

# Identifying requirements for the implementation of production management systems in graphic arts companies

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Keywords: Production Management, System, Requirements, Company culture, Implementation, Workflow

## Abstract

Graphic arts companies have a clear need for structured production management methods. A specification of requirements for production management identifying needs based on operational and administrative activities, can contribute significantly in the selection and implementation of a production management system.

In order to identify a generic set of production management system requirements, a prototype questionnaire has been designed. This questionnaire has been tested and validated through in-depth studies at one Swedish graphic arts company and through verification studies at seven other companies.

The study indicates that, in addition to the technical functionality of the production management system, an understanding of company culture, including working routines and organizational functions, is necessary to decipher both technical and operational bottlenecks. This is the foundation for a successful implementation of a production management system.

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## Introduction

The graphic arts industry is facing an increasing pressure from the customers. The customers demand shorter lead times, lower prices and the trend is toward shorter run lengths (Karttunen 1993). One of the reasons for this is the increasing competition from other media. Print is no longer the only way to convey a message to the consumer.

The industry is facing several other problems as well. The transformation from a handicraft based industry to a process industry is not easy (Bellander et al. 1997), (Handberg et al. 1998). The companies are also in general very small, giving them difficulties to invest in equipment, training and development. There is often also a lack of highly educated staff in graphic arts companies (Aniander et al. 1995).

In order to make the graphic arts industry more competitive, many efforts have been done during the last years in the area of production management. At several institutes research projects have been carried out in this field (Nordqvist 1996), (Stenberg, 1997), (Fekete et al. 1993), (Juhola et al. 1992), (Pasagic et al. 1996).

The number of suppliers of production management system have increased during a number of years. At DRUPA 1990 four suppliers were present, two with own stands. At DRUPA 1995 there were ten with their own stands. At IPEX 1998 over twenty suppliers were present, many also showing cooperation with production equipment suppliers. Most of the suppliers have built their systems specifically for graphic arts production but there is also an increasing interest from traditional system suppliers to other industries to approach the graphic arts industry.

### Implementing a production management system

Graphic arts companies have expressed their need to have a production management system, which will give them a good overview of the production and provide them with useful reports. However, previous research has shown that along with the technical infrastructure in a company, organizational culture and the national culture have to be taken into consideration when making a decision to purchase e.g. a production management system (Koulouvari, 1998).

A production management system is a much more complex part of the company that it is to be embedded in than is usually perceived by its

staff. It is not just a new technological investment, but a component which has to fit the company's culture. It has to be embedded in a network of other technologies, companies and individuals through which it will be exploited. A production management system can not be fully utilized unless it will become an equivalent part of the organization and treated in the same manner as other resources in the company (Ford et al, 1998).

When companies, which are in the fore front of development, buy and install a new technological application, this regularly does not work as it was expected to. And not only this, it has also happened that new technologies cause stumbling or even failure in already successful companies. Why? The organization's structure and how its groups work together have been established to facilitate the production of its dominant product. But when a new technological application appears or a technological change occurs, a very different set of skills from those that an established firm historically has developed is required. And, as the company's structure is mirrored on its product's architecture, when the two do not match, for any reason, this can become a problem (Christensen, 1997).

#### Aim of the work

In the graphic arts industry there is generally a lack of competence regarding production management and how to set requirements for and implement production management systems. This paper is part of a project with the aim to help companies in the industry to obtain a better understanding of the needs of such work and to provide them with better tools.

The aim of the present paper is to provide a manner of thinking for the company's employees which can be used as a tool for facilitating the implementation of a production management system. It is based on a set of "requirements" which have been identified as key factors.

Seven Swedish graphic arts companies have been studied. A case study in a bookbinding company has resulted in a requirements list based on technical functions that the system should have as well as a description of the most significant routines in the company, indicating how the system will be used. The research in the six other companies has approached problem areas which are expected to be treated through the purchase and implementation of a production management system.

The conclusion is that the successful implementation of a production management system depends on how well the problem area has been identified, approached and on how precisely its requirements have been described.

