MODELLING OF PRODUCTION MANAGEMENT SOLUTIONS: TidSim NEWSPAPER PRODUCTION SIMULATOR

Stig Nordqvist*, Johan Stenberg*, Simo Karttunen**

Keywords: Integration, Newspaper production, Simulation, Systems design, Object-Oriented Design (OOD).

Abstract: Simulation is a computerized modelling tool which can be applied to describe the production activities, resources, and timing, in for instance newspaper production. The topic of our project, production management systems (PMS), is a new concept in print media research. Simulation is a promising method for defining processes, variables and models and for testing complex effects over the whole production chain. The TidSim simulator was developed to cover the central production stages, to incorporate essential activities in the job flow and resourcing, and to perform monitoring, scheduling, product structuring, and some management functions. The first of the earliest results are here reported. Three key topic areas have been tested: a) Global information interchange with a five window module, b) The effects of newspaper physical structure and press configurations, c) Prepress back-end and scheduling. The work with the TidSim simulator system, concept and its coming successor systems continues. We follow up the penetration of local PMS-modules and functions in the numerous commercial production systems. Since it is an object-oriented system, this simulator is a flexible method of approaching real production management modules and systems.

INTRODUCTION

When our project "Future Newspaper Production" was planned and started in late 1991, there was almost no reported or ongoing research within the scope which we defined for the project: the global or plant-wide production management systems (PMS). Under this topic, we include all production stages, i.e. the whole production chain in newspaper production (the most time-critical production),

* Royal Institute of Technology, Division of Graphic Arts Technology, Stockholm, Sweden (stign@gt.kth.se and johans@gt.kth.se).

** VTT Information Technology, Helsinki, Finland (Simo.Karttunen@vtt.fi).

modular systems approach, utilization by open systems, and a hypothesis that an essentially improved production management will lead to higher flexibility and competitiveness. The goals and concepts of the project have been presented in several recent publications of its members [Karttunen, Nordqvist and Stenberg 1992, 1993] – all within a time span of two years (1992-94). The five goals set in the first report [Nordqvist and Stenberg 1992] were as follows:

- Effective utilization of resources.
- Flexible production.
- Improved quality.
- Decision support.
- Support regarding follow up and analysis.

Although these five goals are very general and equally important, we feel that the first, i.e. utilization of resources and flexibility, are perhaps the most concrete. The total quality concept can be combined with the improved production [Karttunen 1993, 1992]. Which comes first may vary in the practical case of a publisher. Total quality management, TQM, and certificates (e.g. ISO 9000) can be reached more easily with efficient PMS. Organizational and operational quality must include the production management aspects and its systematics, the PMS. The last two goals call for support to decision making and business analysis. PMS can certainly produce data for business management and decisions are needed for capitalising the benefits: efficiency, flexibility and quality.

In one of the papers [Stenberg 1993] we listed and discussed the methods used in this project. Production stages from prepress, or even from prepublishing operations, to the mailroom and distribution are included. Systematic Description of Activities (SDA) has been used for detailed mapping, analysis and structuring of the production chain [Nordqvist 1993b] in our case-companies. Additional information about production practises and existing production systems has been collected and mapped through numerous visits, discussions, exhibitions, meetings, and conferences. Our second main method, simulation, and our system TidSim are reported in this paper. It is important to understand that in the simulation, particularly the data concerning products and processes comes from the newspaper companies where SDA was utilized to map their processes and problems.

In our project we are beginning to synthesize our results to give useful concepts in the system design of PMS modules and integration and in the use of PMS in daily newspaper production. Simulation gives us an unlimited spectrum of variation possibilities to set product and resource parameters. We have to limit our work to

the most relevant modelling methods and we expect that TidSim, including its later versions, will give us the possibility to define real global PMS modules as well as enhance local PMS solutions and their functionality.

In computer integrated manufacturing (CIM), there are many systematic modelling methods which have been reviewed by various expert groups [Scheer 1991, Azari 1993 and n.n. 1993]. Many such approaches will improve the manufacturing of modern products. The characteristics of newspaper production are however fairly unique with three specialities:

- Mixed type of sub-processes – very information-intensive image and prepress operation, batch-process-like printing, and post-press mechanical assembly, packaging and materials handling.
- Time-critical production with parallel planning and implementing sessions until the product is completed – the stage of ready pages, exposed films and plates which have to be final and faultless.
- Two interlocked products, advertising and editorial material, both setting hard and different requirements with regard to the basic material, customer satisfaction and level of service.

