KNOWLEDGE-BASED MANAGEMENT OF NEWSPAPER PRODUCTION

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Abstract: A computer software system for designing newspaper structure and its production has been built. The system resides on generic models for the printing press as well as for the logical and physical structures of the newspaper. Based on the models, an optimal way to run the printing press can be deduced from a selected newspaper structure and vice versa. The system takes into account the limitations imposed by the printing press on the newspaper structure and it can be adapted to a particular printing press configuration and a particular newspaper style by an appropriate specification of attributes in the model. In addition to a single newspaper edition, the design process can be extended to cover the successive production of multiple newspaper editions or different products altogether. The optimization of the production takes into consideration both the internal costs for one particular newspaper edition and the costs involved in configuration changes between the individual editions.

Introduction

A modern rotary printing press offers a high degree of flexibility in the production of daily newspapers. In practical cases, this flexibility is not always fully exploited. It is very common that only a limited number of the choices are used in the daily production. This means that the flexibility offered to the printer by the manufacturer may, in fact, be transformed to restrictions to the designer of the product.

This paper aims to facilitate the exploitation of the printing press flexibility. The first topic of the paper is the establishment of a link between the newspaper production and the newspaper design, as seen in the editorial and advertisement sales departments. This leads us to generate separate descriptions for newspaper structures and press configurations. The generation process is automatical and can proceed in two directions: it is possible to generate a newspaper structure starting from a given press configuration and, conversely, all possible press configurations for a given newspaper structure. The practical limitations in the use of the press as well as the conventions in the newspaper structure are included in the generation processes.

The second topic of this paper is to choose optimal conditions for the production process. This means that the design of the product and the planning of its manufacturing are seen as interacting tasks which include fitting together the needs of different operative partners in the newspaper production (Veijonen, 1991). The notion of optimization goes beyond the production of a single edition of the newspaper, since the

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adjustment of the printing press between individual editions may turn the individual optimal choices globally unoptimal.

The key notion of our presentation is modelling, i.e., giving accurate separate descriptions of the product and the tools to be used in the manufacturing. The description of a newspaper structure is divided into two parts, the logical and physical structures. The former refers to the topic sections, their order inside the newspaper and their desired sizes and colours. The description of the material to be placed onto the pages is included in the logical structure as well.

The logical structure is mapped onto the physical structure, i.e., to the concrete sections and pages having individual colour requirements. An important tool in this mapping is an automated placement of advertisements with consideration of requirements for their positioning and colours (Veijonen, et al., 1991).

The techniques used in the modelling stem from the theory of knowledge-based systems, a subfield of artificial intelligence. The descriptions consist of hierarchically ordered object classes which make it possible to focus the information to a proper position. The hierarchical representation leads to explicit descriptions of the components and their connections. The representation is general in the sense that it can include each individual object type. The practical application is defined as individual instances of these general object types. A description about the use of this kind of techniques in the graphic arts applications is given in Ahonen et al. (1989).

A prototype computer system for designing a newspaper and its production has been written using a widely spread extension of the LISP programming language, called CLOS (Common Lisp Object System) (Keene, 1989). The computer platform was first Symbolics® Lisp Machine but due to portability of the language it runs in the UNIX®, Macintosh® and DOS-environments as well.

Flexibility as source of variations

The variations in the structure of a newspaper produced with the help of a rotary printing press may be divided into two parts: (1) variations in the section structure and (2) variations in the colour structure.

The section structure, i.e., the number of separate sections and the number of pages inside each section depends, on the selection of the number and widths of the webs, on the positioning of reels on the reel stands, on the way of leading the webs to formers (i.e., on the use of angle bars), and on the order in which the sections are collected from the formers (Fig. 1). On the other hand, the section structure does not depend on how the webs are passed through the printing units.

