SIMULATION OF NEWSPAPER PRODUCTION PROCESSES—DECISION AND MANAGEMENT SUPPORT TOOLS

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Keywords: decision support systems, newspaper production, process control, production management, simulation.

Abstract: This paper presents and discusses general simulation models and global simulation systems for newspaper production, an extreme case of concurrent engineering where the final product is defined very late in the manufacturing process.

Based on earlier work on production tracking and control models we have developed simulation models for newspaper production decision support. The aim of simulation is to generate adequate decision support data for the efficient control and management of the entire production process—from the editorial offices to the distribution. The focus has been on product modelling and on the simulation of processes and resources. The simulation models will also be included in a global production management system (GPMS) for the newspaper production process.

INTRODUCTION AND BACKGROUND

This paper discusses three, by tradition, quite disparate subjects—newspaper production, decision support systems and simulation. One overall goal for this paper is to create a model for decision support for newspaper production by using simulation methods, i.e., to apply simulation as a base for building a real time decision support tool [Sullivan 1985]. The model defines a framework and a methodology

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- A model of a simulation-based decision support system within a global production management system.
- The creation of an influence model for the functions that we want to support by simulation.
- How the influence model relates to the simulation model.
- Simulation for decision making in a broader context.

We will argue that the proposed simulation based decision support system should and can be designed and closely integrated with a so called global production management system (GPMS), defined earlier in [Nordqvist et al 1993] and in [Karttunen 1993]. These systems have been defined to include simulation as a module along with monitoring, scheduling, and control modules. A control model has also been defined that describes the connection to product, process and resource models [Nordqvist 1995]. From these, valuable simulation input data can be accessed.

When designing a decision support system for newspaper production, and from a simulation standpoint, we must acknowledge the high amount of interaction between the products being produced, the activities that refine the product, and the required set of resources necessary to produce the products. The newspaper production process is rather linear, even if a high amount of parallel work is being done, but considerable complexity lies within:

- The tight time schedules and the time critical nature of the process.
- Parallel design and production of the same product, i.e., extreme concurrent engineering [Nordqvist et al 1995].
- The high amount of process feedback.

- The considerable effects that sudden unplanned events, customer and subcontractor behaviour can have on the production.

A typical newspaper production run—from design to distribution—takes 100–1000 persons 24–36 hours to accomplish.

We know of some earlier attempts to simulate the newspaper production process. To our knowledge, Dr Hacker was the first to build a computerized simulation tool, described in [Hacker 1969]. Some problems identified by Dr Hacker are still not solved: local suboptimizations of the production, inflexible schedules, and the lack of efficient prognosis tools. A second case of newspaper simulation models is called TidSim, developed by the authors and published in [Nordqvist et al 1994a].

By combining experiences from these cases with empirical process knowledge we now attempt to develop a new generation of simulation tools for use in actual production situations. Such tools can give valuable support in critical decision making on different managerial levels in the production set-up. The problems and questions are, however, many. We need to:

- Understand, map and define the process that we want to simulate.
- Set goals for what information should be generated by the simulation.
- Define a model for tool usage in a dynamic, actual production environment.
- Define methods for continuous data acquisition from the process.
- Integrate the model with a global production management model.
- Test the model in real production or with a subactivity within newspaper production.

NEWSPAPER PRODUCTION FROM A SYSTEM VIEW

We will present a decision support system model for newspaper production based on simulation. However, before discussing the actual decision support system and the simulation model, we will specify a general model for the entire newspaper production process and identify the production flows and critical influences within the process.

The publishing process has been mapped and discussed in several publications, especially in the case of newspaper production [Nordqvist

1994b and Stenberg 1994]. Based on earlier work we can approximate the entire production process—from the editorial offices to the distribution—as in figure 1. The following discussion of simulation and decision support will concern, and be based on, the simplified process model in this figure. The principles presented will, however, be applicable also on more detailed process models. The process functions are briefly described below.

