WORKFLOW MANAGEMENT AND DECISION SUPPORT IN A DIGITAL ENVIRONMENT – AN IFRATRACK-BASED PROTOTYPE IN REAL PRODUCTION

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Abstract: During 1997 a prototype of a global production management system was installed at the Swedish daily newspaper Östgöta Correspondenten. The Intranet-based business wide system is now in daily use and covers the entire workflow - from the planning of the product and the production to the delivery of the newspaper copies. Several key activities and workflows in three different companies are linked to the same global production management system (GPMS).

The IFRAtrack recommendation has been used in order to create standardised communication links. The production database and a file system with history data are linked to a web-server and the client software is mainly based on Java-technology. The GPMS co-ordinates the product, production and distribution planning, and tracks the production status of the different workflows in real time. The tracking data is used for decision support and in order to perform risk analyses and prognoses of delays.

The implementation of the prototype was a complex task. The organisation was not used to global thinking, and the new IFRAtrack and Intranet based solution was not fully compatible with the old systems. The use of the GPMS has led to several changes at Östgöta Correspondenten. The knowledge and understanding of the overall production process has increased. Decisions can be based on facts from a global point of view. The co-ordination of the different activities and workflows has been improved. New methods for developing fault tolerant production and distribution plans are used.

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INTRODUCTION

Background

Competitive products, efficient utilisation of resources and good customer service are necessities in the modern society. Newspaper publishing is no exception, but an obstructing condition is that newspaper publishing consists of two disparate activities – journalistic creative and investigative reporting and market oriented sales of advertisements and circulation.

The prepress production has, due to open systems, de facto standards and increased capacity, become almost totally digital [Juhola et al. 1992], [Enlund et al. 1994]. The digital prepress production and the development of standardised network protocols and reasonably priced high speed communication, facilitates distributed printing – the location of the printing plant can be more flexible [Stenberg 1997].

The technology in the printing plants has also undergone a radical change due to the developments in information technology. Some examples are new automation technologies and improved control systems in printing presses and mailrooms [Karttunen 1993], [Karttunen 1994], [Fuchs 1995].

Altogether, the new tools mean new conditions for newspaper publishing. The technology can be used to make the production less resource consuming and more flexible and to support improved quality of the products.

The present infrastructure – in terms of networks, databases and computers – can be an important factor in order to create a better controlled and more flexible production environment. The openness of the systems can be used to bridge the former system islands and to enable inter system communication and use of global production management systems (GPMS). The main objectives of the GPMS are to increase the flexibility and productivity [Alasuvanto et al. 1994], [Nordqvist et al. 1993], [Nordqvist 1996], [Stenberg 1997].

The systems can be used for tracking, scheduling and controlling on a global level. A GPMS collects and refines information from the subsystems and serves the overall organisation with information regarding schedules, status information, decision support and reports [Enlund 1994], [Nordqvist 1996], [Stenberg 1997], [Fällström 1997].

This paper presents the results from a research project carried out at KTH during 1995 to 1997. A research group including people specialised in production engineering and computer science has designed and developed a prototype-system of a GPMS.

The Big Brother project

In 1992, a number of researchers at KTH started to design TidSim, a stand-alone simulator of a business-wide production management system for newspaper production. The simulator was focused on workflow management and was developed in an object-oriented environment. A number of key activities in the newspaper production process were included in the simulator – from edition design to distribution [Fällström et al. 1994], [Nordqvist et al. 1994].

A project titled Big Brother was formed during 1994, and in the beginning of 1995 the project work started. A number of objectives were defined for the Big Brother project:

- Publishing of articles, reports and academic papers.
- Examination of researchers for the degree of Licentiate of Technology and Ph.D.
- Development of new methods for global production management.
- Development of a prototype system installed in a real production environment.
- Exchange of knowledge between industry and academic world.

The research project has, in addition to the research group at KTH, involved and been funded by the six Swedish newspaper companies Expressen, Göteborgs-Posten, Nerikes Allehanda, Pressens Morgontjänst, Svenska Dagbladet, Östgöta Correspondenten, as well as by the Swedish Newspaper Publishers' Association. The work has partly been funded by the Swedish government through NUTEK, and hardware and software have been supplied by Apple, IBM, Oracle and Sun Microsystems.

Prior to the TidSim project, the research group included only researchers specialised in graphic arts production and newspaper production. In the TidSim project a group of computer science specialists were involved in the research and during the Big Brother project additional computer science specialists were added to the group. The total budget, excluding hardware and software, has been approximately 5 million Skr (650 000 USD) corresponding to 12 man-years of work.

