Sheetfed Productivity Characteristics

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Abstract

This study was designed to benchmark companies' performance based on imaging, press makeready, downtime, plate remakes, maintenance, and other key operating measures. This gives unequivocal comparisons with competing firms since all companies will be producing the exact same job.

> *Benchmarking is the process of identifying, understanding, and adapting outstanding practices from organizations anywhere in the world to help your organization improve its performance.*
>
> —Wikipedia

The objective for this investigation was to provide a technical benchmark for sheetfed printers on their production performance both in the prepress and then on the press. This information was gathered using a "real" production job where it has been possible to characterize each individual step of the process. Two earlier studies, carried out in 1998 and 2006, proved effective on identifying the bottlenecks within workflow systems, provided opportunities for improvement, and revealed which equipment changes had a large impact on productivity.

The job selected for this study is a four-over-four print run, that has been provided as either PDF files or Adobe InDesign files, which in both cases one side needed to be imposed. The test files have been designed to challenge the prepress workflow and identify differences in performance. There is no specified screening technology; the prints produced have been made using both conventional and stochastic screening methods.

The benchmarking evaluation has shown that there are significant differences in imaging, platemaking, production speeds, and waste levels and downtime between the printers that participated in the study. Press sheets were provided to allow an acceptable match to be obtained. The main differences in performance are identified and solutions suggested improving performance.

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Introduction

This study has been designed to allow companies to benchmark their performance based on imaging, press makeready, downtime, plate remakes, maintenance, and other key operating measures. This benchmarking service gives unequivocal comparisons with competing firms since all companies will be producing the exact same job.

The objective for this investigation was to provide a technical benchmark for sheetfed printers on their production performance both in the prepress and then on the press. This information was gathered using a "real" production job which made it possible to characterize each individual step of the process. This provides unequivocal data on the status of production for each of the participants manufacturing sites and across the industry as a whole. By providing this data it allows for an informed decision to be made on the production priorities, areas for improvement and areas where companies have excelled. An earlier study, carried out in 1998, proved effective on identifying the bottlenecks within the different workflow systems, provided opportunities for improvement, and revealed which equipment changes had a large impact on productivity.

The job selected for this study is a four-over-four print run, that has been provided as either PDF files or Adobe InDesign files. Design of the form included a single image placement on one side and a series of images that required imposition on the apposing side. The minimum sheet size for the job is a 19x25-in., with a weight between 80 lb. and 100 lb. The test files were designed to challenge the prepress workflow and identify differences in performance. The content of the poster has been specifically selected to provide help in solving different printing problems throughout the workflow as a usable promotional piece for the participants. There is no specified screening technology; the prints produced have been made using both conventional and stochastic screening methods dependent on the existing practice at the printers' facility.

Investigation Overview

The images for the test form were designed with elements selected to test the capabilities of both the prepress and pressroom. The front image is a poster that included fine reverse text, heavy coverage, and a number of file issues specific to the images, Figure 1. The file challenges include a vectorized image (hand on the color measuring instrument) and highly oversized images, which required a reduction to fit. These all would not affect the final image quality, though they would affect the time for processing if not handled correctly.

The back-up to the front poster, was a five-page document that had to be imposed. Just like the front, several elements were built into the images and layout that would challenge both prepress and the pressroom. Some of the troublesome elements included a variety of flesh tones; very saturated process builds of spot colors, potential for mechanical ghosting, and fine reverse type. Unlike the past benchmarking study run, the use of a two-sided document more accurately portrayed a typical production job for a sheetfed press.

Figure 1. *Front side poster (left) and back side imposed document (right).*

The job was produced at the Printing Industries of America production facility on the Komori Lithrone sheetfed press to provide press proofs for all of the participants. In addition, this provided the opportunity to confirm the relevance of the questionnaire provided, assess different workflow systems, and benchmark the production. The results of the internal press trial were included in the results as this facility functions as a production facility.

