A Simulation of Newspaper Mailrooms*

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Abstract

The daily goal of a newspaper organization is to produce papers and deliver them to customers. The mailroom provides the necessary link between the two functions. Newspapers are transported from printing presses to the mailroom, where the papers are tied into bundles and distributed to delivery trucks. These mailroom operations occur while newspapers are being printed and must proceed efficiently if newspaper production is to continue. Rockwell International uses discrete event simulation extensively in systems analyses of newspaper mailrooms. These analyses are undertaken for the purpose of assessing the compatibility of proposed facilities with planned operating conditions, solving operational problems in existing systems, and developing support software for customer use. A necessary condition for such a study to be successful is a mutual understanding between customer and analysts of goals and proposed solutions. The customer is the sole judge of success and determines when and whether objectives have been satisfactorily met. The purpose of this paper is to discuss the simulation of newspaper mailrooms and to describe activities and methods which have culminated in successful simulations and useful results. Illustrative examples from past work are provided.

I. BASIC MAILROOM OPERATION

The printing of newspapers proceeds according to a predetermined press production schedule. For each printing press, the schedule specifies the product types and amounts to be printed, when printing is to begin and end, and production rates.

Newly-printed newspapers, called run-of-press product or ROP, move in uninterrupted lap streams into the mailroom, where previously printed materials, such as advertising supplements, Sunday comics packages, and geographically zoned sections, are stored. These materials may be placed manually or by machine into some or all of the newspapers to form finished products calles completes. Alternatively, the materials may be stacked alone and tied into bundles. Two completes having the same ROP newspaper type are designated as two distinct product types if they contain different insert combinations. Thus, even if only one ROP type is printed, there may be many product types.

The completes and ROP papers are stacked and tied into bundles by machine. While bundles of a given product type generally contain the same number of newspapers, some bundles may contain less than the standard amount. This difference in bundle size distinguishes these bundles from others of the same product type and effectively creates another product type. Immediately after being tied, bundles are placed on a material-handling system which transports them to chutes that lead from the mailroom to the truck-loading docks.

One such type of material-handling system is a 'tray' system, which includes a series of carts that are connected end to end and move in the locus of a closed loop. Each cart may hold one or two bundles. A tray system allows bundles which do not quickly exit the mailroom to recirculate the loop. Another type of material-handling system, a 'fast belt' system, contains a series of linear conveyor belts which lead from the places where bundles enter the mailroom to the exit chutes. Although it is operationally simpler, a fast belt system does not allow bundles to recirculate.

A truck manifest defines the intended order of truck entry into the docks, and for each truck, lists the product types and amounts the truck will request, and the order, if any, in which products must be received by it. There are customarily dozens of trucks in the delivery fleet.

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* This work was done at Rockwell International, Graphic Systems Division, Chicago, Illinois.

Proceedings of the 1982
Winter Simulation Conference
Highland * Chao * Madrigal, Editors

Bundles of each available product type are scheduled for imminent exit from the mailroom only if the product is being requested at the loading docks. Thus, while entry of bundles into the mailroom is largely predetermined by the press production schedule, the exiting of bundles from the mailroom is controlled by current events, which are a function of the truck manifest and other constraints, such as the rate at which trucks may load bundles and the availability of trucks.

The extent to which the unforeseen occurence of late truck arrivals at the loading docks decreases the rate at which bundles leave the mailroom often depends on when those delayed truck arrivals occur. Figure 1. is a composite of results from 25 simulation runs. In each run, trucks were randomly delayed in arriving at the docks. The figure is a graph of the average tray conveyor contents in bundles versus time. While the probability of a truck arrival delay is time independent, the effect of delays on tray conveyor contents varies, as shown by the large standard deviations, indicated by bars, at certain times.