Since this study has been carried out in Swedish companies, all of the results may not as such be valid in other countries.

### Other similar attempts

Also in other countries in Scandinavia, development in the area covered in this paper seem to be a matter for the graphic arts trade organizations. There are similar projects going on both in Norway and in Denmark. Thus effort will be made to take advantage of each others work and to make a Scandinavian gathering around these matters.

### Method

In the initial project (called Little Sister, <http://www.gt.kth.se/research/littlesister/>), studies have been made at eight graphic arts companies in Sweden who volunteered to enter the project. In the beginning of the project all companies were studied in a similar way to get a better knowledge of workflows in commercial printing (Bellander et al, 1997).

In this paper our methodological approach is basically divided in two parts.

A. In the later part of the project, one bookbinding company became a case company for a deeper study (called the pilot company). The seven other companies became reference companies. At the pilot company, semi-structured interviews, open ended interviews and discussions have been undertaken together with studies of existing systems, routines and documents, e.g. the ISO 9000 binder of the company. The semi-structured interviews have been based on a question guide developed earlier in the project (Handberg et al, 1998). The aim of the studies has been to get a deeper knowledge of how the company works and wants to work and to try to establish requirements for a production management system.

The approach of the study has mainly been based on the Grounded Theory (Glaser et al, 1967). The aim with the interviews has been to find out the way things really are without prejudice. The people on the

shop floor have been able to express their views on how they see the needs in the company without interference from the management.

B. The six case companies (six of the seven mentioned above) have been approached through a prototype questionnaire, open ended discussions, personal observations, workshops and feedback on the results from the companies management and employees crew. Each of the companies has been visited for three days in a row and the main aim was for the researcher to become an insider in order to understand, decipher and describe each of the company's culture and how this is reflected upon decisions made (Schein, 1997). Qualitative results are used in order to present quantitative outputs in a comparable way among the studied companies. The aim was to approach the company's culture in order to come close to the real problem areas, and see them from different perspectives; those who buy a production management system, those who use/will use it, and from an outsider's point of view. These opinions do not usually match and decisions made do not always take in to consideration the real problem area or they do not treat it.

Our research has also been enriched by literature studies concerning other industries than the graphic arts. The aim was to become aware of similar problems and approach solutions that have been applied and verified in other industries.

We have also studied the ongoing projects in Norway and Denmark and how they have approached the same problem area. Partial co-operation has been achieved in order to exchange information and experiences.

## Results

The results have been divided into a number of sections according to the two-folded methodological approach.

A: The first section is a description of the way the pilot company handles significant routines or wants to do it in the future. These findings are direct results of the interviews at the pilot company. In the following section the company itself is described. Then follows a section on the functionality requirements on a production management system identified through an analysis of the needs of the pilot company as defined by the interviews. This follows by a brief description of similar work in Scandinavia.

B: In the last section the findings on how important the awareness of the company's culture is in making a successful implementation of a

management information system are presented. These results are based on studies at the six case companies.

### Expected usage of a production management system in the pilot company

One of the documents we have used to describe the requirements on a production management system in the pilot company contains a description of the significant routines which are applied in the company today. There are also suggestions for changes in some of the routines to better utilize the possibilities provided by a production management system. This method of introducing changes when implementing a new system is also supported by Wallen (1996).

The description of the routines does not actually form requirements on the system, but will help the system vendor understand how the system will be used once implemented in the company and hence has an impact on the success of the implementation.

In the pilot company, the focus of the work has been on order handling and status information (in time and space). To obtain the status information, the registration of events and communication within the company and to customers and partners have been defined as significant routines.

#### Order handling

There are many routines connected to order handling. The following listing is only a brief summary of all those studied at the pilot company.

#### Sales

At the pilot company there is a large number of precalculations and quotations made because several print shops are bidding on the same job and each one of them asks for quotations for the finishing part. These tasks are today handled manually and communicated to the customer by fax and mail. An increasingly automated process is sought in this field in order to reduce response time and to be able to focus the manual handling on the more complicated quotations. Very often the requests for quotations are not completely specified and the quotations need to contain a variety of options based on a main quotation. Email and WWW are tools the pilot company wants to use much more in this area, with the possibility for the customers to take a more active role in the

process. Better production statistics are also needed in order to reach these aims.