The specifications for the print run were provided to all the participants, ***Table 1***. The objective was to allow each of the participants to follow their typical workflow and not to have to purchase any specific materials or modify their typical operational procedures. The image was 19x25-in. to allow any half size or full size press to participate or full size 40-in. press. Screening was not specified, and it was recommended to use the operation's typical screening method. Paper and ink were not specified either, but it was highly suggested to print on 80lb. or 100lb. coated stock. By using a heavyweight sheet the samples returned for analysis could be compared in terms of print quality, which included densitometric measurements and image quality inspections.

Press requirements	19x25 inch or larger format size, four units or more.
Screening	This is to be determined by the printer.
Paper	80lb. to 100lb. C2S #1 or #2 grade, any finish.
Ink	Standard house ink.
Job sequence	Sandwich the benchmarking job between live jobs or insert as the final job of a shift. No cold start. No change of ink sequence.
Color OK:	The objective is to visually match the supplied press OK sheet.
Coating:	Please ensure that the test strip is **NOT** coated.
Total run length	1,000 good sheets to be produced.

Table 1. *Specifications for the print run.*

The one requirement specified to the printers was that the job needed to be sandwiched into normal production and not be the first cold start of the day. This would provide a more representative evaluation of the print run. The total run length was to be 1,000 good sheets of which 50 needed to be returned for analysis. The quality of the prints was evaluated to ensure that the job was of commercial quality. During a previous study it was necessary to eliminate participants from the study due to poor print quality. During this study none of the prints were eliminated as all the companies' submitted prints that were considered acceptable.

A questionnaire was developed to document the company profile and the equipment that was used to produce the job in both the prepress and pressroom. The times to perform each step through prepress and in the press room were broken down by task. This breakdown of time covered from insertion of the DVD into the drive to end of the production run. Finally, there were questions related to the general waste numbers and process controls that were used by the printers.

Upon completion of the press run and questionnaire, 50 sample press sheets and the questionnaire were to be submitted back to Printing Industries of America so that the results could be analyzed.

Results and Discussion

A discussion of the finding from this study will be separated into several sections. The first section will include an explanation of the demographics of the participating companies to include classification, market segment, staffing, and equipment utilization. Following the demographic information the results of

prepress operations is discussed. This will cover the time from when the DVD was entered into the computer until the final plate inspection took place. In the pressroom, productivity will cover the time for each of the makereadies time required spent performing other tasks to get the job off press, and information about the press operational conditions to include press speed and configuration about the press.

Demographics

Participation in the benchmarking study was open to any printing operation with some form of sheetfed lithographic printing equipment. Participation was not limited by the size or number of units on the press. In the past there have been participants that printed on a two-color press, but during this analysis all presses were four-color or more.

Of those printing operations that participated, the majority classified themselves as general commercial printers (82%), Figure 2. The term general meant these prints were not focused into a specific market but would take on any print job that could be produced on the equipment in that particular printing operation. The second largest group of participants, which were significantly less than the general commercial printers, were those that classified themselves as "other." This group included in-plant operations and those in education or correctional facilities that did their own printing.

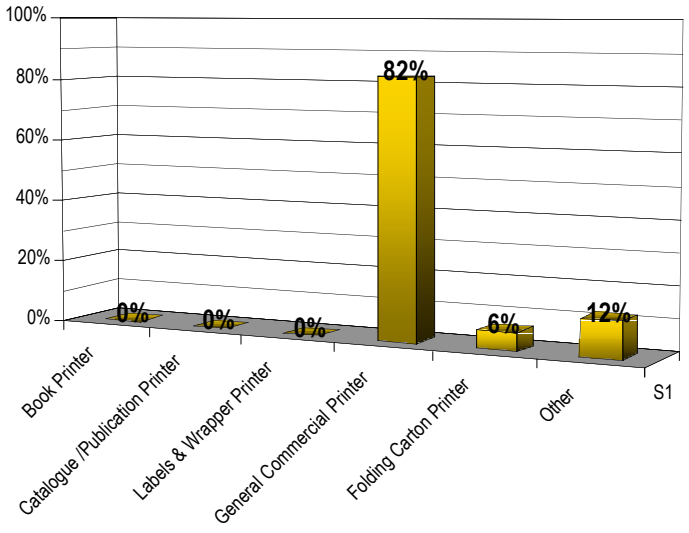

Figure 2. *Category of participants.*

In addition to general commercial printers and those catering to their own internal needs, there was a small group of printers that did folding carton work. This group of four printers was shown to have much larger printing presses and not only printed for color process but had many units designated for spot color work and/or coatings/ overprint varnishes.