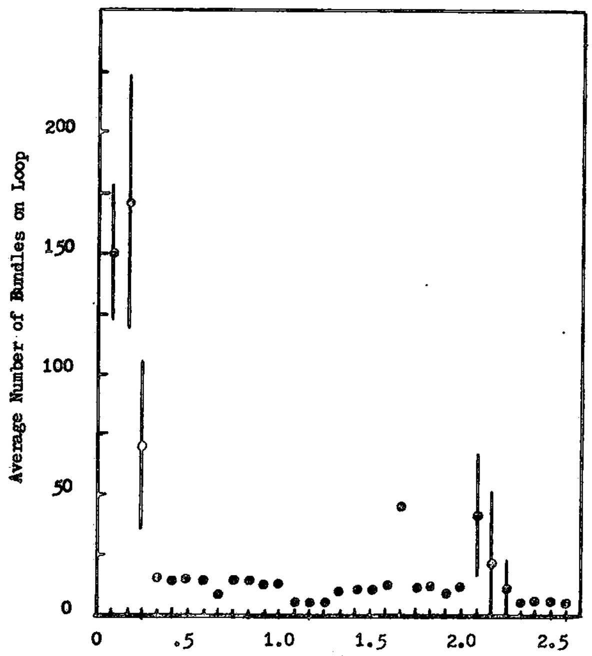

Figure 1. Time from Production Start (Hours)

Material-handling operations in a newspaper mailroom are perhaps atypical in that there is a continuous flow of material entering the mailroom at a rate of up to 75,000 papers per hour per printing press. This material must be quickly processed and removed from the mailroom in order to make room for new product. Depending on the number of papers in a bundle, the mailroom may handle, say, 300 bundles each minute. A tray conveyor of average size can hold about 300 bundles. Since the ultimate goal in the material-handling operations at a newspaper is the prompt delivery of the latest edition to customers, sufficient amounts of the proper product types should always be available in the mailroom to promote efficient loading into the trucks. In addition, large amounts of unrequested products should not accumulate in the mailroom. Using the bundle input rate and tray system bundle capacity mentioned above, a tray conveyor can reach its maximum contents in about five minutes. These stringent operational conditions can only be met if there is a close dynamical relationship between press production schedule and truck manifest. One goal of systems analyses of newspaper mailrooms is the verification or establishment of such a relationship.

Mailroom systems analyses usually involve an evaluation of planned operations for proposed mailroom systems or finding solutions to existing operational problems. In the former case, when these studies indicate that planned operations will be inadequate to meet goals of production and delivery, the task becomes one of determining satisfactory operational procedures which meet necessary constraints.

A mailroom systems analysis study begins with the establishing of goals between customer and analyst. These goals may include specific requests by the customer for, as an example, a revised production schedule or truck manifest. Also, the analyst observes the customer's existing mailroom operations under conditions as close as possible to those to be simulated. Results of the analysis are presented to the customer at another meeting. At that time, the customer decides if goals have been reached. If not, or if study results are preliminary, further discussion establishes revised goals. This procedure continues until the customer's needs have been met. The next section summarizes two simulation studies.

II. EXAMPLES OF MAILROOM SYSTEMS ANALYSES

A. A PROPOSAL FOR A NEW SYSTEM

The analysis and simulations considered two representative days of mailroom operation: a Saturday night, when the Sunday edition is printed, and a weekday. This discussion will be restricted to the weekday operation. The proposed mailroom system which was studied would, when built, be an entirely new production facility.

The truck manifest for the day listed 33 trucks. Each truck requested two product types: one type which was dedicated to the truck (and so would not be requested or loaded by any other truck), and a second product which was common to all trucks. Thus, there were 34 distinct products. Each bundle of a truck-dedicated product type was formed by counting a specified number of newspapers, tying them into a bundle, and then labeling the bundle so that it would be identified as belonging to a particular truck.

Two basic modes of product production were investigated. In one mode, the truck-dedicated product types were processed 'on demand.' That is, the preparation of the product was begun in the mailroom when the truck was ready to load the product and requested it. In the other production mode, these product types were produced according to a predetermined production schedule in anticipation of the arrival of the corresponding trucks. In both modes, the product common to all trucks was produced continuously according to a predetermined press production schedule.