Post-calculation of orders is today a tedious task due to the lack of accurate and easily available information about the production of the orders. There is a lot of manual checking of the information, which should be reduced with a more reliable information system.

Evaluations of the quotations and orders won and lost and analyses of the market situation in general are not done as thoroughly and often as needed due to a lack of both accurate information and tools.

### Registration

When a quotation is turned into an order, registration should be an easy task, handled by either the customer contact person or by the order registration person. One of the problems to tackle in this task is that frequently the orders have changed from the quotations so much, that it is hard to connect them if there is no reference number identifying the quotation. This problem is not easily solved.

It must also be possible to handle registration of orders outside office hours since orders regularly arrive during the evening shift when the staff normally doing the registration has ended their work for the day. Since the lead times are so short (delivery is normally the next day), the registration cannot be postponed to the next day. The requirement of the company is that no production may start before the order has been registered in order to be able to track all operations carried out with the order for invoicing purposes.

### Production

In the production, the most significant routines are connected to the reporting of production events, including the handling of the products (where they are placed between the production steps, etc.). The information collected from the production forms one of the most important foundations in the company's information bank. The cost for the production is calculated, production statistics for improved planning is aggregated and tracking of the actual production is maintained based on the collected information. One of the largest problems in production is expected to be solved with a new information system, that is to know exactly where to find the products at any time, without having to spend a lot of time looking for them.

It is also very important to give feedback to the production on the information collected in order to be able to find potential improvements in productivity.

### Communication

In order to perform the detailed planning of the orders in the different production steps, status information is communicated between the responsible person of each department. This is normally an oral procedure on a need to know basis. It works as it is today, although improvements would be welcomed. An easily accessible, up-to-date status information is very much required. This is expected to be realized through the implementation of a production management system.

An improved information transfer to the customers is also foreseen and required with a new system. The pilot company is prepared to allow regular customers have restricted access to the status information of their own orders in the system. Customers should also be able to place orders themselves and get price estimates of orders automatically. This is seen as an enhanced service to the customers, especially outside office hours.

### Types of users in the pilot company

The system should provide possibilities to limit the actions a user can do in the system, depending on logon ID, both regarding read and write possibilities and regarding which information the user will have access to. An other aspect of limiting the information presented to the user is not to drown the user with more information than necessary. The information will then be more manageable for the user.

In administration there are basically the following categories of users:

- System administrator.
- Sales people.
- Person responsible for updating on order to make sure all basic data in the system is accurate.

In the production there are four different kinds of users:

- Person registering the orders.
- Person responsible for planning, making the long and short term planning.
- Shift leader who needs to obtain status information about the orders in order to execute them, and to arrange them into working sequence.



- Operators, feeding the system with information about the production.

On top of this there is an aim to give the entire staff, as well as regular customers, the possibility to look at the production status in real time.

### Description of the pilot company

The kind of information about a company that we have found necessary to convey to a system supplier in order to purchase a production management system is:

- Size, number of employees etc.
- Number of production sites.
- Expected number of users in the system (in total and concurrent).
- Description of the expected users.
- Description of the production.
- Description of required, flows for material and information.
- Description of customers and orders (types, frequencies, volumes).
- Tasks that are important to carry out using the system (existing problems that must be solved)

We have here chosen not to list all the details of the pilot company but rather chosen to characterize the company according to the model suggested by Berry & Hill (1992). The important parameters in this model are the market characteristics, the order winners and qualifiers, and the manufacturing strategy. The characteristics for each of these parameters are given in table 1.