Staffing within these operations varied based on the type of printer they were and the equipment they were operating, Figure 3. The vast majority of participants had between 50 and 99 employees in total. The smallest operations had between 20 and 49 employees, which constituted for 18% of the participating body. Twenty-four percent of participating companies had more than 100 employees. The majority of these employees from the larger companies worked in other areas besides the pressroom to include, bindery, fulfilment, digital printing, and/or other non-printing related services.

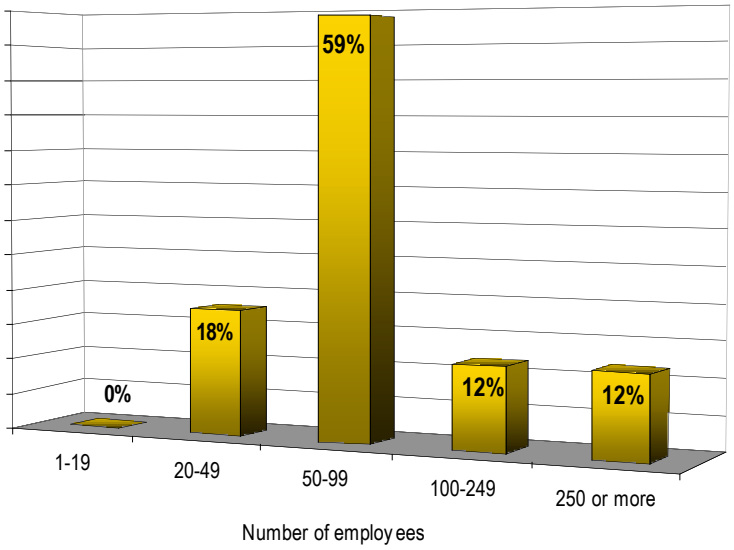

Figure 3. *Number of employees.*

Crew size of the presses being benchmarked varied among the participating operations. A total of 18% of the participants operated the press with a single press operator. This individual was tasked with feeding and operating the press. Of these single operator operations, 28% of them had an individual on staff classified as floor help. This individual was used for staging of materials for the operator so that operator time was not wasted between jobs.

The majority of participants (82%) operated the press with a two-person crew. These two-person crews were operating 6- to 12-unit presses with sheet sizes varying from 28-in. to 41-in. in width. Floor help on these presses was available in 72% of the operations. These were typically the larger pressrooms with multiple presses and therefore the floor help was not designated to a single press but to multiple presses and in some cases all of the presses to include any other printing methods they may house. This includes digital, heatset web, flexography, or gravure.

Sales volume of these operations did not correlate very well based on the number of employees, Figure 4. This confirms that sales can not be tracked by employees, but is directly related to the products they produce and additional services they supply, such as fulfilment.

