

Control Cards Design in Process Manufacturing

Violina Georgieva¹ and Alexander Hadjidimitrov²

¹PhD. Student, Technical University Sofia

Faculty of Automatics. Sofia 1000

8 “Sv. Kliment Ohridski” Blvd

{violina.jg@abv.bg}

²ERP consultant at Team VISION Bulgaria Ltd

Sofia 1712, 41 “Alexander Malinov” Blvd

{Alexander@Hadjidimitrov.com}



ABSTRACT: *In process manufacturing, control over the process is often more important than control over the product. In production departments, operations and quality control are registered with “Control cards.” Control cards are then used to analyze defects, claims, machine and employee loads, etc.*

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1. Introduction

The current paper describes the usage of control cards as a tool for quality control of the production process. The authors share their experience in the creation of a software module for control cards management as a part of an enterprise resource planning (ERP) system. This module is integrated to the existing manufacturing module of the ERP system. The system is implemented at a manufacturing enterprise that produces electronic equipment (cash registers, fiscal printers, scales, etc.). Before the creation of the module the control cards were created manually on paper. The implementation of the module automated the process of Control Cards management and increased the control over it. The paper describes the basic concepts of control cards, the main issues that are met during their creation, the structure and the concepts of the module created. The usage is illustrated with examples from the enterprise, where the system is implemented.

2. Company Structure

The main departments in the company are:

- Trade (international and domestic) manages the sales of production and the purchase of materials and goods.
- Manufacturing of products
- Manufacturing of Printed circuit boards (PCBs)
- Semi-finished products
- Software – develop software and firmware for the products produced
- Development – develop new products and modifications of the existing products
- Accounting
- Management

Control cards are used in production departments (products and PCBs.)

The manufacturing process consists of two stages production of semi-finished products (PCBs) and production of products.

The production of PCBs consists of

- Delivery of the components needed
- Print of the blank PCB
- SMD assembly Visual control
- Conventional assembly
- Visual control
- Control card filling
- Transfer of the produced PCBs to the manufacturing department

The production of the products consists of;

- Preliminary operations
- Test of PCBs, recording of firmware
- Assembly of the components of the product
- Assembly of the final product
- Packaging

The registration of the planning and production processes in the system consists of the following stages:

- **Sales order** – it is created every time when a new order from a customer is received.
- **Main production schedule** – this is the planning stage. It is based on the Usually it is prepared once a production orders for the created.
- **Start of the production orders** – each order is started when the production of the product in the manufacturing department is started.
- **Registration of the production** – at this stage are filled up the serial numbers and lot numbers. The control cards are also filled.
- **Consumption of materials** – the system proposes the materials to be consumed based on the “Bill of materials” of the

product. Manual adjustment of the quantities proposed is allowed.

- Finalization of the production order.

3. Application of Control Cards

The quality control of the products is based on the control of the production process itself. The documentation of the process is done using control cards. Thus is tracked that all operations needed are done and also is tracked who are the employees that have done the operations. This way two important targets are achieved:

- Following the sequence of operations described in the control card is guaranteed that no operations are skipped;
- In case of defective product is easy to find which operation has caused the defect and to trace who is the employee who has done the operation and when is the operation done. Thus the reasons of the defect could be analyzed and actions to be undertaken in order to change the process to avoid future problems of the same type.

The most important thing during the creation of a control card is to define a proper list of control points. Each control point describes one operation or a group of operations that are done in conjunction during the production process. Defining the list of operations should keep in mind that operations should be grouped in control points in a way that no operation is skipped but also the list of control points should be short enough in order to be easy to be documented and followed. It's advisable to group related operations that are done together by the same employee. As an example if during the assembly of a product 5 Integrated Circuits (ICs) should be mounted in the sockets on a PCB by the same employee these could be grouped to one control point ("IC mounting) as during this operation the employee receives a PCB with the sockets mounted, mounts the ICs in the sockets and afterwards transfers the ready PCB to the next stage. In other case if the employee should mount only three of the ICs, a test should be carried out and afterwards the two other ICs should be mounted then maybe it would be better to separate the process in 3 control points ("Mounting of the first group of ICs", "Test", "Mounting of the second group of ICs"). This will help the process to be tracked properly in order to allow future analyses in case of defects or claims.