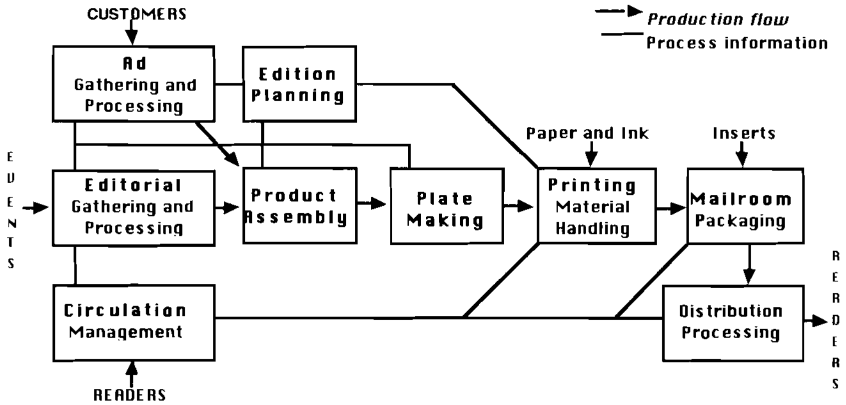

Figure 1. An overall model of newspaper production and the relationships between the activities within the process, described as production flow and process information exchange.

Ad Gathering and Processing. Ad marketing, sales and space reservations are coordinated. Incoming external ad material is received from the customers and is checked and routed forward. The ad material can have different forms—analog or digital, complete or only partly assembled. The *input* to the function consists of customer contacts, ad material and edition planning information. The *output* from the function consists of finished ads and pages or parts of pages containing ad material as well as space reservations.

Edition Planning. This planning function is an iterative process of balancing ad reservations and editorial requests within the space available. The *input* consists of ad space reservations, editorial space requests, and information on process capabilities in printing and mailroom. The *output* consists of detailed edition plans, i.e., plans for the structure and scope of the product to be published.

Product Assembly. The page layout and assembly of page elements into fixed and numbered pages for a specific physical product. This is normally an integrated part of the editorial work. The *input* is logical product descriptions from edition planning and content material. The *output* from the function is physical page descriptions in an electronic format [Thoyer 1995].

Plate Making. The so called back-end of prepress consists of converting the electronic page description into a printing plate. The working steps are ripping, recording (optional) and printing plate exposure. The *input* is physical page descriptions in an electronic format and the *output* consists of printing plates.

Printing and Material Handling. Consists of replicating the originals, i.e., the printing, cutting and folding of newspapers and preprinted inserts. The function also deals with material handling, primarily of paper reels and inks. The *input* is physical product descriptions from edition planning and exposed printing plates. The *output* consists of printed copies.

Mailroom and Packaging. Postpress production consists of assembly of the complete newspaper product, including the main product, supplements and inserts. Thereafter the product is prepared and addressed for distribution, which includes counting, stacking, bundling, labelling and palletizing of the product. The *input* is printed copies, preprinted copies and inserts. The *output* consists of addressed copies and bundles.

Circulation Management. This function manages subscriptions and circulation. It can also include distribution planning, i.e., the planning of routes, transportation and delivery personnel. The *input* is orders from subscribers and calculated sales of copies. The *output* consists of circulation orders for printing, address data for labelling of copies and bundles, and a distribution plan.

Distribution Processing. Consists of the transportation and delivery of copies to retailers and subscribers. The *input* is a distribution plan, addressed copies and bundles. The *output* consists of finished newspapers delivered to the customer.

This overall model of the newspaper production will be used as a foundation for the construction of the decision support system model.

AN APPROACH TO USING SIMULATION AS A REAL TIME DECISION SUPPORT TOOL

In this chapter we discuss the properties of process simulation and its relationship to decision support systems. We also present a model of a decision support system (DSS) within a global production management system (GPMS).

Typical simulation applications are non-linear, stochastic and too complex to be expressed as a mathematical model [Hacker 1969]. Hence we choose to use a simulation model, because a mathematical model of the newspaper production process cannot easily be derived.

One problem of dynamic simulation is that the system to be simulated is often very complex, and complex simulation models require extensive computer time [South 1995] and data acquisition is often time consuming. This is one important aspect to consider when using simulation for real-time applications. There is also a need to analyse the correctness of the simulation and to validate the model produced [Bossel 1994].