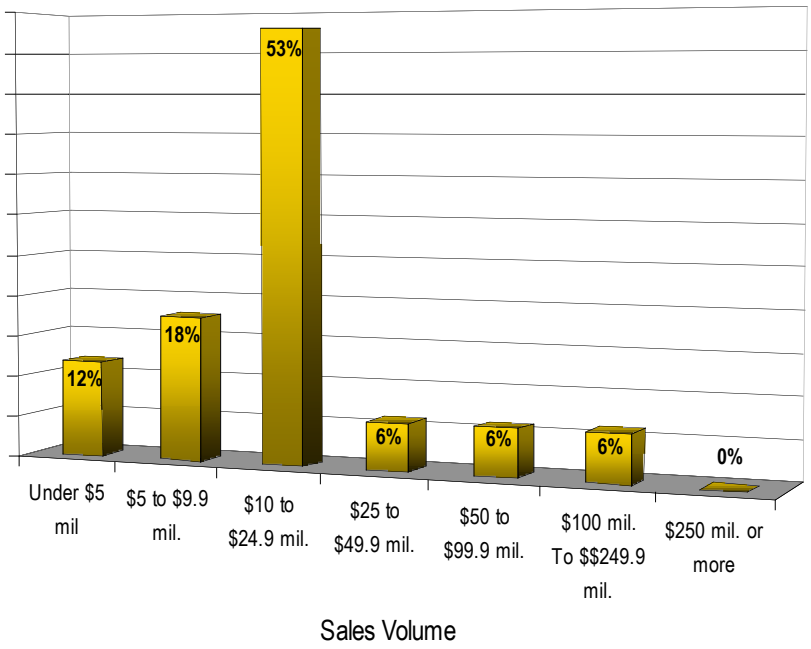

Figure 4. *Annual sales volume of participating companies.*

Those printers that exceeded annual sales of $25 million or more (18%) were those printers that had eight or more presses with the majority being 6 or more color sheetfed presses and at least 5 heatset web presses. There was one single participant that was in this annual sales range that did not have heatset printing

capabilities but did have nine digital presses. Of those printers that did not exceed $25 million in annual sales, 86% of them had at least one digital press.

Image Processing and Plate Production

The primary focus of this benchmarking study was to document the production time of the same job produced by many different printers utilizing a wide variety of prepress and pressroom equipment. This information was to be used to provide direct feedback to the printers as to their performance and to provide the industry with an understanding of typical production times producing a 4/4 sheetfed print run. To accurately gather the total production time, the time required for each step in the process was collected separately.

Prepress production time was separated into the time required for file preparation, RIP and trapping of the files, additional time processing the files, followed by plate production time.

Plate production was separated based on equipment utilization. In previous studies it has been show that the level of automation in prepress for plate production had a significant impact on the total production time of the plates.

The test image files supplied to each participant were in both PDF format and Adobe InDesign. By supplying the files in two commonly used file formats the operator was allowed to determine which files would be used based on the workflow and equipment available. The InDesign files were assembled prior to packaging for the printer, with the packaged files containing the layout, images, and fonts. The PDF files available for use were generated from the InDesign files and distilled based on the PDF/X-3:2002 specification.

File utilization did not show one file format to dominate another. However, the majority of printers (41%) did use the PDF files as these printers had a PDF workflow in place, Figure 5. Almost a quarter of the participants did not use the PDF files, but instead used the InDesign files. InDesign users stated that these file formats were used based on a non-PDF workflow or the operator felt that they had more control over quality if InDesign files were used. Of those using the InDesign files it was identified that 35% converted the InDesign files to PDF.

The concept of converting the InDesign files to PDF was considered at first to be a non-traditional approach as this was seen as adding addition time to the file processing process. To discover why this was done, all of the participants that converted the InDesign files to PDF were contacted. Information supplied by these printers revealed that based on their workflow it was more time efficient to impose side two of the poster in InDesign instead of generating an imposition

template in their workflow. Others stated that the file format conversion was done so that the PDF files were produced based on a custom set of settings used by that operation to provide better image quality and color control.