Therefore we think that simulation gives the best possibility to adapt the models to the processes. As we have earlier been pointing out, the prepress back-end is driven by the commands of the design workstations – where at the same time the last changes can be made. The creative design, decision making and process commanding meet here, and only for a few minutes. The RIP, film recorder, and plate making lines are a genuine bottleneck. Any serious delays occurring as early as then in the plate making may have costly effects in delayed distribution, even if the printing and mailroom work normally.

Another direction of great potential to PMS is naturally the developments in the infrastructure of data processing. Data management in networks, databases, groupware, image systems, Open Prepress Interface (OPI), media managers, communication and production servers, and in the final output has been developing side by side with an enormous increase in the capacities of workstations, memory media and networks. Many prepress vendors will apply – some of them are already starting to do so – new data management concepts to build more functional, integrated and open system architectures. Data management is a vital part of any production management system.

THE TidSim CONCEPT – SYSTEM DESCRIPTION

This chapter briefly explains the technical aspects of the software system TidSim. We wanted a system that , on an overall level, could simulate the production process of a newspaper. The system uses real data from our co-operating newspapers and from work with other newspapers as well. The data relating to each newspaper is contained in a set of thirteen Excel data files. Each test session can be logged and saved, with respect to time and function. The system relies on: modular structure, client/server-architecture, time control, log capabilities, and covers the whole production process.

Development environment

The client/server principle (figure 1): The client/server concept is used in this application as follows. A central unit (server) collects and compiles the information of the whole system. This unit is connected to several other units (clients) who can view information from the server. A client can send a request to the server and confirm that its task is allowed in relation to the behaviour of other clients.

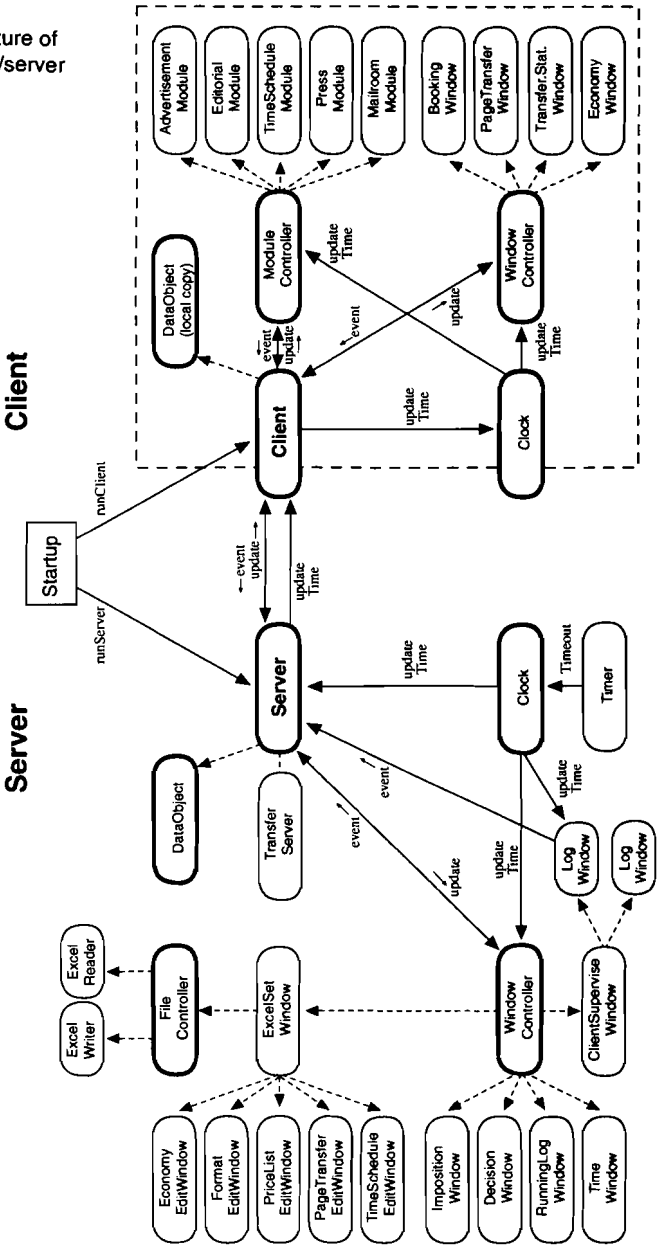
Object-Oriented Programming (OOP) was used to define different object classes. An object class can be seen as a data structure with functions which perform operations on given variables. The object itself is viewed only as a unit that receives variables and performs a given task. This allows a better programming environment and a better program structure than other programming languages. This is achieved by a father-son relation ship – the mechanism of inheritance. By building an object so that it uses other objects to perform its task, the system becomes modular and the need to rewrite code in different parts of the program is eliminated.