We normally call a process that has been mapped and transferred to a simulation model a simulation system or just a *system*. When creating a simulation system, first an overall model is constructed, called the *global system*. This is then broken down into *subsystems* [Bossel 1994]. This modularization methodology is very well suited for object-oriented thinking and for later realization in a prototype system.

The Relation Between the Past and the Future

When designing a decision support system, we need to place the proposed system in the full context of the production set-up that should be supported. In figure 2 we emphasize the importance of the time variable in the production systems. This is partly based on the time critical nature of the newspaper production mentioned earlier. Let us explain the figure from left to right.

The left container in the figure represents a set of production plans which is a collection of all executed and planned schedules for the entire production. There is likely to be a number of more detailed subschedules which together form a global master schedule. The current schedule for the ongoing production is represented by the *current time* indication.

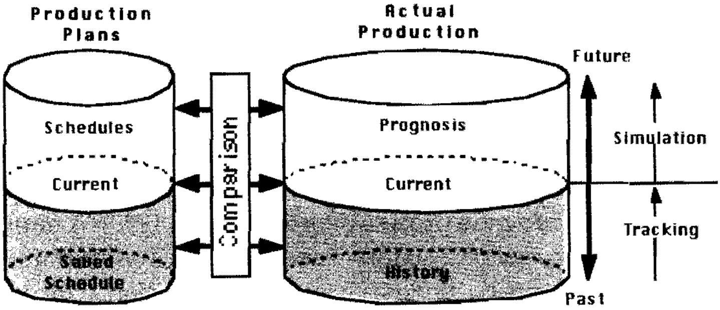

Figure 2. Time relationship between production plans and actual production. The figure also indicates the use of simulation for prognosis.

Saved Schedules is the collection of the actual final executed schedules and production plans for each previous production run. In some applications we could argue for the need for saving the history of every single schedule itself—the evolution of each single schedule. The obvious problem with this is the amount of data that would have to be stored and the possibilities of redundant data.

Current is the set of schedules that is presently applied to the current process.

Schedules. Future plans for the production.

The right container in the figure represents the set of status information of the actual production process, including all production related variables. The container also includes a collection of results of activities and object transitions within the process.

History. Production history is a structured collection of all production events and the objects they concern. The production history is built from production tracking data that are generated by mechanisms that continuously monitor the production process [Thoyer 1995].

Current represents the present time in the production, i.e., the current production status as expressed by the set of current states of all process variables.

Prognosis is a subset of the set of possible future states of the production. Since the complete set of possible future states would be very large, a probable subset must be generated based on previous experience, statistics, simulation, and educated guesses.

If we consider the plans and schedules to represent the *planned values* and as the actual production run generates the *actual values,* decision support can be based on a comparison function.

We propose that simulation can act as an extension for tracking, in the sense of creating possible future production data through the execution of *virtual production runs*. Tracking will only register the history and the current status of a production process [Nordqvist et al 1993]. A simulation can use actual production history and proposed schedules. The simulation then generates a prognosis for the production which can be used to evaluate the production schedules and thereby serve as a decision making tool.

Simulation as Part of a Global Production Management System—the Issue of Data Acquisition

In order to enable real-time simulation of a production process we need to feed the simulator with real on-line data from the process under consideration. One way of solving this is to use the concept of a global production management system (GPMS). Such systems include functional modules for production tracking, scheduling, control and management (MIS and EIS). A functional GPMS has to include detailed product, process, and resource models [Nordqvist 1995] from which the required data can be retrieved for use in a simulation.

The process interface between the simulator and the actual production process can be accomplished through a GPMS. The primary objectives of the GPMS system, i.e., tracking, scheduling and control, in combination with the maintenance of dynamic product, process, and resource models guarantees data availability. The exact relationship between the simulator and other modules in a global management system depends of the functions to be simulated.

We can illustrate the relationship between simulation and other relevant modules in a GPMS by the diagram in figure 3. The figure represents a real-time decision support system based on simulation. The main information flow for the simulation is marked in bold, in the centre of the figure. The workflow of the simulator can be divided into three phases: defining the starting state, performing the simulation, and producing the resulting output.