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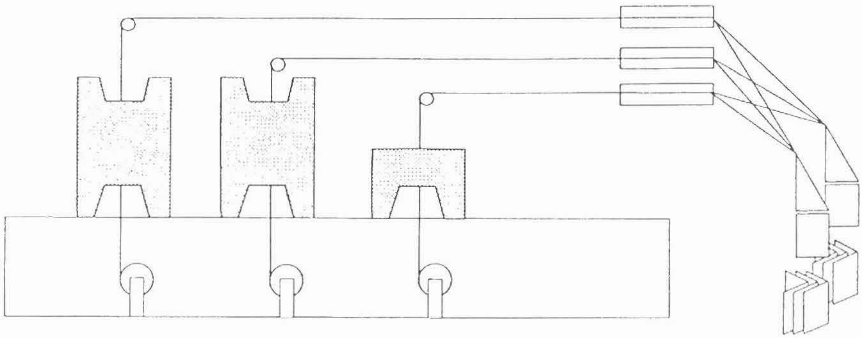

Figure 1. Components of the printing press determining the section structure of a newspaper.

If the section structure of a newspaper has been fixed, then the colour structure is solely determined by the routes of the webs inside the printing units. There are several alternative routes and a web can pass through several units (Fig. 2). The colours available to each individual page are determined by the usage of printing couples. Here again, we have several choices: a suitable colour may exist after the production of the previous edition, its use may be excluded in this edition, or it has to be changed.

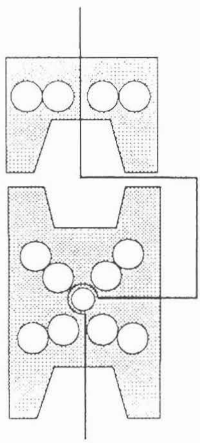

Figure 2. Routing of a web inside a printing unit and between units.

The separation of section and colour structures has been very useful in writing a computer program for generating the newspaper structure from a printing press configuration (forward generation) and for finding the possible configurations for a given structure (backward reasoning). The separation does not necessarily reflect the practical design process in which the section sizes may depend on the colour choices.

The generation module of the software assumes as its input that an instance of a class of printing presses has been created on the basis of the general model. Some of the parameters describing the use of individual components may have fixed values or they may have a certain range of values. For example, it may be desirable that one of the webs always has the full width and that it passes through a four colour unit. The generator goes through all possible values and determines the corresponding section and colour structures. The computation is rather straightforward due to the exact descriptions of the components in the model.

The backward reasoning is more difficult, since each particular newspaper structure may be produced with several printing press configurations (cf. Fig. 3).

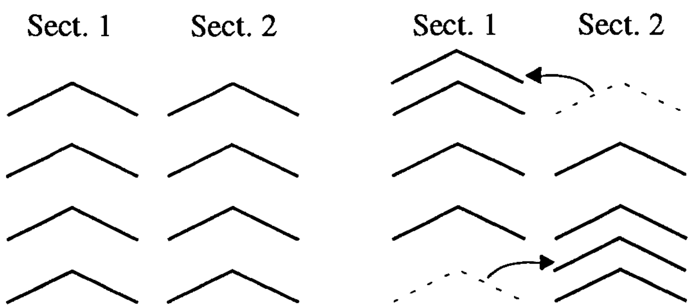

Figure 3. Example of two identical sections with different printing press configurations.

A combination of direct reasoning and a search algorithm has been implemented (Genereseth, et al., 1987). The direct reasoning starts with the number of sections and the number of pages within each section and determines a set of combinations of numbers of webs and web widths. The search module tries to find the use of angle bars and the combinations of reel positions of the narrow webs on the reel stands. The constraints determined by the required colours on the pages and the colours available in the colour units are also taken into account.

Optimization tasks

There are, at least theoretically, several printing press configurations for each newspaper structure. All of these are not practically feasible. Some of them may be excluded simply because no presetting values are available. Others may turn out to require too many changes in the current state of the printing press. For example, a new configuration may be accomplished only through tedious washing operations in colour units.

The simplest optimization task, which is to choose the best configuration for a single newspaper structure is appropriate in checking whether a given structure is producable (Fig. 4a). This may be important when planning a long term default structure for the purposes of advertisement sales. The comparison of feasible configurations is based on internal costs of each configuration. The term cost generally refers to some quantitative estimate which reflects the desirability of the choice. The desirability is affected by several factors such as risks of web breaks or degradation in the quality of colours. For example, a complicated use of angle bars is more expensive than passing the webs directly to the folders.