Focus

The project focused on the design and implementation of a GPMS supporting production and distribution of morning newspapers in the Nordic countries, and especially in Sweden. The situation in this area is somewhat different from the situation in many other countries. There is a number of common and significant conditions:

- The page count and advertisement volume in the products are relatively high – approximately 45% of the column space is covered by advertisements.
- There is wide use of colour in ads and articles.
- The page count is flexible and changes from day to day. The page count is partly determined by the sold advertising volume.
- The infrastructure of the newspapers consists of modern computer networks, open systems based on modern database technology and possibilities to communicate through use of TCP/IP.
- The prepress production is often completely digital and PostScript files or compressed bitmaps are sent to remote printing plants.
- A large share of the circulation is subscribed.
- The home delivery operation is performed by semi-professional carriers and the publishers often guarantee the customers delivery before 6 am.

These factors have influenced the systems design, the applications developed and the functions in the systems [Stenberg 1997]. All workflow analyses have been carried out in regional or national newspapers with several editions and a circulation exceeding 50000 copies per publishing day.

THE DESIGN OF THE PROTOTYPE SYSTEM

Activity analyses

Activity analyses were carried out by the research group already prior to the Big Brother project. The activity analyses were supported by the SDA-method [Boström 1988] and have been reported in [Stenberg 1994] and [Nordqvist 1994].

Additional activity analyses was performed in the pilot company Östgöta Correspondenten during 1995. During the project, activity analyses were also carried out at Svenska Dagbladet, Pressens Morgontjänst,

Expressen and Nerikes Allehanda (still in progress). Altogether, the activity analyses have covered:

- Administrative routines related to production.
- Administrative routines related to distribution.
- Material and information flows within advertising and editorial departments.
- Material and information flows between the publishing house and the remote printing plants.
- Material and information flows within the printing plants.
- Material and information flows related to the distribution operations.

The results of the activity analyses have been approved by the companies involved. The activity analyses made it possible to identify a number of critical parameters. These results were also used in order to define functions in the GPMS.

Data exchange mechanisms

The technical development with respect to e.g. operating systems, computer networks and databases has made inter system communication possible. But there is still a need for a common structure with respect to terminology and information exchange mechanisms.

IFRA has presented a basic model of newspaper production [Fällström 1997]. The model illustrates the newspaper production from a global point of view, and covers the main production stages from ad sales to distribution. The model includes a number of critical process stages: production planning, prepress production, page output and plate making, printing, mailroom operations, and distribution operations. Within every process stage there is a number of production related activities. The activities generate output in terms of objects (ads, images, articles, physical pages, films, etc.).

In the IFRAtrack recommendation, a number of newspaper production related product and process object classes and states have been defined. The state of an object is modified through processes. The IFRAtrack recommendation includes object definitions, semantics, syntax, and suggested message exchange mechanisms.

In the beginning of the project the IFRA 1.0 recommendation was just released. As the objectives of the Big Brother project demanded resource

management, scheduling and decision support, a number of extensions were made.

As the second generation of IFRAtrack (2.0) includes support for resource management, this version of IFRAtrack meets a major part of the requirements with respect to information exchange that has been identified during the development of the prototype [Nordqvist et al. 1998]. In the latter part of the project, full support for the IFRAtrack 2.0 recommendation were implemented.

System design

Already during the development of the TidSim simulator some major decisions were taken regarding the system design. TidSim was object-oriented and developed for the NeXTSTEP environment (Unix). TidSim was client-server based but lacked connections to relational databases.

When the Big Brother project started, many of the ideas from the TidSim project were taken into account. In addition a number of guidelines with respect to the systems were defined:

- Client-server solution.
- Object-oriented applications.
- Modular systems design.
- Platform independence.
- Data stored in a relational database.
- TCP/IP communication.
- All input data in IFRAtrack format.

These guidelines have influenced the system design and the final version of the prototype system meets all these requirements.

IMPLEMENTATION OF PROTOTYPE SYSTEMS

Pre-alfa versions

The first version of the system prototype was developed during 1995. As the local systems at Östgöta Correspondenten were not ready to deliver IFRAtrack messages, and the structure of the system design was not completed, the TidSim was used as IFRAtrack generator [Fällström et al. 1997].

The first version of the prototype used a number of functions in the Oracle 7 environment, including Oracle Power Objects, an Oracle tool allowing development of client applications running on both PC and

Macintosh platforms. Power Objects made it possible to use the same source code for Mac OS and Windows client applications.