Starting State and Input. The main function of this phase is to select a set of input parameters for the desired simulation. The choices can be guided by *statistics* that are key values derived from the comparison of production history and production schedules. For example, the number of pages can be suggested based on statistics by comparing with the same day in a production from an earlier year. The choice is also limited by constraining *rules*. These rules are derived from experience and may include externally derived factors, for example, decisions that may affect the economy negatively but are considered necessary for goodwill purposes. An example would be the rule of adjusting the suggested number of pages based on market trends, special holidays and other factors that affects the number of advertisements which in turn affects the number of pages in the newspaper. These rules are manually evaluated and entered by experienced staff.

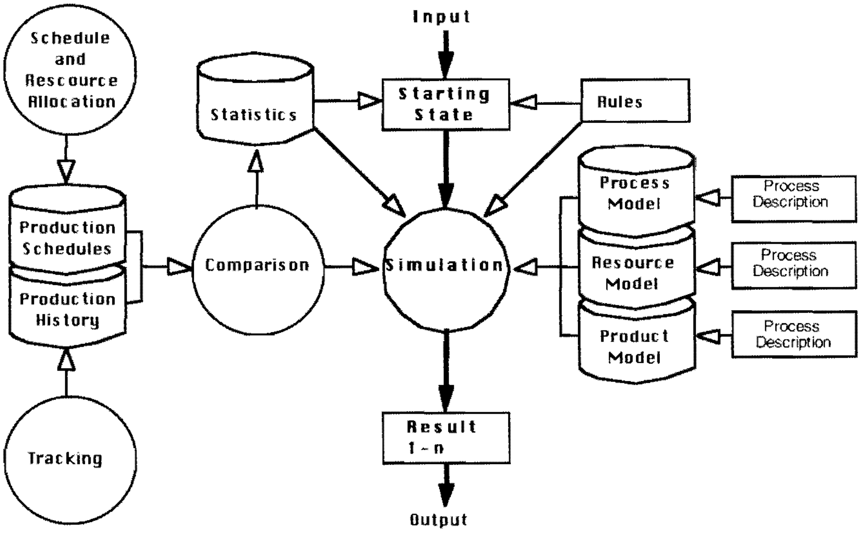

Figure 3. A model of a decision support system based on simulation integrated within a global production management system.

Simulation. Depending on the starting state and the objectives of the simulation, there is a specific need for supporting data for the simulation. This data is supplied from four sources, given the specified starting state: *Statistics* are key values derived from comparison between the production history and saved production schedules. A *comparison* presents either sets of planned values derived from the production schedules, or actual values from the production history, or an analysis of both, i.e., the difference between planned and actual value. We define the comparison as an engine for generating data from production history and production schedules, by request from modules such as simulation. *Process, resource,* and *product* models are the collections of updated descriptions of the products produced, descriptions of the possible processes, and information on the available resources. *Rules* define constraints that cannot be derived from other sources, as explained above.

Results and Output. This last phase outputs a collection of results. These results can be requested key values, typically time and cost. The results can also be presented as graphs where a set of compared alternatives can be presented. The number and format of the results is a consequence of the starting state and of the user requests.

INFLUENCE MODEL OF A SELECTED OPERATION

The actual design of a simulator is mainly dependent on the intended use. We will now attempt to identify a well-defined operation within the newspaper production, suitable for serving as an example of how simulation can be used. The overall goal is to create decision support for decision makers within the process. We start out by creating an influence model for the functions that we want to support by simulation. This influence model is the first blueprint for the design of the simulator. The model must cover the entire production process that affects the subject of the simulation, in order to avoid suboptimization of the model [Nordqvist et al 1993].

In this paper we will only describe one single operation serving as a test case. The selected operation is used to investigate the data requirements of the simulation model.

Model for the Determination of Physical Product Structure

We will present a global influence model of the factors relevant to the choice of physical structure (format) and press configuration for a newspaper. The model is adapted to the time frame of 10–24 hours before the product is delivered to the customers. Today, these decisions are normally made somewhere between noon and 4 pm, if the delivery deadline is around 6 am the following day.