The development environment was NEXTSTEP on Intel 486 hardware. It is a Mach UNIX dialect and is totally object-oriented, since development environment Objective-C and a package of tools have been used. The disadvantage of NEXT-STEP is that it is a relatively unknown OS. The advantage is that it is a very powerful development OS and development platform, especially for the purpose of building prototypes. Some tools have been especially useful, e.g., Distributed Objects which allows us to create a client/server solution and the Interface Builder for the easy buildup of user interfaces.

Logical structure of TidSim client/server model

The design of TidSim is based on our studies of newspaper production using a method called systematic description of activities (SDA) with activity graphs.

Figure 1:
Logical structure of
TidSim client/server
model.



An earlier report [Nordqvist 1993b] shows how SDA enabled us to create data for TidSim and, at the same time, to build models and concepts for simulation. To use the system, three steps are required– A) parameter setup, B) server definition and C) usage (simulation) in the client/server mode. The user interfaces incorporate these steps (A, B, C) as follows:

- Set-up window (A).
- Excel file editor and selector (A).
- Content format vs. press configuration decision window (A, B).
- Time control window (B, C).
- Imposition window (C).
- Log window (B).
- Client inspector (B).
- The global client view module with a five window-selection (C): priority scheduling and page status, advertising booking, editorial booking, press key figures, distribution vs. delay-cost.
- Client help windows (C): editorial and advertising booking page inspector (page and section level), RIP – to – press control, page film status and global unit cost window.

The core of the global PMS systems – to give the users on-demand and relevant information regarding the production process on demand to the users is achieved in TidSim with two types of user interfaces – windows and modules. Windows are examples of functions in the local systems that are simulated in TidSim. They must be included to enable the simulator to be run on a global level. These are, e.g., page transfer, advertising and editorial booking. Modules, as in the global client view module, perform as a set of global information user interfaces.

The logical relation between objects in TidSim is shown in figure 1, a conceptual model of TidSim, simplified but still with the core relations. The figure shows the server to the left and the client objects to the right. In the middle are the time-related objects that control events in the server and connect all clients at the same time.

The idea is to run the client software in the background on all PC's, Macs and Workstations involved in the production. The program is activated whenever a user needs information about the status of the production or would like to simulate the effects of a certain decision.

USE OF TIDSIM – THREE KEY FUNCTIONS

This chapter describes the global client view module, which allows users to obtain a plant-wide software view of the production, and the tools for decision support. It provides deeper information concerning two of the basic functions in the TidSim system: (a) the link between the physical structure and the press configuration and (b) the link which controls the status and predicts the time span from ready pages to the plate-in-press stage.

The global client view module

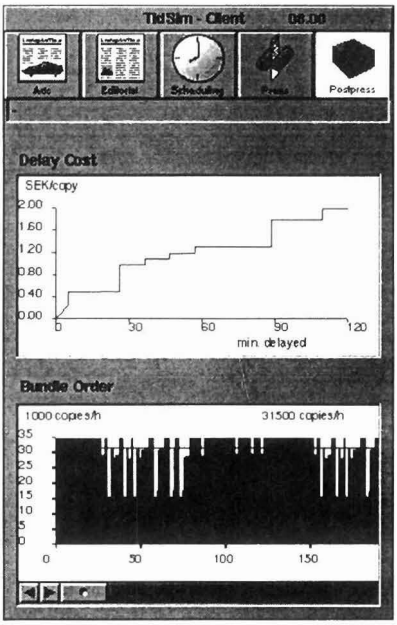
The resource and time-critical production must be supported by large quantities of freshly processed information if the goals – editorial quality, technical quality, delivery service and economics – are to be successfully attained.

The global TidSim system acts as a glue between the different production stages in order to optimize the total results of the newspaper production process. It also combines and manages the different criteria that have to be considered when a decision is to be made. These criteria may be the overall effects on resources, time, income and expenditure of certain decisions. An economy help window (see figure 1) monitors a short income/cost comparison for the staff members. The client/server model of TidSim makes it possible to distribute information in a proper manner. The modular structure is very important and makes the system flexible. In a real version, every department will run its local PMS which will interact with the global PMS as well as with other local systems.