In the second version the client applications were re-written using HTML. The use of HTML was a consequence of the development in the area of Internet applications. As a result some applications were run through use of web browsers like Netscape Navigator and Internet Explorer.

The Alfa version

The first version installed and tested in real production was the Alfa version. The Alfa version was installed in real production in November 1996. The IFRAtrack generators were moved into a client application used in the edition design stage and in status reporting applications used at the editorial department and in the printing plant.

The server applications used the information in the IFRAtrack messages in order to update the states of the objects tracked. The objects of the Alfa version lacked deadlines.

The Beta version

In the Beta version a number of client applications were re-written in Java. In addition resource and deadline management were added. Further one difference from the Alfa version, was the introduction of automated links to local production systems, i.e. output systems and systems in the area of the printing and mailroom operations. Also, these systems generated IFRAtrack messages. The Beta version also used web pages for reporting and event driven automatic generation of e-mail reports [Hedin et al. 1997].

The Prototype 1.0

Prototype 1.0 implied that most parts of the system were re-designed in order to improve the performance and facilitate future extensions. The server applications were re-written in Java, and an object server was developed in order to get an object oriented approach through out the complete system. Clients were converted to Java 1.1 and new features in Java 1.1 are used in the new client applications.

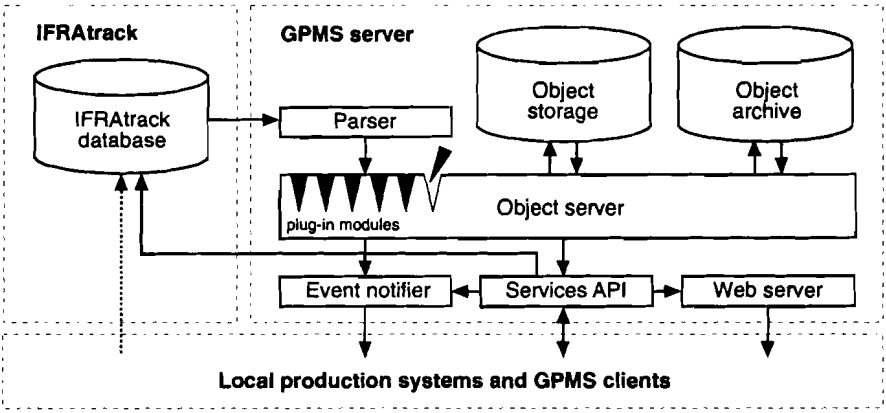

Figure 1: The prototype 1.0 system design.

The archive function is still quite primitive as history data is stored in a file system. In the future history data will be aggregated and stored in a relational database. In addition report generators creating web-reports and reports in i.e. Microsoft Excel format will be developed.

THE INTRODUCTION IN THE ORGANISATION

Product specification and film approval

Initially, a limited number of persons at the editorial department and in the printing plant were involved in the development and influenced the design of the functions and the user interfaces.

The first tests included a format planning client application used in order to define the main products of Östgöta Correspondenten with respect to the sections, the number of pages, the colour configuration, and the editions.

The product definitions were used in order to manually acknowledge the completion of the page make-up at the editorial department and the reception and quality control of the corresponding films in the remote printing plant.

During a relatively short test period the related client and server applications were fine tuned in order to satisfy the demands with respect to functionality and performance.

Integration of page make-up operations

The introduction of deadlines and resource management was partly a consequence of the need for workflow management during the page make-up operation. The capacity in the subsequent production steps – from PostScript generation to plate mounting in the printing press depends on a number of parameters and includes several bottlenecks. A continuous flow of pages from the editorial department during the page make-up operation is therefore a necessity.

The page make-up was carried out using QuarkXPress with links to the editorial system. The editorial system did not support deadline management with respect to the page make-up operation. This was solved through the development of an XTension to QuarkXPress which made it possible to distribute dedicated deadline information with respect to every person involved in the page make-up and every page. The XTension also includes an IFRAtrack generator which sends IFRAtrack messages on certain pre-defined events.

The trial period for the new routines and the new client software used in the tracking operation at the editorial department covered a period of four months. The technical problems were moderate. Instead, the hardest part was to convince the editorial department that the prototype was created as a tool in order to improve the flexibility and secure the delivery of pages to the printing plant. Furthermore, the system allows the editorial department to make late changes with respect to the different pages, without loosing control in the subsequent steps of the workflow.