This influence model will lead to the creation of a function tool that supports the decision makers in the editorial and ad departments by supplying information on how different structures of the newspaper will affect the production characteristics [Nordqvist et al 1994a and Stenberg 1995]. The model is primary constructed around the functions *press configuration*, *colour requests*, and *page count and structure.*

The influence model in figure 4 consists of a set of interconnected boxes which represents the different functions that influence each other. There are two types of special boxes. A well-box implies that the function is not influenced by any other described function and that the influence comes from an external point. The grey-filled boxes indicate that the source affects economy more directly than other sources. The influence directions are indicated by the arrows. It is important not to see this figure as a workflow scheme. It describes the logical influences between the functions. This model can be used in the design of an simulator.

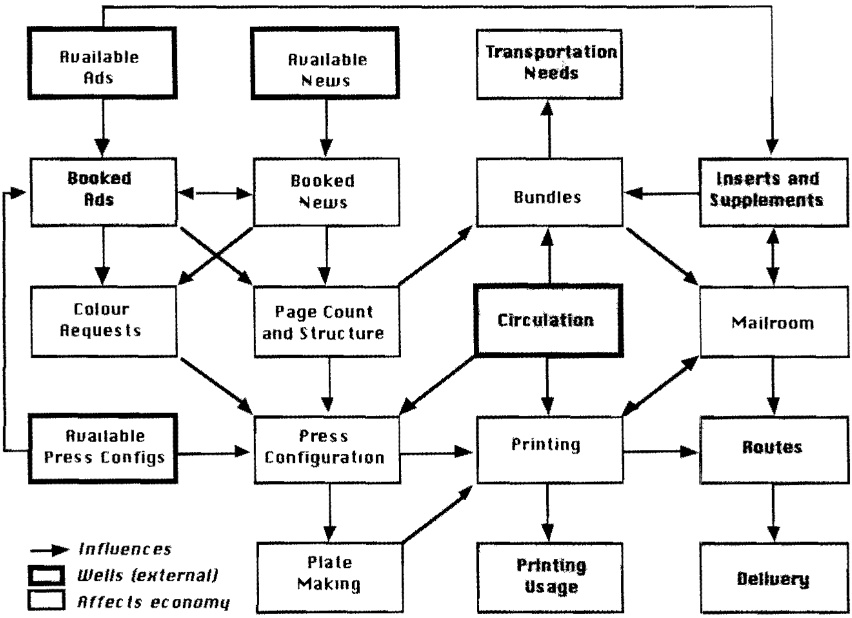

Figure 4. An influence model of the process for the determination of physical product structure.

Available Ads. The amount of ads and insert material on the market accessible to the newspaper. *Influences*: the amount of booked ads in a way that varies randomly, according to marketing efforts, and by season. It also affects the amount of inserts and supplements in the same manner, both in the short and in the long term.

Available News. The amount of available news is determined by random functions which obviously cannot be predicted. *Influences*: the booked news—the more (important) news available, the higher the demand on booked news.

Booked Ads. This function is concerned with the booking of ads in the newspaper and on specific pages. This is done in connection with the ad marketing efforts and is limited both by the market and the need for keeping a balance between ads and editorial material. The booked ad volume is *influenced by*: the amount of available ads in balance with the booked news. The available press configurations set constrains especially on where colour ads can be booked. *Influences*: although ads and editorial contents compete for the available space, more booked ads can generate more space for booked news. Booked ads affect the specific colour requests and number of pages. It also affects the volume of space available on pages for news booking.

Booked News. The function of planning and assigning editorial material to the newspaper and to the specific pages. *Influenced by*: the amount of available news. Booked news is also directly affected by the volume and placement of booked ads, which often also determines the colour availability for booked news. *Influences*: booked ads, colour requests and number of pages.

Colour Requests. The function of assigning colour to a number of pages within a product. *Influenced by*: the booking of ads and news generates a set of colour demands. This *influences*: the choice of a press configuration that corresponds to the colour needs.

Page Count and Structure. The final number of pages in a newspaper issue including all sections. *Influenced by*: the volume of booked ads and news. *Influences*: the choice of press configuration and the bundle configurations (quantity, weight and height).

Available Press Configurations. The set of possible configurations in the printing press. For each combination of page count and maximum colour availability, the press configuration contains information on runability, estimated amount of waste, and maximum press speed.

Influences: the amount of booked ads and the selection of actual press configuration.