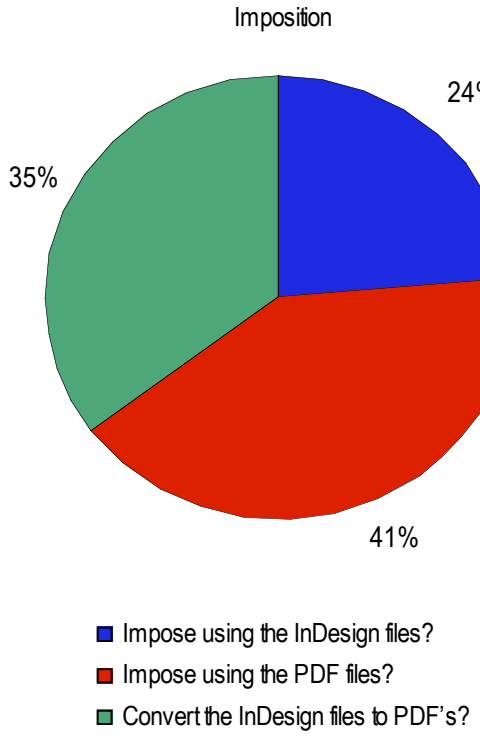

Figure 5. *Utilization of file formats.*

In terms of time required to process the two file formats, there was a clear distinction as to the more efficient file format. The results show that the InDesign file users required on average 70 minutes to process the files. PDF users/workflows were much more efficient with an average of 39 minutes to process the files and prepare to make plates.

Analysis of all of the participating printers combined showed that the average time to process the files was 70.5 minutes, Figure 6. This value was skewed by one significant outlier that took 175 minutes to process the files due to font issues. The median which omits this outlier shows that only 39.75 minutes were required to process the files. The top 25%, all of which were PDF users completed all of the file processing tasks within 30 minutes. Those that took the longest (in the 75% quartile) to process the files required 64.8 minutes.

After the files were processed and plates were ready to be made, a new time count began. At this point, the time required to produce all plates required to produce the job was counted.

During the plate production process there were two scenarios that took place. The most popular of these scenarios was to produce eight plates, four for the front and four for the back. The second scenario was to setup the job as work-and-turn, which only required four plates, but could only be done on the 40-in presses.

The results of the analysis process show that the work-and-turn option was the most efficient, not only based on material savings, but times savings as well. More interesting than the efficiency capabilities of the 40-in. presses was that fact that less than 5% of the participants printing with a 40-in. press utilized this technique.

The results of the plate output were separated based on those systems which were automated, meaning no operator handling of the plates and those systems which were not automated, and meaning an operator had to handle all of the plates.

Here it has been show that based on the average the automated systems required 63% less time than the manual systems, Figure 6. The fastest 25% included a significant number of those printers utilizing a 28-in. press and the printers utilizing the work-and-turn process. As expected, the time required to produce a 40-in. plate was almost double that of the 28-in. plates.

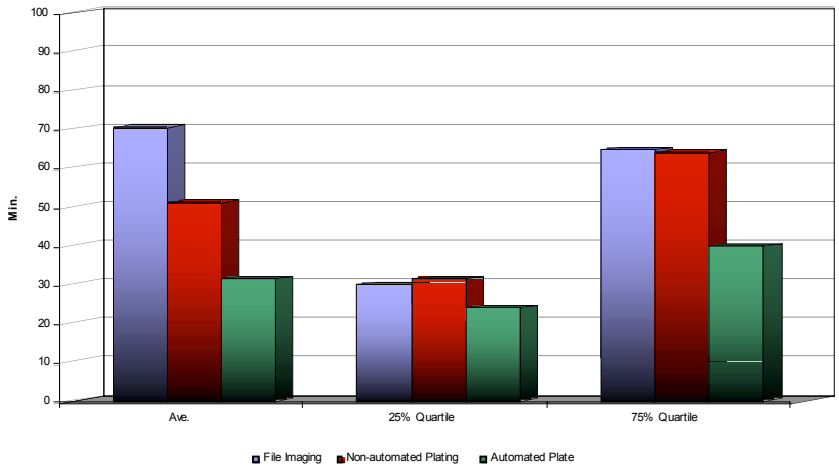

Figure 6. *File imaging and plate production time.*

Production of plates by those printers in the 75% quartile required an average of 64 minutes for those without an automated plate system and 40 minutes for those with an automated plate system.

The reasoning for those who ended up in the 75% quartile varied. For some it was experience of the operator or time required performing other tasks within the operation, but more often than not it was related to the equipment.

Discussions carried out with those printers in the 75% quartile revealed the slow processing times were directly related to the processing speed of the plates, pre-bake and/or post-bake requirements, and errors during imaging, which required plate(s) to be remade.

