Proceedings of the 2014 Winter Simulation Conference
A. Tolk, S. Y. Diallo, I. O. Ryzhov, L. Yilmaz, S. Buckley, and J. A. Miller, eds.

PRODUCTIVITY IMPROVEMENT OF A LARGE COMPLEX TRANSACTION PRINT PRODUCTION AND MAIL ENVIRONMENT UTILIZING SIMULATION-BASED MODELING AND SHORT-INTERVAL SCHEDULING

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EXTENDED ABSTRACT

We present a case study in the use of data analytics and discrete-event simulation to improve productivity in a large complex transaction print production environment. Such print manufacturing environments are commonly found within large service bureaus or large financial institutions. These facilities print and mail financial documents in support of such products and services as checking and savings accounts, quarterly reports, and credit card statements and solicitations. Often these documents are legally mandated. In many instances such operations are outsourced to print and mail outsourcing specialists such as Xerox Corporation.

In this case study we investigate an operation that provides print and mail services to over 330 different clients. The overall workflow begins with a print-ready file arriving at the production shop. This is followed by printing on large continuous feed or cut-sheet devices, transportation of the printed output to an insertion area where the documents are inserted into envelopes either manually or by machine, and finally packaged and mailed through a postal service. In addition to the printed documents being inserted, other inserts may include pre-printed documents. Both printing and insertion steps require close coordination with warehousing to provide paper stock for printing (for example white paper or pre-printed stock with institutional logos), pre-printed stocks, and envelopes. Each document printed contains sensitive customer data and often has very short cycle-time requirements (same day to a few days). Errors both in terms of content being printed, insertion errors, as well as missing due date requirements are associated with very large financial penalties that are mandated by regulatory agencies. The demand profile also demonstrates significant variation over time. For example due to financial reporting requirements, print volume in January, month-end, or quarter-end is significantly higher compared to other times of the year. In addition to the need to meet stringent quality and deadline constraints, most of the clients served by this industry have unique production requirements. Customer requirements are highly variable regarding paper stock types, envelope types and sizes, the number of documents being inserted, and the number of inserts going into envelopes and the like. These operations face a very daunting task of running efficiently and profitably in the presence of such sources of variability.

Over the past decade a significant amount of effort has been expended towards implementing ideas such as lean manufacturing and related process improvement techniques under the broad framework of Lean Six Sigma as well as proprietary solutions such as Lean Document Production. In this case study, we will describe how a next level of productivity improvement was achieved by an in-depth analysis of diverse types of production data coupled with targeted simulation modeling and optimization. A key characteristic of the modified workflows included job partitioning into different categories and the introduction of dynamic flow manufacturing with short interval closed-loop feedback into the operations.

One important characteristic of the print and mail operations is that machine throughput varies significantly with the product type being manufactured. Implementation of flow balance between multiple steps is therefore difficult as it is different for nearly each of the 330 products. Historical data was analyzed to determine how throughput varied for each product across all machines on which it was produced. Simulation models were built for different scenarios to estimate the capacity of the shop and expected performance at different demand loadings. Based on the simulation results, staffing and equipment assignments for different product types were developed.

A short-interval scheduling approach was implemented whereby jobs were sequenced and prioritized using a combination of job size and due date requirements. Machine assignment mappings were developed using available equipment that resulted in balanced flow across the multiple steps of the production process. Production metrics were monitored on an hourly basis and machines were pre-empted by new jobs to ensure that that job work in process (WIP) was controlled and flow was maintained. A tool was also developed that enabled operation managers to evaluate different flow balance options in real-time. Simulation models were utilized to study various scenarios by estimating production metrics (such as job lateness, throughput rates, cycle times, and WIP) and determining improved operating policies. Data visualization techniques were deployed to provide further insights into the various areas of production operations.

The solution was first implemented during a quarter-end production run when volume is typically high (a stress case). The new approach demonstrated a reduction in overall makespan from 7 days to 5 days and an average job cycle time reduction by 33%. Further, periods of under-utilized capacity were identified during non-quarter end periods. Workload balance across a similar site was performed to significantly reduce overall enterprise operational costs. Deployment of size-based routing policies across a broad mix of equipment and job types resulted in improvement of flow and capacity utilization. Overtime labor cost savings of 6% were realized for quarter-end production along with a reduction in equipment service and maintenance costs. 10% reduction in recurring labor costs during the remaining (non-quarter end) periods was also realized. The site production volume on the reduced cost-base was increased by 40%. The client contract for this operation has 5 years remaining. Therefore, implementation of these changes going forward will result in millions of dollars of costs savings over the life of the contract.

In summary, this case study describes the use of high-variety data analytics, visualization, and simulation modeling for capacity and real-time production process planning. In addition, we describe the use of short-interval scheduling policies motivated by simulation studies in a high variety production environment. We demonstrate significant productivity gains over and above what can be achieved through standard process improvement techniques prevalent within the industry.

By capturing data from multiple sources in these large service operations, aggregating them intelligently and performing analytics and simulations, it will be possible now to achieve significant productivity improvements within an industry that is facing extremely high cost pressures and ever increasing requirements on cycle time and quality.