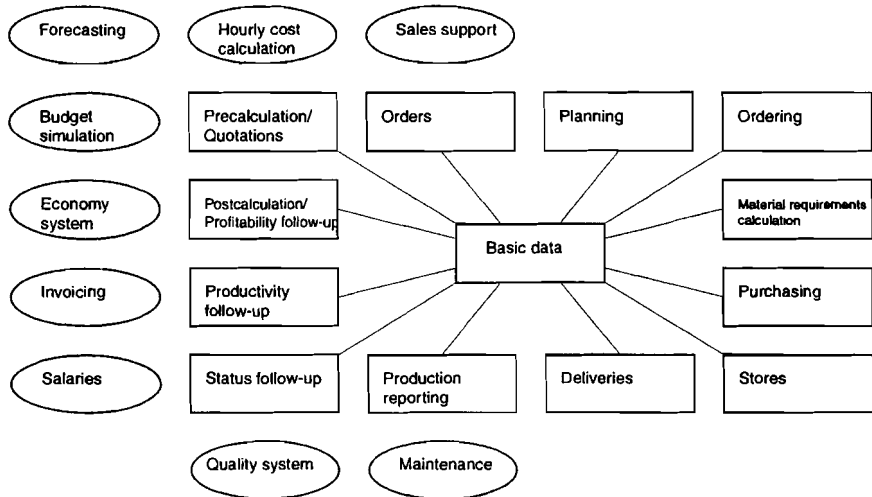
Market characteristics	Order winners and qualifiers
Standardized products Narrow product range Low volume per product Make-to order Initial and repeat orders	Delivery time Delivery assurance Quality Price

Manufacturing strategy				
Manufacturing		Manufacturing planning and control system		
Task	Features	Master production scheduling	Material planning	Shop-floor control
Reducing process lead time To manufacture to specification and quality standards Deliver on time	Batch oriented component assembly Simple work flow High precision work Low material cost High labour cost	Make-to-order, assemble to order Storing Delivery	Low	Push system Sometimes in batches Priority scheduling Frequent rescheduling depending on incoming customer material Order tracking and status information

*Table 1  
 Characteristics of the pilot company according to the model suggested by Berry & Hill (1992).*

## The functionality requirements list

A company can have different needs of system support for their administrative routines. The routines can be grouped in modules as shown in figure 1.



*Figure 1*

*General scheme of modules for administrative routines in a company. These can also be grouped in Manufacturing Planning and Control system (rectangles) and other adjacent systems (ovals). The model is developed from a model suggested by Olhager & Rapp (1985).*

In the pilot company it was chosen not to cover all modules in figure 1 but to focus on production supporting modules i.e. rectangular ones concerning manufacturing planning and control and also maintenance and quality assurance. The company regards the other routines as sufficient and with limited connection to the production supporting routines which were considered more important.

When the list was made it was also taken into consideration experiences from studies at the reference companies.

The list groups demands for functions within each module and has a defined priority for each function.

Some important modules are:

- **Basic data**  
The Basic data module consist of quite static information where the company is described by what can be done and where (operations and cost centers). It also contains lists of customers and suppliers and also several sorting concepts for use in the follow-up modules.
- **Precalculation/Quotations**  
The module contains all necessary functions to make, sort and follow up quotations. Precalculations can be made by using earlier orders, earlier precalculations, product models or by using the prices of single operations.
- **Orders**  
The module contains all necessary functions to define, sort and follow up orders. Orders can be made from an earlier order, precalculations, product models or by using single operations.
- **Production reporting**  
The module contains routines for data acquisition from the production. If possible, data shall be acquired automatically directly at the source. Thus the system should support the IFRAtrack standard (Fällström, 1997).
- **Status follow-up**  
The module contains routines to follow the status of the production's progress for an order.

There are also general requirements on the system concerning hardware, software, database, system administration and security. There are also requirements on customers use of the system, i.e. customers of the pilot company, who shall be able to use the system and get access to data concerning their quotations and orders including making quotations, place orders and follow status of orders.

### Comparison with other work

The corresponding project in Norway is performed by the national graphic arts trade organization and has resulted in a requirements list. It has in our opinion lot of good content but many things are missing. The list also mixes demands on technical functionality in the system and demands on the future users of the system (include reference). In our work we have separated the system functionality specification from the specification of how it will be used in the company and described this in different documents. This gives the possibility to develop the requirement specification into a more generally useable tool, not tied to one company's working practice.