On the questionnaire the participant was required to document the time spent inspecting the final plates. Here it was discovered that 18% did not inspect the plates at all. On the questionnaires that did not have a plate inspection time it was noted that the plants are randomly inspected per shift, not all plates. Of those that did inspect plates the time spent varied. The average was approximately 1 minute per plate for a total of 8 minutes for the set. These in the 25% quartile spending the least amount of time inspecting the plates averaged 3 minutes. One of these printers said they only measure the dot area of the cyan plate for each job to ensure the proper curve was applied and the dot area was correct. An average of 10 minutes was spent inspecting the plates for those in the 75% quartile. These printers said the time was spent inspecting the image content against the proof, measurement of all plates, sometimes at multiple screen values, and a combination of image inspection and measurement.

Press Room Productivity

Productivity in the pressroom was separated out into several time intervals based on commonly performed tasks during the makeready process. This information was further separated by the fact that two makereadies (side 1/side 2) were required to complete the project. For each makeready the operator(s) were asked to record the time spent on setup activities (blanket washing, plate mounting, loading paper, adding ink, etc.), achieving register and color, number of pulls to achieve register and color, and the total number of makeready sheets consumed.

The results from the information collected was be based on the time required for the two makereadies based on the total time required to perform all makeready steps and the total amount of material consumed/wasted during the makeready process. Actual production time of the good prints is not discussed, but is included during the discussion of the total production time to complete this project.

During the makeready process the two primary achievements were to get the press setup to print and then the actual makeready process. As each printing operation has different equipment, staffing, and methods for setting up the process of preparing to print which was defined as all activities required to setup the press, up to the point of turning the press on.

The first makeready setup activities showed that the average operation required 21.2 minutes to setup the press. Several of the printers did it much faster than the average as the top 25% completed the setup activities 6.2 minutes faster for a total average time of 15 minutes. Those printing operations that were slower than the average either lacked press help, did not have materials or instructions ready, or both as these printers took 9 minutes above the average to complete the setup activities. If one estimates that an operation can do 6 makereadies per shift and 9 minutes are wasted per makeready, which equals approximately one full hour per shift wasted.

Setup activities for the second makeready were on average faster for all printers in comparison to the first makeready. Prior to the second makeready, the setup activities were completed for the average printer 3.3 minutes faster. Those in the top 25% quartile performed these activities 5 minutes less than the others. Those printers producing the greatest time difference amongst setup times were those in the 75% quartile. These printers on average saved 10 minutes. This contributed to the fact that these operators spent more time gathering materials before setup activities for the first makeready; therefore, they did not have to do so for the second makeready. The fastest operations used floor help to gather materials saving the operation 10 to 15 minutes per makeready.

Upon starting the press, the time required for achieving register and color for each makeready was collected. This information shows for the first makeready that the average printer spent 30 minutes to complete these activities consuming approximately 688 sheets of paper, Figure 7. The top 25% completed the steps of achieving register and color in 15 minutes only consuming an average of 400 sheets of paper. Some of the printers at the average time spent achieving register and color consumed 900 sheet or more these printers either took a lot of pulls or printed an excessive number of sheets per pull.