The global information interchange in the TidSim version discussed here includes five modules (window 1-5): (1) Advertising, (2) editorial, (3) priority schedules and page status, (4) printing and (5) postpress production. Each module works as an information filter to the local subsystems, in our case Excel data files, and collects data relevant to the overall process.

To obtain the most essential information from the different modules, the user simply clicks on the related icon. Key figures and graphs are shown and, if the user requires more information, help windows can be activated.

1. **The advertising module** includes text, graphs and key-figures presenting the status of the different page elements. The physical size, economy, number of colours and the data volume are presented for each object.
2. **The editorial module** is very similar to the advertising module and allows booking and tracking of page elements. The physical size, number of colours and the data volume are shown for each object.



3. The scheduling module monitors priority and deadlines, and acts as a page-tracking system. The module lists the number of pages ready in the different priority groups. It is also possible to see the total volume of data on each page (in megabytes, MB). This figure is originally estimated from statistics and rules, but when the different elements are paginated the amount of data is recalculated and the approximation becomes progressively more accurate.

4. The printing module includes information about the estimated production time in the printing press and shows the estimated consumption of paper in different grades. It also maps the levels in the paper stock.

Figure 2: User interface from the global client view module, here the postpress module with mailroom and distribution.

5. The postpress module includes information about the estimated production run in the mailroom and the costs for the distribution, see Figure 2. All data are related to the estimated production time and paper consumption. The values given are related to statistics from earlier production under the same circumstances.

Physical structure and press configuration of the newspaper

This is a function that supports the decision makers in the editorial department with more information as to how different structures of the newspaper will affect the production run in the printing press. The function collects data from the press control system, prepares the data and distributes the information to the advertising and editorial modules. Information about possible configurations in the printing press, the estimated amount of waste for the chosen configuration, estimated press speeds and estimated total costs for the production run provide decision support in the planning of the physical structure of the newspaper, see Figure 3.

When the advertising booking starts, a preliminary number of pages has been chosen. In large presses, the number of possible press configurations is high and

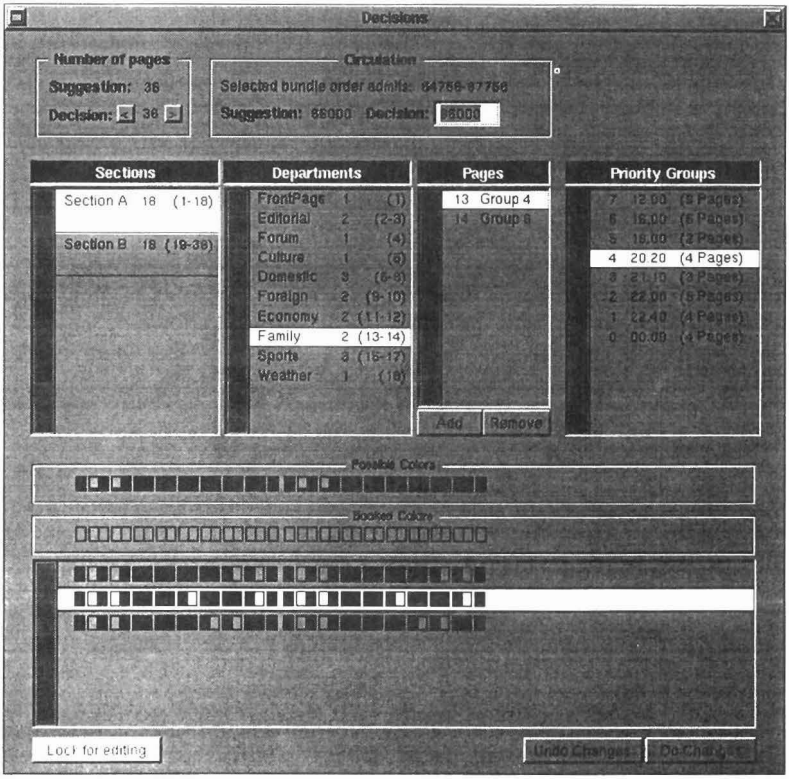


Figure 3: User interface from the decision window where newspaper physical structure and press configuration are set.

depends on the number of webs and colours and on the equipment in the printing press. Restrictions regarding some configurations might decrease the number of configurations compared to the theoretical figure. As the advertising booking continues, the number of possible press configurations is gradually reduced as a result of the increasing volume of the newspaper and colour advertising on certain pages.