Press Configuration. The choice of a press configuration is the focus of this particular exercise. *Influenced by*: the colour requests and the number of pages made in ad and editorial booking, as well as the structure of the newspaper product. It is also constrained by the available press configurations and affected by the required circulation which could demand the use of several presses. *Influences*: the runability of printing because of the specified combination of total number of pages and their individual colour placement. It also affects the structure of the newspaper product.

Plate Making. The process beginning with ripping and ending with the exposure and preparation of printing plates. *Influenced by*: the number of plates that should be produced is determined by the press configuration. This affects production capacity and speed for the plate making process. *Influences*: the start time of the printing job(s) concerned.

Transportation Needs. The specification of the demand on capacity in transportation. *Influenced by*: the bundle sizes and quantity which vary from product to product and from day to day.

Bundles. The collection of printed newspaper copies into bundles of varying size and weight. *Influenced by*: the number of pages in the product, as well as by the dimensions and number of inserts and supplements which all affect bundle size and weight. The circulation in combination with the size and weight of each copy affects the amount of bundles that is going to be produced. *Influences*: the transportation needs due to different weight and quantity. The number of bundles and their dimensions affect mailroom runability.

Circulation. The number and location of subscribers and the expected sale of single copies determine the required quantity of printed copies. Circulation is defined in the figure as a well but the element could also be designed as two separate elements where the well is called available readers and a second function is named circulation marketing and management. *Influences*: the choice of press configuration and the printing so that enough copies can be printed prior to the set deadline. It also determines the mix of quantity and location for copies in the bundle configuration.

Printing. The replication of the page originals in the form of printed newspapers. *Influenced by*: the plate making affects the start time for printing and the chosen press configuration affects the runability. The configuration and circulation affects the printing time. *Influences*: the runability and quantity printed affects the paper usage. The printing also affects the mailroom runability and the departure of the routes in distribution.

Paper Usage. Used paper reels in different qualities and widths. *Influenced by*: printing runability and the number of printed copies.

Inserts and Supplements. The collection of commercially sold inserts and regular editorial preprinted supplements. *Influenced by*: commercial inserts are directly a function of market needs, i.e., available ads in the figure. The mailroom capabilities also put constraints on how many inserts and supplements that can be accepted. *Influences*: the inserts affect the size of each copy, i.e., the bundles size and weight. It also affects mailroom runability and its maximum production speed as determined by the properties of the inserters. It also affects the number of inserts and supplements that can be handled.

Mailroom. The assembling of the complete newspaper product and preparing it for distribution. *Influenced by*: Printing speed and inserts affects runability of the mailroom. The sizes and weight of the bundles affect runability and the speed, set by the mailroom capacity. *Influences*: the overall mailroom runability affects the printing speed.

Routes. The routes that transports the bundles from the printing plant to a delivery station. *Influenced by*: the printing has a varied performance that affects the departures of the routes. Bad mailroom performance can also delay routes. *Influences*: the start of delivery.

Delivery. The final step in this influence model is the function of carrying out the newspaper to the readers. *Influenced by*: the arrival of the routes affects the schedule of delivery to the readers.

Economy plays an important role in the decision making in this selected operation. We have therefore analysed the most important influences that affect the decision making from an economy standpoint. The calculation of the cost of a decision is made by identifying the specific cost related to the decision and the corresponding share of the total costs. When added, this is equivalent to the cost of the decision which can be compared to the budgeted cost. The specific related costs are of prime importance in decision making.

The identified sources of decision related specific costs are shown as grey-filled boxes in the figure. The income comes partly from circulation, i.e., subscriptions and single copy sales, but mainly from the sales of ads—both display and classified—and commercial inserts. The latter normally account for approximately two thirds of the total revenue of the newspaper.

Specific decision related costs originate from the paper usage in printing which varies by circulation and the page count and structure. One important factor is the cost of distribution of the newspaper. This is affected by different transportation needs, variations in routes, and cost of delivery. The costs can increase rapidly, especially in the case of delays in production.

COMBINING THE DSS SIMULATION AND THE INFLUENCE MODEL

Let us now combine the simulation-based DSS model with the influence model (as depicted in figures 3 and 4). In figure 5 we show how the different elements in the influence model relate to the simulation model. Different elements in the influence model have different roles in the decision simulation.