The initial goal of the study was a very general one: to determine the facilities and operational methods needed to produce an effective and efficient bundle delivery system. Two of the most important operational conditions which a mailroom system must meet are (a.) that press production and the entry of materials into the mailroom do not have to be slowed or halted due to an overabundance of newspaper products in the mailroom, and (b.) that the number of bundles in the delivery system is always low enough to provide an adequate safety margin against overloading.

As work progressed, the number of goals increased and became more specific, and included the following:

1. Evaluate the relative merits of a tray system with one loop of carts, a tray system with two loops of carts, a fast belt system, and a system which included both a tray conveyor and a fast belt system.

2. Evaluate the relative merits of on-demand production versus anticipatory (or scheduled) production of truck-dedicated product types, and in the latter case, determine an acceptable order of truck-dedicated product production.

3. Find the minimum number of truck-loading docks needed to operate the system effictively.

The computer model of this bundle delivery system was executed approximately 100 times. From these simulations, it was determined that a tray system with one loop of carts was sufficient to operate the system efficiently, and that a two-loop tray system or a combination tray-and-fast belt system was unnecessary. In addition, it was found that as long as no trucks were late in arriving at the docks (so trucks could sign into the loading docks in the predetermined order) both a single-loop tray system and a fast belt system performed satisfactorily.

Figure 2. is representative of results obtained from simulating a tray system with one loop of carts in which no trucks were delayed in arriving at the docks. This figure is a graph of the bundle loading rate at one truck-loading dock as a function of time. Truck arrivals into the dock are indicated.

Under conditions when even a few trucks were late in arriving, the fast belt system performed poorly, due to its inability to allow bundles to recirculate on the belts. Conversely, the tray system could better adapt itself to late truck arrivals, because it allowed recirculation of bundles on the cart loop, thus acting as a temporary storage facility.

With certain customer-approved production schedule changes, eight truck-loading docks were sufficient to effectively operate the simulated system and still allow for a reasonable number of unexpected truck loading delays or late truck arrivals. The on-demand mode of truck-dedicated product production was determined to be more effective than the anticipatory production mode, since the former is more responsive in accommodating truck-related delays.

B. THE OPERATION OF AN EXISTING SYSTEM

The intent of this project was to provide means of reestablishing an acceptable performance margin in an existing system after production changes had degraded the quality of operations. Unlike the previous example, this problem was purely operational in nature and did not involve a determination of facilities.

Originally, one product type was produced. Each bundle contained two kinds of printer matter, ROP newspapers and pre-printed materials. System performance decreased when the number of product types was increased from one to two by putting ROP newspapers and pre-printed materials in separate bundles. This doubled the total number of bundles processed by the mailroom. As a result, the bundle delivery system was experiencing a severe build-up of unrequested products much of the time.

Mailroom operations for two representative weekdays were considered in the analysis. A required constraint for the simulations was that the truck departure times should closely agree with those which actually occured. Figure 3. is a graph of truck departure time as occurring in simulation versus the truck sign-out order provided by the customer. Results provided to the customer also included revised truck manifests and production schedules. In particular, the order of product type requests in the manifest underwent major changes. The strategy behind these changes attempted to:

1. Provide for a greater variety of available product type requests at any one time. This increases the probability that all available products will be requested in sufficient numbers and that trucks will be able to load bundles at higher rates than before.