The information is presented in a window that gives an overview of the possible options concerning one-, two- and four-colour pages in relation to the chosen number of pages. If the number of pages is changed, TidSim recalculates all the figures to relate the chosen number of pages to new options of press configurations and related production figures.

Prepress back-end and scheduling

The main objective of the prepress back-end and scheduling function is to control the production and harmonize the flow from the transmission of the ready pages to the press start.

The status and weight of each ready page is controlled in the priority scheduling and page status module. It is also possible with this module to decide to transfer pages to the printing plant from. The pages may be sent manually or automatically based on a page transmission schedule. When a page has been transferred to the printing plant, a cross (checkmark) appears to indicate that the page has left the queuing server, see Figure 4.

It is now possible to track the pages through the different stages between the page transmission and printing. A help window indicates where the pages are in the chain of page transmission: WAN, RIP, film recorder, developer, plate making and plate-to-press. The help window can handle parallel processing and shows whether a page has been put in a queue. The simulation is based on controllable capacity parameters in page transmission, raster image processing, film exposure and plate making.

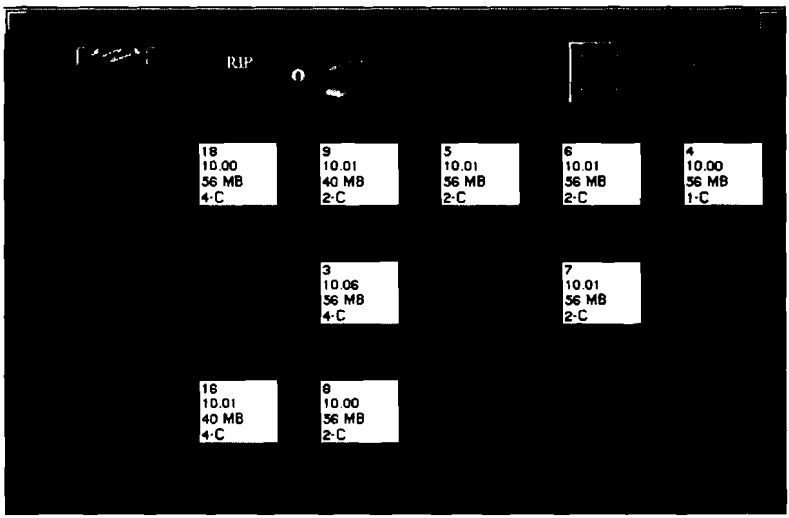


Figure 4: User interface from the prepress back-end monitoring.

EVALUATION OF THE THREE KEY FUNCTIONS

This chapter presents a limited set of results from the evaluation of TidSim. During the spring, a number of user groups have evaluated the simulator. The groups have included newspaper executives, journalists, technicians, system vendors and researchers in graphic arts technology and production systems. The number of test persons and the volumes run have so far not been very high.

In this report, we focus on reporting the three key functions described. The test persons have been introduced to the TidSim concept and system, and some of the persons have also practised working with the simulator. After each session, the test persons have evaluated the concept and the system in a questionnaire with questions to answer and the possibility of writing further comments. The following chapter is a summary of this investigation.

Test: The global client view module

In the test, a set of questions where asked. The test persons had to rate their answers as:

(– –) very bad/almost nothing.
(–) relatively bad/not much.
(+) relatively good/relatively much.
(+ +) very good/almost everything

The results are summarized in Figure 5.

1. User Interface – what do you think about the use of symbols, text and colour?
2. Are the included modules the most relevant for a global system?
3. Is there any IT-support for global data-collection, processing and presentation of production information in newspapers today?
4. Is there any need for a dynamic global planning, control, tracking and reporting?
5. Is there a need for global IT-support in future newspaper production?

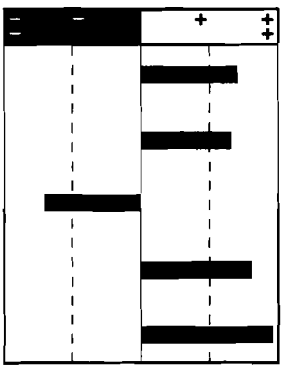


Figure 5: Results from the evaluation of "The global client view module".