The choice of the best configuration can be combined with the design of the newspaper structure leaving the structure at least partially open (Fig. 4b). This type of task can be solved by a reduction to a set of tasks of the first type. This means that the printing press configurations are created for all the newspaper structures which can be chosen in the particular open case. If the structure has many alternatives, the number of possible configurations may become too large unless some cut-off cost is used to exclude too expensive individual configurations.

The optimization within the production of a single edition can be strengthened. The printing press is always in some state before printing one particular edition. The previous state may be the configuration needed for the production of another edition or there may have been some maintenance or cleaning operations (Fig. 4c). The work involved in adjustments between different states may affect the choice of the configuration and has to be taken into consideration as well.

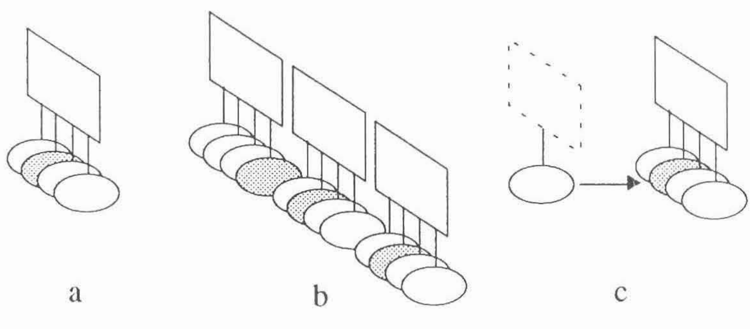

Figure 4. Optimization tasks in the case of a single edition. In (a), the newspaper structure is fixed and in (b) it may have several alternatives. In (c), the former state of the printing press is taken into consideration.

In practical situations, the scope of designing the production of a single edition is not sufficient. There may be several editions to be produced one after another (Fig. 5) and some of these may have an uncompleted, open structure. The optimization task has been generalized to finding an optimal path in the network of different configurations.

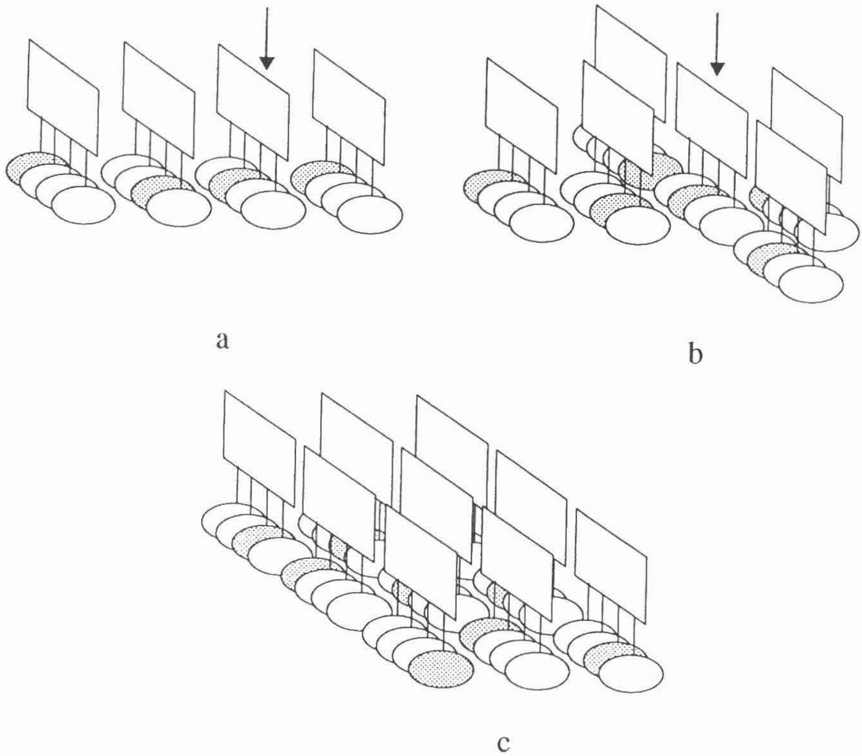

Figure 5. Optimization tasks in the case of multiple editions. In (a), the structure of the "current" newspaper is fixed and in (b) it is open. In (c), several editions are considered to be open.