The remaining links from local systems are mainly carried out automatically and has worked out smoothly.

The integration of the GPMS and the local production management systems

A number of local systems are linked to the GPMS and sends IFRAtrack messages to the IFRAtrack database. The present installation includes IFRAtrack connections to:

- Product planning.
- Production planning.
- Page make-up.
- Output systems.
- Film quality control.

- Plate making.
- Printing and mailroom operations.
- Truck loading.

The IFRAtrack messages are generated in the local production systems on certain pre-defined events. The delivery to the IFRAtrack database of the GPMS is mainly carried out through use of TCP/IP-sockets.

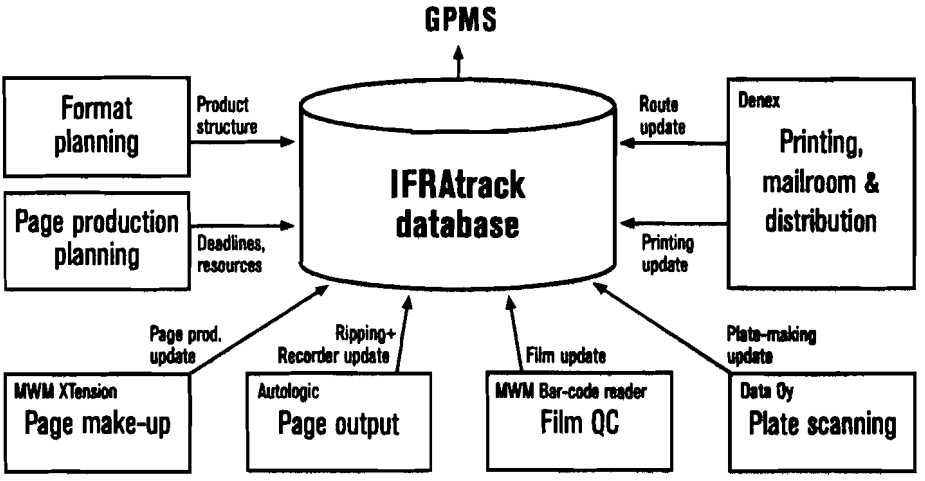

Figure 2: IFRAtrack connections from local systems and dedicated GPMS clients.

External systems from Autologic, Data Engineering Oy, Denex Systems Technology, and XTensions to QuarkXPress generates IFRAtrack messages besides client software specially designed for use with the GPMS.

IFRAtrack messages can also be generated in client software using bar code readers in order to identify bar codes on i.e. films or bundles.

When the existing local systems are replaced at Östgöta Correspondenten, IFRAtrack interfaces are planned to the new circulation system, advertising system, editorial system, and page databases.

THE GPMS IN DAILY OPERATIONS

A functional description of prototype 1.0

The present version of the prototype is focused on "real time" workflow management. The workflow management covers activities three different companies involved in the process:

- The newspaper Östgöta Correspondenten – product specification to PostScript files.
- The printing plant Tryck & Media – PostScript files to prepared bundles.
- The distribution company Tidningstjänst – prepared bundles to truck departure.

The system is prepared to also to visualise the workflow of the distribution and the carrier operations, but at the moment no data can be captured. The status of the different workflows are visualised in the client software based on Java and accessed as stand alone applications or through the Intranet using a browser.