The evaluation of this function also included the following comments:

- "The idea of having a compact module available at all times in most personal computers in the organization is good."
- "There have been attempts to build management information systems (MIS) or so-called executive information systems (EIS). Neither has yet been successfully implemented. It seems possible to include such functionality as an additional module over the global PMS."
- "Extend the functionality to cover alternative distribution solutions, e.g. on-line, fax-, and CD ROM-publishing."
- "The need for this kind of global approach will increase with the use of multiple distribution media."

Test: Newspaper physical structure and press configuration

The results are shown in Figure 6.

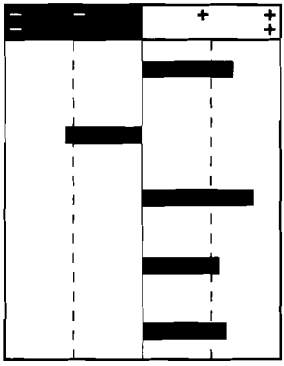


Figure 6: Results from evaluation of "Newspaper physical structure and press configuration".

The evaluation of this function also included the following user comments:

- "By connecting information from the press control system to the editorial or advertising booking system, it might be possible to use this function on a global level today."
- "Similar functionality can be found in existing heterogeneous local systems (e.g. press control systems and advertising booking systems), but they are not connected to each other in a dynamic manner."

Comments by the authors: The need has increased since many modern presses have been installed with the possibility of combining colour webs in a number of different ways. So far many newspapers are using their extensive colour possibilities quite poorly. The work of defining product models and their characteristics is very important. Different product models must be developed to act as support for the planning.

Test: Prepress back-end and scheduling

The results are shown in Figure 7.

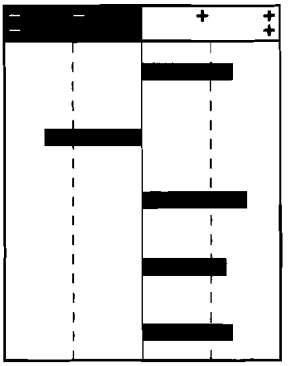


Figure 7: Results from evaluation of "Prepress back-end and scheduling".

Comments by the authors: The newspaper production tends today to be separated into two physical and organizational processes – prepress and printing. These two production steps are geographically separated, and the connecting link is often merely a communication link (wide area network, WAN). With respect to the production, it is often referred to as a black hole where material is misplaced, delayed or stuck. This is closely related to the scheduling of pages at editorial and advertising production level.

The investigation indicates that much can be done in the area of functionality. Concepts such as dynamic scheduling, decision support given by expert systems, simulation, workflow control and just-in-time delivery will become increasingly important in the near future. Due to the digital prepress production, there is a need for an overview window which covers the status of all pages in the product.

CONCLUSIONS

The results from the last questionnaire are summarized in Figure 8.

16. What do you think of the client/server solution in this kind of global system tool?

17. What do you think of this kind of modular software?

18. Do you think it is possible to integrate global-PMS (as TidSim-concept) with existing local production systems of today?

19. Will the users in the future manage to do their own integration of global systems?

20. How mature is the industry with respect to utilization of IT in this kind of system?

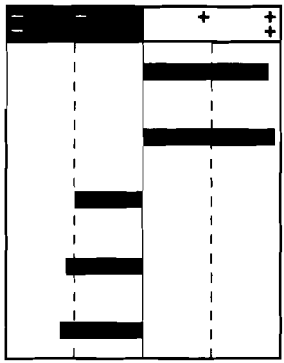


Figure 8: Results from evaluation of the overall concept of TidSim.

Conclusions by the authors

- The interest in global PMS is there, but the organization is in nature inert. Nevertheless, a few pioneers develop advanced production monitoring systems. The bigger the organization, the bigger the need.
- A basic problem is the lack of understanding of the whole process at all levels in the organizations. A global PMS system approach cannot succeed before the users have identified the global processes. Before global management can be implemented in an existing organization, the production process in that specific organization must be mapped, analysed, optimized and reorganized. This work serves also as a foundation, e.g., for the introduction of new organizational or process structures.
- Education and changed work-profiles will lead to better possibilities of achieving in-house integration in the future. Costs related to this education can be extensive.
- TidSim itself serves well as a system for education and research. The TidSim system allows people involved in the creation of newspapers better to understand how the product is produced and distributed. They can, without any risk, explore how different actions affect the overall result with regard to time, quality and costs. TidSim as a research system allows us to, e.g., test new productions models and evaluate resource allocation. We can also use the TidSim system to develop models and methods for global PMS.
- The PMS-concept will be needed in the future when more alternative distribution media are available, i.e. there are more deadlines to meet and more time-critical decisions to make on economically tighter markets.