Solution

The optimization tasks within the scope of a single edition serve as a basis for the more complicated tasks including several editions. An essential part of the optimization is formed by determination of internal and adjustment costs. The determination is based on a separate cost model. The model includes the analysis of tasks required in setting up a given configuration. As in the case of the models discussed above, the tasks are represented in the form of hierarchically ordered task types. The actual costs are introduced in instances of tasks of appropriate types. This makes it possible to introduce very detailed production and site dependent costs into the optimization.

The optimization algorithm is based on a famous dynamical programming algorithm (Bellman, et al., 1962). The basic principle is to proceed from one set of configurations to the next set and to find the cheapest transition from the previous states to each next state. At the end of the calculation, the cheapest path is found by starting from the cheapest last state and traversing the states backwards along the marked cheapest transitions (Fig. 6).

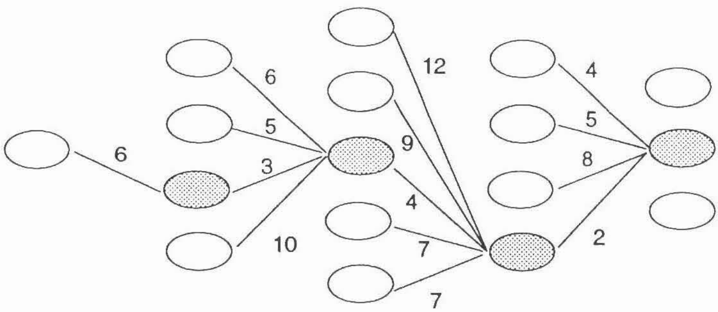

Figure 6. Principle of the Dynamical Programming in the case of multiple editions with fixed newspaper structures. The optimal path consists of the shaded configurations. The numbers represent costs between the configurations.

When the number of configurations is large, the optimization tends to become time consuming. The algorithm is improved by grouping the configurations along their internal costs and by using a heuristical cut-off cost in the choice of configurations taken into consideration. Although the security in obtaining the optimal path will then be lost, the practical cases show that there are clearly distinguishable "nonfeasible" cases which can be omitted in the optimization.

Acknowledgements

The work is done within an ongoing research project supported by the Technology Development Centre of Finland. The project is carried out together with Ahlstrom Automation Corp., and Systepo SyPress Corp.

Literature Cited

Ahonen, H.
1989 "Knowledge-based integration of newspaper design and layout." Lasers in Graphics Conference, Sept. 1989, New Orleans, pp. 224 - 226.

Ahonen, H., and Karttunen, S.
1989 "Knowledge-based system design for ghe graphic arts." TAGA 1990 Proceedings, pp. 555 - 568.

Bellman, R., and Dreyfus, S.
1962 "Applied Dynamic Programming" (Princeton University Press, Princeton, N.J.).

Genereseth, M, R., and Nilsson, N.J.
1987 "Logical foundations of Artificial Intelligence" (Morgan Kaufmann Publishers, Inc., Los Altos, CA.)

Keene, S.E.
1989 "Object-oriented Programming in Common Lisp. A Programmers Guide to CLOS." (Addison-Wesley, Reading, MA.)

Veijonen, T.
1991 Computer-aided Design of Newspaper Structure. Master Thesis. Espoo, Finland, 55 p.

Veijonen, T., Ahonen, H., Niku-Paavola, J., and Ylä-Jääski, J.
1991 "Knowledge-based system for the design of newspaper structure". The World Congress on Expert Systems Proceedings 1991, Vol 3. pp. 2172 - 2179. (Pergamon Press)

Ylä-Jääski, J., and Ahonen, H.
1990 "Knowledge-based newspaper pagination." SPIE Conference on Applications of Applications of Artificial Intelligence. SPIE Proceedings, Vol. 1293, pp. 767 - 774.