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A SIMULATION OF THE PRODUCT DISTRIBUTION IN THE NEWSPAPER INDUSTRY

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ABSTRACT

On-time delivery of the paper is critical in the newspaper industry since it is directly related to the quality of service; therefore, it enhances or damages sales. This study was focused on determining the means to meet required delivery times, and in identifying ways to improve it, so that there is a lower probability of failure. A simulation model was built to model the paper printing, packaging, and distribution processes. The results yielded a press schedule and warehouse assignments that provided a 13% improvement on delivery time. This improvement results in a 97% on time delivery of the paper.

1 INTRODUCTION

Achieving on-time delivery is one of the biggest challenges of the newspaper industry. Service to clients is what guarantees and grants business. In this industry, service is mostly measured based on the ability to meet on-time delivery. For newspaper subscribers, having the paper outside their door in the mornings is imperative; otherwise, they will not subscribe to such company.

Newspaper production operations are based on real world news, which may occur at odd times, even well passed the closing edition time, determining how to operate the printing and distribution of the newspaper is not a trivial task. Standard and static analysis tools cannot capture the dynamics of such a changing environment. That is why simulation is a suitable alternative to model and evaluate alternative ways to operate in this business environment.

Research on this area indicates that simulation modeling is a great tool for the modeling of the processes of the newspaper industry. Some examples include the works by Annikka et al. (1994) and Fredick et al. (1997). Annikka et. al. (1994) used simulation as a tool for strategic management. They used simulation to analyze the complex causalities of revenues from the advertising and circulation market with the economic result of the newspaper. The results of the model indicated how the newspaper market conditions were and described the macro level economical measurements as well. Fredick et al. (1997) used simulation to test and validate a decision support system for the entire production process. The decision support system was called GPMS – Global Production Management System. To test GPMS without disturbing daily production, simulation was used to simulate the events from various production subsystems and achieve the actual production state. These simulation results were then fed to the GPMS for analysis. Thus, simulation has been used successfully to support newspaper production.

In this study, the client's main concerned was to be able to improve the end-delivery time of the home delivery portion of the business. A newspaper business consists, among other things, of what are known as "Home Delivery" and "Single Copy". As these names imply, the "Home Delivery" portion corresponds to the papers that go to the subscribers, at their homes. On the other hand, the "Single Copy" portion of the business corresponds to the papers that are distributed to the newspaper stands and other business retailers. In this project, the focus was the home delivery process. The analysis concentrated on identifying how the to improve the processing and distribution strategy used with the home delivery production. A simulation model was created, which included analysis of various alternative scenarios for distribution of the home delivery copies of the daily paper.

This paper describes a simulation study for a newspaper company. The study yielded a 13% improvement on *End-Delivery-Time* for the home delivery option of the business.

2 MODELING NEWSPAPER PRODUCTION

This modeling effort required a thorough understanding of the newspaper production and distribution operations.

Significant input was obtained from the client regarding specific aspects and requirements for production and delivery of the daily newspaper. The paper printing operations consist of different editions, which vary in content. These editions are different based on the geographical area where the newspaper will be distribute and on the demographics of population in those areas. In addition, each printed edition may change based on the time of the day as the news occurs.

The newsroom is expected to release articles for publication at a given time of the day. However, when the newscast is following developing news, such articles cannot be generated in time; therefore, the last edition printed will vary to include the latest events. For example, sport events may finish after their scheduled time due to weather or to a tie game. Thus, the score and the winner are not known at the time the newsroom send the news to press for the first edition. However, by the time the latest edition is printed, the game may have finished; hence, a new article is included detailing the outcomes of the sports event.

The first task of this study was to determine which production schedule to use to drive the simulation. The Newspaper Company has various publications, which are issue at different days of the week, including the Sunday paper. This is important because the newspaper operation is based on the different editions of the paper that are printed. The schedules used to produce the various editions vary in length and starting times.

After a careful assessment of the various editions, and on the objectives of this study, it was decided that the daily paper schedule would be used as the model driver. With this, both the 2nd and 4th editions of the daily paper were scheduled at the presses. This will exclude the Sunday and other commercial publications.