- There is a need for developing Production Management Systems both on a local and global level. Models and methods concerning monitoring, planning, control, management and decision support of the overall production process must also be defined.
- Design of user interfaces, i.e. text, symbols, choice of colours and sound, is crucial, especially for warning and triggering functions in time-critical situations. Scientific research is needed to develop user interfaces and models for man-machine interface. The distributed information must be zoned and optimized. The right information must reach the right user at the right time.
- A number of evolutionary steps must be taken both in the design and in the implementation of local and global PMSs. The local subsystems of today are heterogeneous. Running this kind of system in a flexible and cost-effective manner demands standardization and open system architecture. If not, changes in the organizational structure will lead to extensive re-engineering.
- The rapid development of operating systems and shrink-wrap software packages indicates that the functionality is becoming even more advanced and open. This means that in the near future it may be possible to exchange, prepare and present data between different operating platforms and shrink-wrap software. Related to global PMS, this technology may be used to create the user interfaces and to some extent the functionality of the clients. The most difficult task will be to define the functionality, to optimize and coordinate data exchange and to organize the underlying database structures at the server level.

Our work will continue towards developing optimal global control methods in newspaper production. The work with TidSim will continue and will include further testing and analysis. To create a more homogeneous system, we intend to develop the press and postpress modules. This will lead to a more unified system with all modules at the same level of functionality. The improved version will be used as an educational system.

ACKNOWLEDGEMENTS

The authors wish to thank the companies involved, the Swedish newspapers, Göteborgs-Posten and Östgöta Correspondenten, and Computer AB (NEXTSTEP), Compaq and DEC. We also extend our gratitude to the two objective-C code producers; Fredrik Fällström and Thomas Petersson (Fällström and Petersson 1994) at the Royal Institute of Technology in Stockholm, Sweden.

LITERATURE CITED

Azari, M.
1993 "Manufacturing Systems Engineering". Doctoral Thesis at the KTH Dept. of Production Systems. Stockholm, Sweden.

Fekete, M., Kihl, L., Nordqvist, S. and Stenberg, J.
1993 "Integrated production systems for the graphic arts industry". 45th Annual TAGA Conference, Proceedings. Minneapolis, p. 414-431.

Fällström, F. and Petersson, T.
1994 "Implementering och design av mjukvarusimulator för tidningsproduktion". System documentation and MS thesis report (in Swedish). KTH NADA. January, Stockholm, Sweden.

Karttunen, S.
1993 "Production and Production Management Systems (PMS) for Publishing and Printing". Graphic Arts in Finland vol. 22, nr 3, p. 3-10.

Karttunen, S.
1992 "Integrating Organisation, Quality and Production Concepts of Newspapers: the Fifth Wave". Paper presented at the IARIGAI Management Conference. September, Rome, Italy.

n.n.
1993 "Evaluation report for constructs for views according to ENV 40003". CEN CENELEC Expert Group. Brussels.

Nordqvist, S. and Enlund, N.
1993a "Global Production Management: Integrating the Systems in Prepress, Press and Postpress". 22nd IARIGAI Conference. Munich, Germany, pp. 15.

Nordqvist, S.
1993b "Work Flow and System Parameters in Prepress Production". 45th Annual TAGA Conference, Proceedings. Minneapolis, p. 1 - 19.

Nordqvist, S. and Stenberg, J.
1992 "Ideas about organisation and production in the fifth wave". (Sandefjord, Norway). Paper at NORDLAB Tekst&Bild '92, KTH – Div. of Graphic Arts Technology, 40 pp.

Scheer, A-W.
1991 "CIM: Computer Integrated Manufacturing : Towards the Factory of the Future". 2nd Ed. Springer Verlag, Germany.

Stenberg, J. and Karttunen, S.
1993 "Systems Integration in Newspaper Printing: The Goals and the Tools". 22th IARIGAI Conference, Munich, Germany, pp. 17.

Sundman, D.
1993 "Distributed Algorithms for a Crash-Proof Mailroom". 22nd IARIGAI Conference. Munich, Germany, pp. 13.