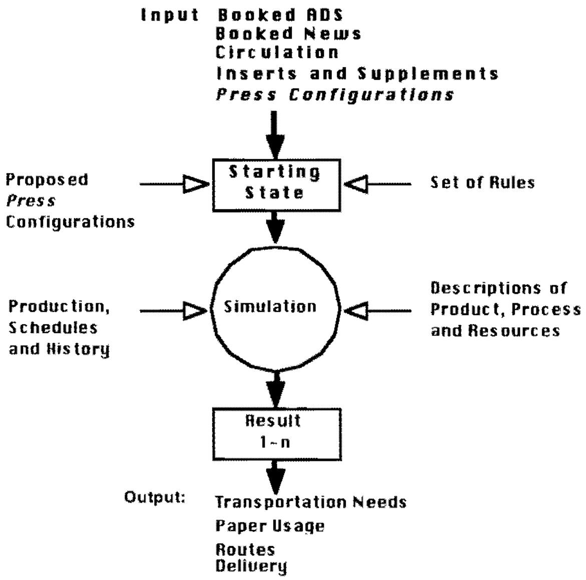

Figure 5. A combination of the influence model and the simulation model.

The set of input data is derived from the so called wells: booked ads, booked news, circulation, inserts and supplements. In addition, we have the special function of press configuration—in this case the variable to be investigated.

The starting state is determined by the input data and the choice of a press configuration, constrained by the given rules, that we wish to test. We may also select a press configuration based on statistics.

A simulation is executed using the required background data, supported by data from the production schedules, production history and the available product, process and resource descriptions.

The result of the simulation can be a single value or a range of values. In this example, the output of the simulation could be the influence that the chosen press configuration would have on the: transportation needs, paper usage, routes and delivery. These four functions are all so called sink elements in the influence model—they do not have any direct influences on other elements. The simulation result is most likely represented by the resulting effect on production time or decision related costs, measures that are closely interrelated.

Simulation for Decision Making in a Broader Context

So far, the discussion has been focused on the systems and not on the users. The need for decision support has been identified by investigating the demands of the users. The scope of this paper has been to design a model for simulation as an engine in the building of a decision support system. Such a system must be designed to make decision making easy and safe.

Figure 6 indicates some major aspects to be considered when designing a decision support system. We have to put the user in focus and observe and analyse her or his real needs for decision support, i.e., map the various decision processes in the operation. We can define two types of factors that will affect the decisions in addition to and in parallel with the decision support system—rational and irrational factors.

The rational factors are the accumulated experience and knowledge that the user applies to solve the tasks in the decision making process. A decision made based on these rational factors can be seento follow logical deduction rules.

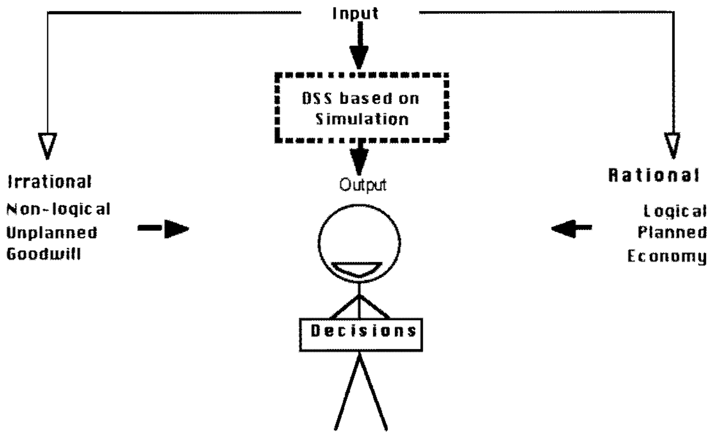

Figure 6. The decision making is supported and influenced by a multitude of factors—both rational and irrational.

The irrational factors in the decision making process are unplanned and non-logical. An example is a decision that will have a negative effect on the resulting costs but is considered to be valuable from a goodwill point of view.

When designing a decision support system we must focus on the creation of supporting data for rational decision factors. The aim of implementing a decision support system should not to be to replace human decision makers with their ability to make seemingly irrational decisions. Instead the objective should be to created automated support for routine, but complex, rational decisions.

