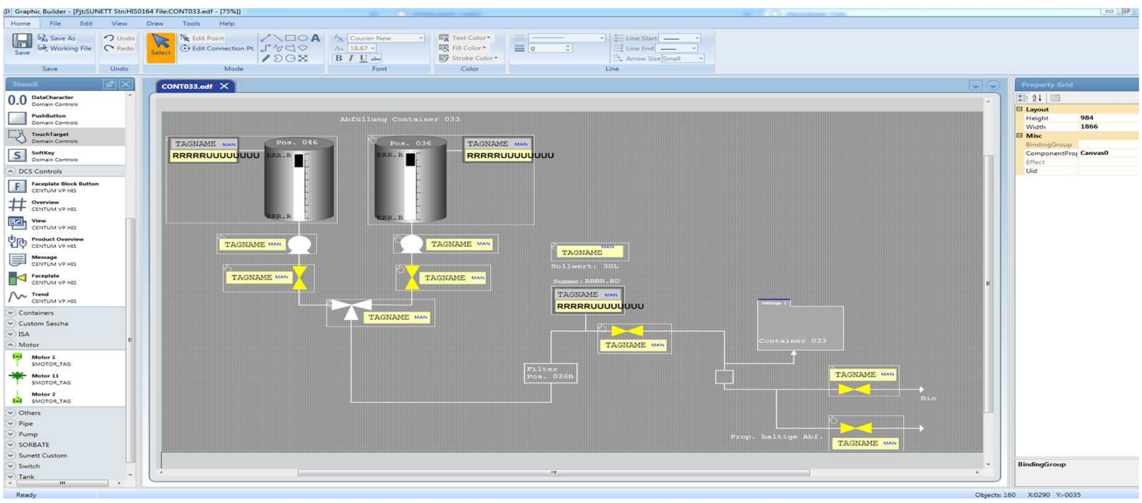

Fig. 14. A graphic example of motor operation, valves, alarms etc, created in the Yokogawa CENTUM system (made by the author) [12]

- The Project Manager is responsible in front of the customer to plan deadlines/ the financial side / follow strictly the given specifications);
- The Project Manager is responsible in front of the company for which he works, to plan and distribute resources/ finances and track customer satisfaction; [15]
- The Technical Leader is responsible in front of the project manager to plan and appropriately distribute resources to bring technical solutions and achieve customer expectations;
- The Project Engineer is responsible in front of the project manager and technical leader to plan deadlines and deliver quality services.

The delivery of work has to be done on time, at a high-quality level expected by the client.

4.1 Testing methodology [11]

Testing ones' work is an obligation of ISO 9001. It is also the best way to avoid errors.

The main steps in implementing an automation project are:

- Test design;
- Internal tests;
- FAT (factory acceptance test);
- SAT (site acceptance test - Site);
- Testing of the software and hardware parts.

All testing must be documented, wherever they are made.

Test results [11]:

After the completion of each project, there should normally follow a "General Test Plan" which provides an overview of all the tests that must be performed: internal tests, FAT (acceptance in the factory), SAT (site acceptance) etc. A general architecture of the testing execution process has to be strictly followed. The idea of following the test results is customary that tests must be made by different employees, and not by the person who designed that part of the project. [17]

- There may be discrepancies between specifications/ customer expectations and the result of the engineers´ work. It may be due to changes in customer requirements or the company contracted a mistake. Each deviation has a unique reference number (also all documents relating to this deviation).
- The deviation index is a standard form of all tests deviations as well as the status of solved tests. There is a deviation index per test plan. [13]

5. ISO 9001 [10]

The ISO 9000 family of standards for quality management systems is designed to help organizations ensure they meet the needs of customers and other stakeholders also interested in the compliance of the legal and regulatory requirements of a product. ISO 9000 deals with the fundamentals of quality management systems, including a number of management principles [14] on which the family of standards relies. ISO 9001 deals with the requirements that organizations want to meet - and the standard must do so.

Third party certification bodies provide independent confirmation that organizations meet the requirements of ISO 9001. Over a million organizations worldwide are independently certified, making ISO 9001 one of the management tools most widely used in the world today. However, ISO certification process has been criticized as wasteful and not be useful for all organizations.

The ISO 9001: 2008 principles that are to be implemented in command schemes of automation lines are:

- Verification of purchased material;
- Traceability of the batch of products;
- Calibration of measuring and control equipment;
- Identifying the causes of nonconforming product (HUMAN-MATERIAL-MACHINE);
- Checking a representative sample.

6. CONCLUSION

This paper has presented the start of a research in process industrial automation, with some basic concepts, and the purpose is to implement this knowledge in the area of quality management. So, even if the exemplification of the integration of quality management in the control scheme will be made on specific automated lines, it is to achieve principles and conclusions that will be generally applicable, including other industries as well. The success of this project depends on the implementation of the market research which is being carried out, in order to get the best quality/ price ratio.

Personal contributions within the meaning of intercalation of signals are also to be achieved, and even an intervention in the control scheme, of certain elements of quality management.

It is intended to provide an extensive research in industrial automation, especially in the field of process sequential control, in chemical and pharmaceutical factories, as well as providing an innovative study that can be applied and used in any of these organizations.

In this article, the current state of the quality system in Batch process automation is presented, with a slight emphasis of the testing and quality control process.

This research will be carried out with the support of the Technical University of Cluj-Napoca.