In order to be possible to use control cards in the production. process is required to prepare templates of the control cards for each product (semi-finished or final) that is tracked separately (e.g. for each PCB, each cash register, etc.) Each template contains a list of control points listed chronologically during the production process. If some operation is repeated at different stages during the process (eg. testing of different modules) then it is documented as several control points at the appropriate positions (one control point for each occurrence) in the list.

A sample template of a control card could look like:

- Main board test
- Recording of firmware
- Operator display test
- Fiscal module test
- Top cover assembly
- Bottom cover assembly
- Display assembly
- Final product test
- Final product assembly
- Packaging

This control card template becomes a part of the product specification. It is an integral part of the production documentation. It is used in the preparation of the current control cards of the products during the production process.

Current control cards are filled up during the production process. Based on the production process organization different approaches are possible:

- A separate control card is filled in for each product (for each instance).
- A separate control card is filled in for each lot of products (eg. for the products produced by a single work shift).
- A single control card is filled in for the total quantity produced.

In regard of the selected approach some modifications in the control cards are possible. In general it contains the following fields:

- ID and name of the product
- ID of the production order
- Production date
- Serial number/Lot number (or a list of numbers)
- A list of control points
- For each control point a flag that the operation is done and the ID of the employee (or a list of employee IDs) who has done the operation. If the control card is for a production period longer than one day also a production date should be added to this list [3].

4. Implementation of the Control Cards in the ERP System

Depending on the enterprise and the software used for production planning and management different approaches in the implementation of control cards are possible. In the case described in the current paper an ERP system is used. The functionality for control card management is implemented as an additional development especially for the specific needs of the enterprise. It is integrated to the standard functionality of the system for management of items (products) and production orders.

The control points are developed as a separate table. It contains the full list of operations that are tracked separately. These control points are used afterwards to assemble the control cards of all products. The table contains the following fields:

- ID – a unique ID of the point in the system
- Description a description of the tracked operation

The product control cards are developed as a separate table related to the Item table (that contains the list of items in the system). This way for each item is specified the list of the control points that should be tracked, The table contains the list of the control points that form the control card of the item.

The control points are selected from the global list of control points in the system (the table described above.) This table. contains the following fields:

- **Item ID** – contains the unique ID of the item. It is related to the Item table of the system. Usually for a single item a several lines in the table with the same **item ID are created** – each line contains one control. point from the item control card.
- **Control point** – contains the ID of the control point The field is related to the table with the global list of control points.

This functionality is used for management of control cards during the production process. As the manufacturing functionality itself is based on production order the corresponding control cards are developed as documents related to the lines of the production orders. The production order itself is a document containing one or several lines. Each line describes the production of a single item. For each item are stored its ID and the quantity for production.

The functionality consists of the following tables:

• **Production employee** – contains the list of employees in the production departments. Contains the following fields:

1. **ID** – a unique ID of the employee in the system
2. **Name** – the name of the employee

Production order line control card-contains a list of the control points for the item in the production order line . Contains the following fields:

1. **Production order ID** – the ID of the production order for which the control card is prepared,
2. **Production order line ID** – the ID of the line in the production order for which the control. card is prepared;
3. **Control point ID** – ID of the control point in the control card;
4. **Approved** – a flag that means that the operations described in the control point are done successfully;

• Performed By this table is related to the “Production order line control card” table. For each. control point here are listed the employees who have performed the operations. The table contains the following fields:

1. Production order ID
2. Production order line ID
3. Control point ID
4. Employee ID ID of the employee who has performed the operation

During the initial implementation of the system the global list of control points is set. Periodically in cases of need of new operations the list is updated with the new control points.

Also periodically when new employees are employed the list of production employees is updated.