2. Time product requests so that the associated ROP product is in production when the product type requests are made.

3. Restructure the truck manifest by giving high loading priority to trucks requesting large amounts of a product type.

4. Tend to place product requests for large numbers of bundles ahead of smaller requests in the truck manifest.

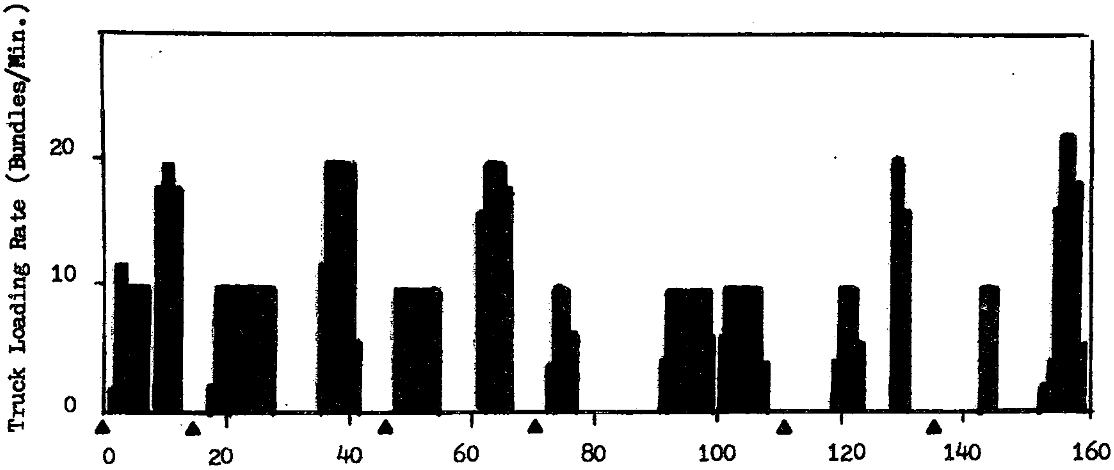

Figure 2. Time from Start of Production (Minutes) (Truck Sign-In: ▲)

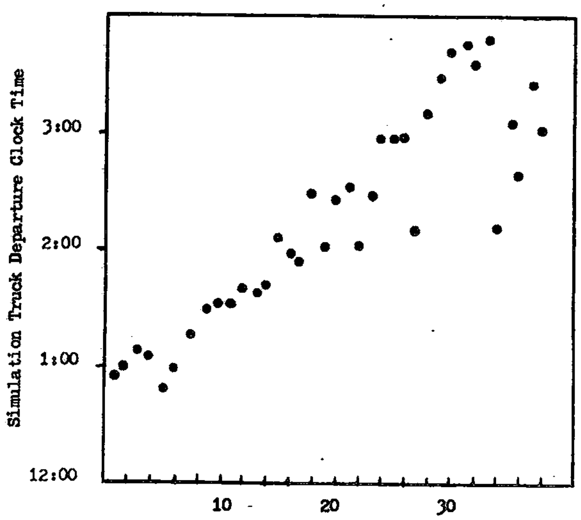

Figure 3. Actual Truck Departure Order

Recommendations were implemented in the operations of the actual system, and as a consequence, the above-mentioned operational difficulties were resolved.

C. SUPPORT SOFTWARE FOR CUSTOMER USE

The insight provided by many simulation studies has made possible the development of system software which is intended for use by customers to increase their system efficiency. This software is a timely alternative to a complete systems analysis and can be used to address the day-to-day scheduled and unscheduled operational changes which every mailroom system experiences.

One software package consists of a set of algorithms which attempt to predict when a tray system is in danger of being overloaded with unrequested product types. Another software package is used prior to beginning a day's mailroom operations. It compares the production schedule with the intended truck manifest, predicts how well production will coincide with product requests, and determines a revised truck sign-in order when the predicted correspondence is a poor one.

III. CONCLUSIONS

A necessary condition for a successful mailroom systems analysis is the existence of a clear and mutual understanding of goals between customer and analyst. This understanding is possible only after careful and detailed discussions between the two parties. These dialogues promote an awareness in the customer of the kinds of questions which analysis and simulation can possibly answer. At the same time, the analyst tries to acquire a familiarity with the customer's system sufficient to allow a credible and realistic analysis. When results are presented, the preceeding dialogues help the customer to judge the success of the work.

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