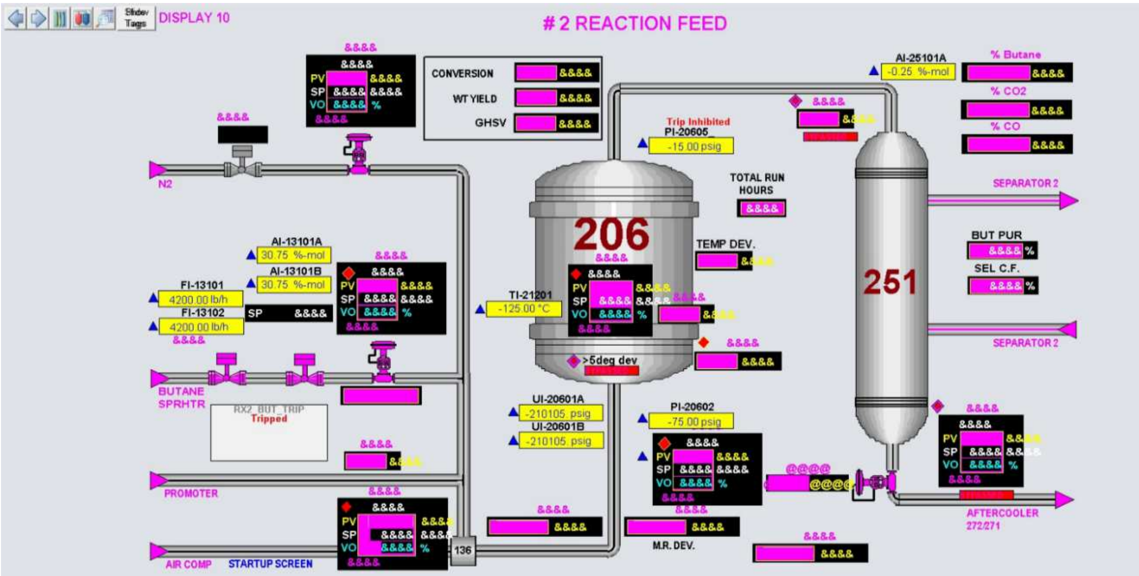

Fig. 15. Control System migration from PROVOX to DeltaV (before migration)

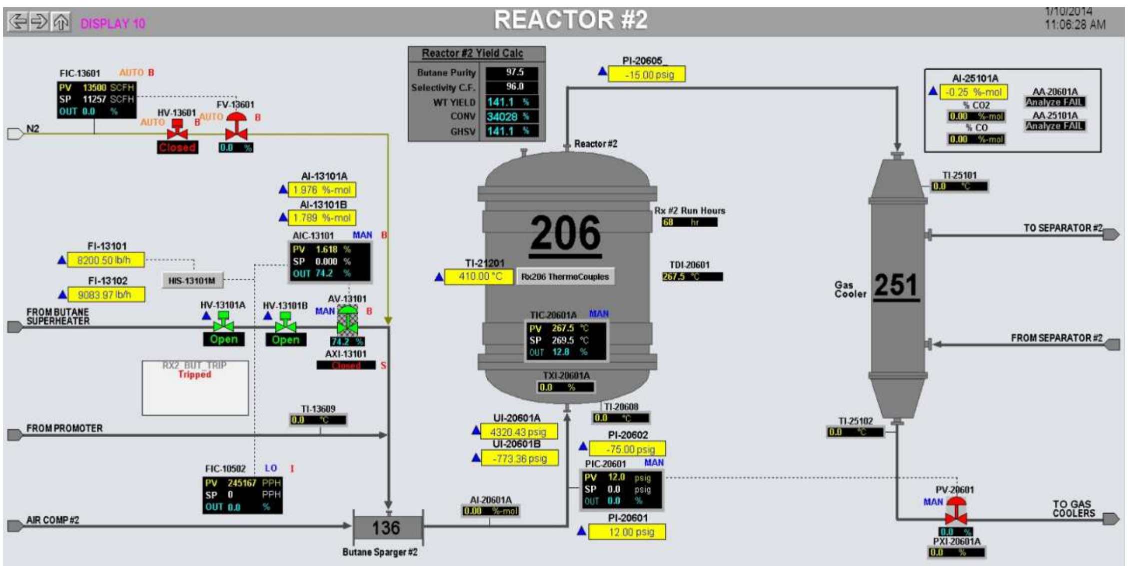

Fig. 16. Operator graphics from PROVOX to DeltaV (after migration of code) – including Safety Systems SIS

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Stadiul actual în implementarea sistemului calităţii în sisteme de automatizări cu comandă secvenţială

Rezumat: Această lucrare stabileşte stadiul actual al punerii în aplicare a sistemului de calitate în automatizarea secventială, având ca scop în special observarea diferenţelor dintre sistemele Centum, PCS7 şi DeltaV, graficele de operare si metodologiile de testare. Sistemele utilizate în prezent au fost observate, în scopul de a stabili o analiză a metodologiei şi de a perfectiona aceste sisteme, în raport cu standardul de calitate ISO 9001. Toate exemplele menţionate mai sus pot fi implementate în diferite fabrici, cum ar fi: producţia de antibiotice şi medicamente, fabricarea produselor chimice (folosind sisteme secventiale), precum şi pe platformele de extracţie a ţiţeiului şi a gazelor sau în producţia de alimente şi băuturi (utilizând sisteme continue).

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