CONCLUSIONS AND FUTURE WORK

The possibility of using simulation as an engine for decision support promises faster decisions, based on more facts and more reliable facts. Decisions can, should one so wish, be made by fewer persons, but using a distributed decision support system architecture, the decision making power can also be distributed among the production staff, giving a less hierarchical decision making organisation.

We also argue that the described models allow the use of more flexible product structures and, at the same time, better utilize available processes and resources. At the bottom line, this will save time and money.

By tradition, simulation is mostly used as a tool in product design, process testing, early estimating and other relatively static applications. This paper emphasizes the use of simulation as a real time decision tool for use during actual production.

A problem here is that the process that has been translated into a simulation model is only an approximation of the process. This can lead to discrepancies in the results when comparing the real process with the output from the simulation.

We also need to feed the simulation model with accurate real time data, statistics and other variables—not an easy task to achieve. This can, however, be accomplished using open databases in a digital infrastructure. One approach is to use a production tracking system covering the entire process and within this system represent the required data in product, process, and resource models [Nordqvist et al 1993]. A global production management system aiming at tracking, scheduling and closed-loop control should contain a module for decision support using simulation.

We intend to continue our work in the direction of extending the definitions of global production management systems and verifying our findings through prototyping. We will especially focus on implementing decision support by using simulation as discussed in this paper. The test case will be selected functions in an actual newspaper production process

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LITERATURE CITED

Bossel, H.
1994 "Modeling and Simulation". A K Peters, Ltd., Verlag ViewegGmbH. 475 p.

Enlund, N., Nordqvist, S., Alasuvanto, J. and Sulonen, R.
1994 "An Object Model for Integrating Production Management in Newspapers". 'Proceedings of the TAGA Conference'. Baltimore, May. Rochester, NY. Pages 498-510.

Hacker, R. G.
1969 "A Simulation Model for the Analysis of Selected newspaper operations". Thesis for the degree of Doctor of Philosophy in the School of Journalism Graduate College of The University of Iowa. 368 p.

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

Nordqvist, S. and Enlund, N.
1993 "Global Production Management for Integrating Prepress, Press and Postpress Systems in Newspapers". Banks, W.H. (ed.), Advances in Printing Science and Technology, IARIGAI '93, Volume 22, Pentech Press. London. Pages 274-294.

Nordqvist, S., Stenberg, J. and Karttunen, S.
1994a "Modelling of Production Management Solutions: TidSim Newspaper Production Simulator". 'Proceedings of the TAGA Conference'. Baltimore, May. Rochester, NY. Pages 511-526.

Nordqvist, S.
1994b "Newspaper Prepress – the Process and its Production Management". Thesis for the degree of Licentiate of Technology, Division of Graphic Arts Technology, Royal Institute of Technology. Sweden.

Nordqvist, S. and Enlund, N.
1995 "Control and management methods for prepress production in multichannel newspapers". 'Proceedings of the TAGA Conference'. Orlando, April. Rochester, NY. Pages 483-501.

South, D. W.
1995 "Encyclopedic Dictionary of Industrial Automation and Computer Control". Prentice Hall PTR, New Jersey, USA. 341 p.

Stenberg, J.
1994 "Printing and Distribution of Newspapers – the Process and its Logistics". Thesis for the degree of Licentiate of Technology, Division of Graphic Arts Technology, Royal Institute of Technology. Sweden.

Stenberg, J.
1995 "Dynamic Control of the Printing, Postpress and Distribution Operations in Newspaper Publishing". 'Proceedings of the TAGA Conference'. Orlando, April. Rochester, NY. Pages 433-449.

Sullivan, G. and Fordyce, K.
1985 "Decision Simulation (DSIM): One Outcome of Combining Artificial Intelligence and Decision Support Systems". Published in 'Decision Support and Executive Information Systems', Prentice Hall, Inc., USA. 1994. Pages 409–419.

Thoyer, B.
1995 "IFRAtrack: a Recommendation for the Interchange of Status Information between Local and Global Tracking Systems in Newspaper Production". Version 1, IFRA. Darmstadt.