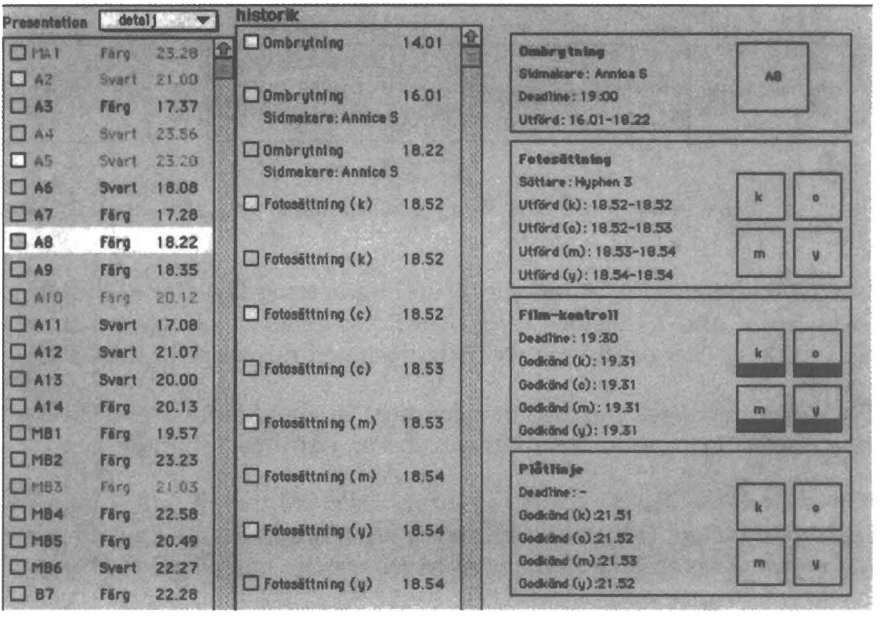

Figure 3: The right column illustrates the workflow a single page (A8) – from page make-up to plate making.

The input to the system starts with the product specification completed just before the page make-up operation starts. All pages are normally linked to a deadline in the production planning operation. The physical pages at Östgöta Correspondenten are linked to seven different deadlines.

IFRAtrack messages are sent from the XTension when the status of a page is changed (In progress, On hold, Completed) during the page make-up operation. Identifiers in terms of PostScript-comments and bar codes are automatically attached to each page.

The rips and typesetters generates IFRAtrack messages as soon as an object is processed. The operation of the plate scanner with respect to IFRAtrack connections is similar.

The printing process at the printing plant of Tryck & Media is continuously tracked. The Denex CopyTrack systems sends IFRAtrack messages with respect to the actual printing job, time information, waste figures, and the number of good copies printed. Also the press speed is monitored. The information is among other things used in order to generate graphs illustrating the number of good copies printed, and waste figures.

The last process tracked is the loading operation. The departure of every truck is tracked as well as the number of copies loaded. Finally, the subsequent distribution and carrier operation is modelled in the GPMS in order to predict late deliveries to the carriers and calculate the delay cost related to every route.

Managing the production and distribution at Östgöta Correspondenten

The present version of the prototype is used on several levels in the organisation at Östgöta Correspondenten. During the production and distribution operations the system is mainly used in order to distribute product information, production plans, status information, as a system generating early warnings, and severing the organisation with decision support information.

The present decision support functionality is based on the visualisation of product structure, the production plan, and the workflow. The production can be re-scheduled according to the normal scheme due to a complex structure of an edition version. Deadlines can also, without loosing control, be changed dynamically during the page make-up, i.e.

in order to re-design a page or wait for late sports results. The new deadline is propagated throughout the system in real time.

Every morning at 05.30 am a number of individually designed production reports are generated automatically by the system. The GPMS-server sends the reports to a number report subscribers. Besides, all production data is automatically published on the Intranet of Östgöta Correspondenten.

The completed production and distribution operations are, on a daily basis, analysed at a meeting with representatives from different key departments at Östgöta Correspondenten. The GPMS serves these analyses with facts from the operations.

The system is also used in order to identify potential improvements of the production and distribution operations, i.e. re-design of general guide lines for production and distribution planning.

A consequence of the use of the GPMS-prototype, is the introduction of a process owner at Östgöta Correspondenten. The process owner is responsible for co-ordination and the overall planning of the operations. This includes time tables and guidelines for the page make-up operations, available resources in the output operations, and scheduling with respect to printing and distribution.

CONCLUSION

During 1997 a prototype of a Global Production Management System (GPMS) has been gradually installed at the Swedish newspaper Östgöta Correspondenten.

Besides the prototype system, one purpose of the project has been to form a theoretical base for creating a control and management system operating in a heterogeneous computer based environment. The conditions for product design and production is characterised by concurrent engineering.

A number of local production systems are linked to the GPMS. The local systems sends tracking data in real time. The IFRAtrack recommendation has been used in order to create standardised communication links. The production database and history database are linked to a web-server and the client software is based on Java and is in use in an Intranet environment.

The GPMS co-ordinates the product, production and distribution planning, and tracks the production status of the different workflows in real time. The tracking data is used for decision support and in order to perform risk analyses and prognoses of delays.

The technical problems have been moderate. Instead, the hardest part was to convince the editorial department that the prototype was created as a tool in order to improve the flexibility and secure the delivery of pages to the printing plant. Furthermore, that the system allows the editorial department to make late changes with respect to the different pages, without loosing control in the subsequent steps of the workflow.

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Future extensions of the system can be implementation of tracking functionality also in the area of distribution and carrying operations. This will give an customer to customer tracking – from ad booking and subscriber reservations to the delivery to the newspaper products.

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