Figure 1 shows the process flow of a typical newspaper operation. The pressroom is where papers are printed and transmitted to the mailroom, usually by some automated material handling equipment. The most commonly found is a gripper conveyor. From the pressroom, the printed copies are stored in a buffering device before they go into the "*inserters*" where the inserts to the main jackets of the paper are added. The inserted copies are then bundled together and stacked up prior to delivery. Once the carriers arrive to the facility, they have an assigned route for the single copy carriers. They pick their copies, load them on a truck and leave. In the case of the home delivery scenario, the carriers have an assigned distribution center where they go pick up the paper to complete their route. The earliest the papers make it to the distribution centers, the earliest the carriers can make it to the subscriber's home; hence, the earlier they can complete their assignment. The challenge is when to schedule the carriers to pick up their copies, and what distribution center assignment to have per carrier and customer-base.

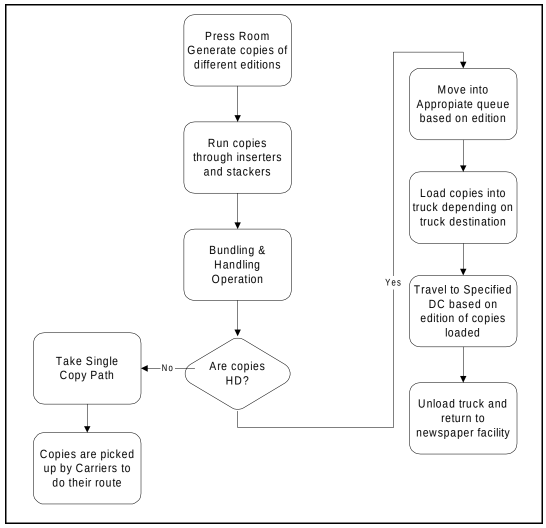

Figure 1: Newspaper Production and Distribution Flow

The newspaper distribution network consists of two Production facilities and five Distribution Centers (DC). Facility number 1 contains the highest production capacity, whereas facility number 2 is reserved for the West edition production only. However, due to capacity constrains, and market size of the West edition, facility 1 produces a portion of the West edition along with all the other regions.

The simulation model was used to determine which of the existing distribution centers was the best candidate for closing, and which combination of DC and carriers will have the earliest delivery time. For this analysis, a series of criteria were set that included changing the production schedule at the press to get the farthest geographical locations out of the press room first, and take advantage of it to guarantee early delivery.

Based on the client's input, many combinations were developed that included altering the order of the editions in the production schedule, combining and closing distribution centers, and moving partial productions across facilities. Using these combinations, experiments were run to determine which one were worth of further examination. A final set of three experiments that represented the most viable alternatives was selected for further analysis. These experiments are given in Table 1.

Table 1: Alternative Description

Criteria	Editions Order	DC Decision
Scenario 1	W, S, N, E	Close DC 1
Scenario 2	W, N, E, S	Combine All DC's at Facility 1
Scenario 3	S, N, W, E	Combine DC1 and DC2 on Facility 1

Several assumptions were made regarding transportation times, truck loading, and field inserting. Field inserting occurs when a paper copy bypasses the inserting on site; hence, the carriers hand-insert the paper at the DC. Truck capacities were assumed at 18,000 copies with loading and unloading time requirements based on quantity per truckload. Carrier processing time at the distribution centers was assumed at 10 minutes for DC administration and 20 minutes for assembly/bagging (no field inserting). Carrier delivery times were assumed at 2 hours. All this times were used as constant in the simulation. These times were constants given the fact there was no way to measure the variability of them. Nonetheless, the results from the simulation model gave a clear picture of the status as it can be seen in the next section.

3 ANALYSIS AND RESULTS

Once the experiments were designed and configured, and all the assumptions were verified, statistical analysis was performed to determine the number of replications needed to yield statistically valid results. Since the production schedule start at set times and the variability of the system occurs within scheduled process, the average time in the system (in the production site) did not have a high variability. Random processes like breakdowns and downtimes affect printing-end-time, but the loading at the DCs occurs at scheduled times.