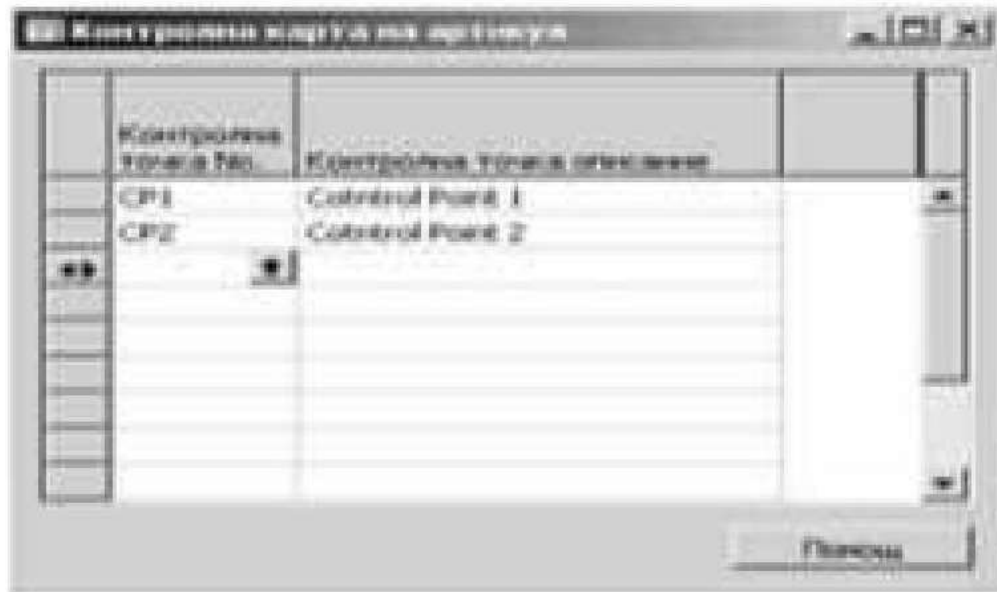


Figure 1. Product control card template

In case of definition of new products a new control card template is created (see Figure 1).

During the creation of new production orders for each line that contains a product the system automatically creates a blank control card based on the template set for that product (see Figure 2).



Figure 2. Production order control card

When an operation is completed the employee in charge sets the “Approved” flag for the corresponding control point and fills the list of employees who have performed the operations.

The control card could be printed on paper at any moment if needed.

5. Benefits From Control Card Usage

The properly prepared control card template contains all operations that should be performed during the production of an item. This guarantees that during the production process no operation will be skipped (because otherwise the corresponding control point will not be filled in and the control card will be incomplete. This should be noticed when the production order is finished.) The ERP system described in this paper checks the control cards during the production order closure and does not allow the order to be finished if there are control points that are not marked as “Approved”.

The second benefit from control cards usage is the possibility for future analyses and control. They are performed in cases of defective production when is needed to find the possible reasons for the defects. Each produced item has a lot number or a serial number. Based on this number the system can identify the production order the item was produced by. In the production order control card could be identified the employees who have performed the operations. This allows to trace the production process for the specific item and to give hints for the possible reasons for the defect [3].

6. Risks

The successful usage of control cards could be compromised if some risks are neglected.

The first risk is the improper definition of the control points. As the control card is a list of the operations that should be tracked and controlled, the proper definition of this list is the foundation for the successful usage of control cards. Possible problems include:

- **Skipping important operations** – in case a control point is not created for an important operation than that operation will not be tracked by the control card. As a result it could be skipped during the production and also it will not be documented and future control and analyses will be impossible.
- **A very detail list of the operations** – in case the operations are not grouped in a proper way to control points a very long list of control points might be produced. This could make the process of filling control cards very tough and the employees

to stop to pay attention to it. As a results they could mark operations as “Approved” without checking their actual status and thus to compromise the process.

The second big risk is the human factor. In general the control cards are created by people and are used to document the work of people.

That’s why many errors and misuse could occur. For this reason it is very important during the implementation of this tool to guarantee the involvement of the team who is supposed to fill and use them in order to guarantee that the information filled is correct. Otherwise they could not pay enough attention to it and to feel it like an additional useless time- consuming documentation that should be filled. This also will compromise the process.

7. Conclusion

Control cards are a tool that allows guaranteeing of the proper flow of the production process and as a result to guarantee the quality in the terms of not skipping operations due to errors. For the proper usage of the tool however it is very important the proper implementation in the organization to be done and to guarantee the involvement of the team who is supposed to use them.

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