The project in Denmark is performed by national graphic arts trade organization in cooperation with the national center for research and higher education in graphic arts technology. This project started later than ours and we have only been able to study project plans. The project aims at the making of a requirements list and also an education package around it.

### Company culture – a missing factor ?

The research carried out in the six companies shows: a) how things can go wrong when the functions of the system are used for other purposes than those they are meant for, and b) the company's culture should be considered more seriously in order to successfully choose, buy and implement a production management system.

The case companies belong in either or both of the following categories:  
A. Have experience from the use of an information system(s), and / or  
B. Have described their need for a production management system

The results focus on real problem areas, which are expected to be treated through a production management system.

The results are described below:

- In a company where communication problems occur, there is a tendency to overcome them with a new production management system. The communication problems have been seen as results of lack of information concerning production's activities and because of wrong information transferred from one department to the other and/or from one person to the other. Even if monitors will be used to display the production workflow, it will not wipe out the communication problems. It might contribute to the solution of the problem but the solution has to be sought through the personnel's relationships. Company's culture and status quo have to change. The relationships have to be reconsidered and rebuilt on different basis. In this new environment the new system should fit in.
- When there is a gap between "them – top management" and "us – production crew" the relationship can not be healthy. The purchase of a production management system has, in this case, been suggested as a tool for the production team. The system is supposed to set some working standards according to production people's preferences. This would cause obstacles if a top management decision will affect

the production. The real problem is the communication between "them" and "us". The contribution of the future system in the solution of this problem is doubtful.

- The production management system, that is decided to be bought, is expected to track sufficient information from the production process in order to give reports. The reports are needed because the company has recently changed owners and has been listed on the stock market. This fact changes many traditional routines of the company and causes personnel's reactions. All the activities of the company have now to become transparent and be exposed to the public. The personnel has difficulties with this. They react and they see the future production management system as the medium which will expose their work to the outside world. Their working way has to be reconsidered and the new production management system appears as an obligation that they can not avoid.
- Partial utilization of the production management system is not sufficient enough for the company's management. The reason for the partial utilization is that the personnel does not find it necessary to work outside of what they consider as their predetermined duty area. This is a result caused because of: lack of interest, lack of enthusiasm and lack of motivation. The managers do not get the information they want, and find the existing system inefficient. So they come out with the solution to buy a new production management system instead.
- The production management system in has been developed throughout the history of the company. Thus, it belongs to the old tradition of the company. The new employees who have joined the company, want a system, which they can totally understand how it operates. The new system should be free from the old system's tradition. The existing system has been built for many years within the company and has been developed during the progress of the company. In addition, it is connected with all the other systems in the company. This makes it difficult for the production management system to be accepted by the new employees of the company. The problem in this case is the "new culture against the old". The new system, no matter which one it will be, will not work unless everybody likes it.
- The information system used, in another case company, offers to its users only the information they need for their job. The fact that the

personnel can not have access to the whole overview of the job they undertake affects them. Their reaction is that “they – managers” do not trust “us – personnel”. This situation influences the personnel’s work. They are interested to follow up the whole production process of the job they undertake, but the information system they use, has limited abilities.

- The personnel in one case company has developed team work mechanisms which perform smoothly. They all participate in meetings and contribute in decisions made. They express their opinions, they come up with suggestions and they feel free to offer potential solutions. These cultural characteristics have been cultivated throughout many years and it is considered as something that could not have been done in any other way. Thus, team work is not considered by them as something special. But, this strong point of theirs should be used when they require a production management system. A system which changes the existing way of work and cooperation between the people would decrease productivity rather than improving the performance of the company.

### Conclusion

From our experience of this work we have concluded the following:

- The increasing number of production management systems to choose from on the market indicates even more the need for companies to have competence to specify requirements for systems and how they best can be used in their organization.
- A well defined strategy and business concept is needed. (Berry & Hill, 1992)(Handberg et al, 1998)
- To establish the technical functionality of the system is only one part of the implementation. Effort must also be made to implement routines concerning what tasks in the system that shall be carried out at different organizational positions.