The number of replications was set at five, and the different alternatives were run. The measure of performance used to analyze and compare the different options was End-Delivery-Time. Table 2 contains the results of the different experiments. This table only reports the end-delivery-time for the purposes of this article; however, many other relevant results were collected, analyzed, and reported for the project. Figure 2 shows a plot of the average end-delivery time per scenario.

As indicated in Table 2, the best alternative was Scenario 3. This scenario consisted of combining the DC1 and DC2 at facility 1 Site, closing its corresponding locations, leaving the production volumes as existing and with the edition order as indicated in the table. Because the objectives of the study was to determine how to improve end delivery time of the home delivery side of the business, it was evident that based on that measure of performance, alternative 3 was the best option. In addition, the economic analysis, not included in this paper, showed that alternative 3 was the most economical. Closing two distribution centers and operating one combined on site offers significant capital cost savings, while saving perpetual fixed cost and variable operating costs.

Although numerically speaking, alternative 3 seems to be the better one, it was decided that a hypothesis test would clearly set such conclusion; hence, a hypothesis test was done to compare the mean value of *End-Delivery-Time* under the various alternatives. The test of hypothesis used

$$H_0 : \mu_1 = \mu_2 = \mu_3$$

Table 3 includes the Standard Deviation of each scenario results. Because the variability of the mean under each alternative was different, a hypothesis test for equality of means, with unequal variances was done. The results of the test verified that the indeed the average long-term behavior, under the three alternatives, is different.

Table 2: End-Delivery Time Per Alternative

Replication	Scenario 1	Scenario 2	Scenario 3
1	5:45	5:52	5:28
2	5:38	5:59	5:25
3	5:42	6:01	5:32
4	5:25	6:05	5:23
5	5:29	6:00	5:30
Average	**5:35**	**5:59**	**5:27**

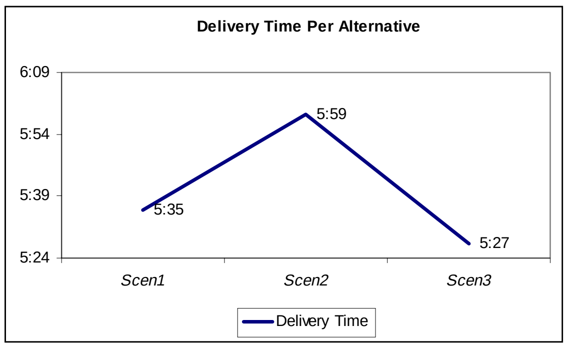

Figure 2: End-Delivery Time Per Alternative

Table 3: Standard Deviation of Alternative Results

Replication	Scenario 1	Scenario 2	Scenario 3
STD	0:08	0:04	0:03

4 SUMMARY

The analysis performed offered several benefits to the client from the stand-point of operations of the manufacturing facility as well as the transportation network improvements obtained from the chosen alternative. The results of the simulation study offer the client a course of action that not only improved the end-delivery time for one of the most important sectors of the business, but it does so with great economic benefits. The alternative selected for home delivery offered a desirable 13% improvement of the *End-Delivery-Time*. In addition, the simulation results allowed the client to target their investment by specifying which investment option offers the highest economic benefits.

The simulation study proved that tangible and quantifiable benefits could be derived from redesigning the distribution network without incurring in equipment expenses to expedite the production cycle. The suggested changes to the distribution strategy are currently being implemented and benefits are foreseen from this implementation.

REFERENCES

Annikka, T., R. Sulonen, M. Savolainen, and N. Enlund. 1994. Dynamic Simulation as a Tool for Strategic Management of Newspaper Evaluation of Rapidly Changing Market Conditions. *Proceedings of the 27th Hawaii International Conference on Systems Science,* 655-662.

Frederick, F., S. Nordqvist, B. Hedin, and V. Ionesco. 1997. Using a Simulator for Testing and Validating a Newspaper Production Decision Support System. *Proceedings of the 1997 30th Annual Hawaii International Conference on Systems Sciences,* 387-396.

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