The implementation of a management support system is an ongoing process of preparing the organization for the new system and introducing it in such a way as to help ensure its success. The users must be involved in every phase of the development, while management support is crucial, and the experts must be cooperative (Turban & Aronson, 1998).

- If a company does not have earlier experience from this kind of information systems, common conceptions and terminology must be established. At many companies there exist differences in terminology, especially where there has not been very much communication between departments. This process can take long time and could delay the implementation of the system if it is not handled properly, preferably before the implementation stage. There is otherwise a risk that misunderstandings will give the system a falsely bad reputation as the cause of the problems.
- Within every company cultivates a small society. Everybody and everything as part of it interacts with each other in various ways. There is a dynamic continuous process which should aim in the conscious development and improvement of the organization. In this procedure the leaders/managers highlight the way. Successful organizations have managed to gear their crew in this joint effort. From such companies we learned how they did it. Their success is a gathering of many parameters which are enrolled tightly but smoothly. Every activity that takes place in this society touches upon its culture. Therefore "company's environment", "organizational milieu" or "corporate culture" is of crucial importance. Enthusiasm, motivation, responsibility, nice performance should be characteristics of its members. Ongoing discussions, meetings and rewards should be promoted in a way in which they can encourage the active participation of the personnel.

#### Discussion

It seems like there often is a lack of integration between administrative (financial) needs and production management needs when investment in a production management system is made. The general impression we have gathered is that the top management (with a financial aspect of the company) wants to have information collected from the production in order to make different kinds of financial reports and statistics. This triggers the company to investigate the possibilities to introduce a production management system, a management information system or a similar kind of system. Since the initiative comes from the financial part of the company and not from production, the projects tend to be biased towards the financial side rather than towards the production side. People in the production get less motivated to use the system and the possibilities with the system are not fully utilized. The quality of the information gathered in the production may also be affected by this, since the operators do



not understand why they need to collect the information from the shop floor. It easily turns into a blue collar vs. white collar situation.

The naming of the different kinds of systems and the definition of them is a real problem. There are many terms in use to describe similar systems; Management Information System, Decision Support System, Management Support System, Information System, Management System, Business System, Computer System, Production Tracking System, Enterprise Resource Planning, etc. As the systems today cover a wide spectrum of functionality the borders between different kinds get blurred. It seems like there is a difference between what they are referred to depending on their source application type - the basis they once where developed from. Nowadays they might have more or less the same functionality although with a different approach but have different definitions. The suppliers also approach the market with what they think a user may need, naming the system thereafter. A further study of this matter and a definition of different kinds of systems would be helpful to the industry. Applying the discussion above with who makes the decisions about the purchase of such a system, the situation can become even more confused in the implementation and running phases.

#### A future generic requirements list

In a future generic requirements list, more parts from figure 1 shall be included following the trend in several industries to integrate all systems (financial, production supporting, project planning etc) within companies. A term that is more and more often used for these fully integrated systems is ERP, Enterprise Resource Planning. This will also be a likely development in the graphic arts industry and already some system suppliers offers these kinds of systems.

Since the pilot company is a book bindery, some matters will have to be considered before defining generic requirements for all graphic arts industry. In prepress companies there is another granularity to consider where the system will have to handle also parts of pages (text, images, ads etc).

In print shops there are also differences. There is more material handling with paper and ink and there is also a difference between sheet fed and web fed printing where in the web fed situation the paper reels will have to be handled and reported separately.

## Acknowledgements

This project has been carried out in Sweden with the support from "The Swedish Graphic Companies' Federation" and the Swedish government (NUTEK) in addition to the studied companies. We thank everybody for their commitment and their support throughout our research.

We would also like to thank all the companies which have actively been involved and engaged in this effort of ours, through all the people who have been interviewed and let us come close to them.

We would finally take the opportunity to thank our supervisor Prof. Nils Enlund, who has actively been involved in the project and has inspired us and offered his guidance.

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