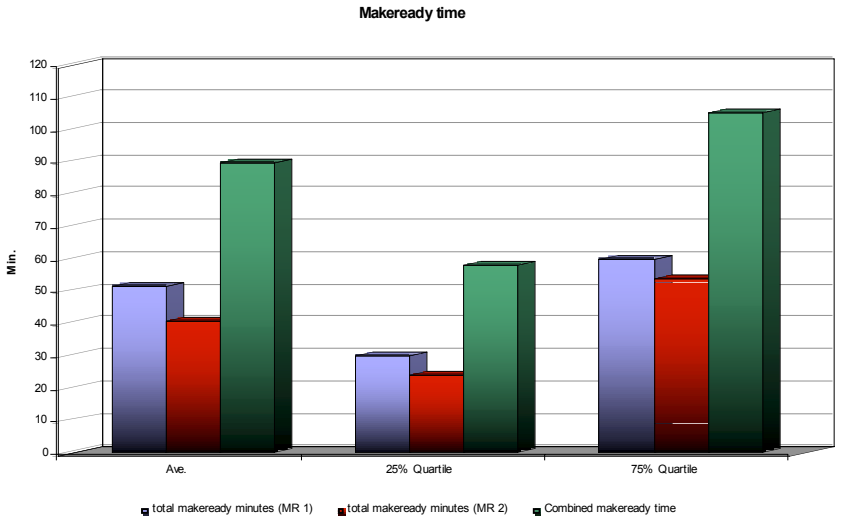

Figure 7. *Makeready time.*

The second makeready showed a substantial savings in time and material. It became apparent that while a crew is working on a particular job, they become more in tune with the requirements and press conditions. As was seen with other activities, the second press runs achievement of register and color was measurable faster. During this makeready, the average time was 10 minutes faster for a total average time of 20 minutes with a reduction in the number of sheets consumed by approximately 200 sheets. Compared to the average, printers in the 25% quartile saved 5 minute in time and more than 150 sheets.

To gain a greater understanding of the makeready process and how time and materials interact, the number of prints produced per press operator pull to make adjustments was calculated.

Prints per pull were calculated by dividing the total number of makeready sheets consumed by the number of pulls the operator took. During the first makeready the average printer made a pull every 142 sheets, Figure 8. Printers completing the makeready in the least amount of time (25% quartile) only allowed 75 sheets to pass through the press before making a pull. Those printers to pass the most amounts of sheets through the press (75% quartile) before making a pull consumed 160 sheets per pull on average.

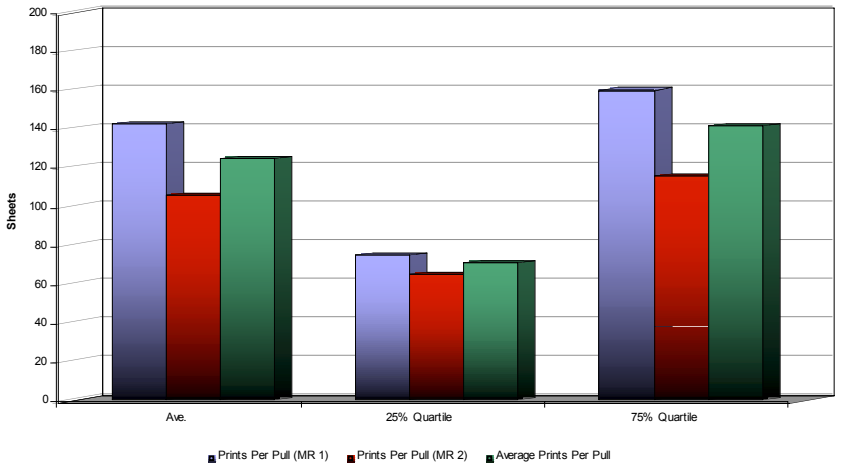

Figure 8. *Prints per pull.*

During the makeready of the second side of the form, the prints per pull were significantly reduced. The average number of sheets dropped from 142 to 106 sheets. The top 25% reduced consumption by 10 sheets per pull. The prints in the 75% quartile had the greatest savings from the first makeready to the second by reducing the prints per pull from 160 sheets to 116 sheets.

In total the combined makeready times between printers were significantly different. When comparing the fastest to the slowest based on a breakdown of the results in quartile format, there is a 45-minute difference between those in the 25% quartile and those in the 75% quartile. The average time spent on the total makeready process based on all participants showed 90 minutes on average was spent performing the makereadies.

Paper consumption during the makeready process was significantly different as was the time spent performing the makeready process. The average printer producing this job used 1,115 sheets for makeready operations. This is significant considering the total good sheet count requested was 1,000 sheets. Consuming the least amount of makeready sheets were those who ranked in the 25% quartile. These operators on average consumed 665 sheets, a savings of 450 sheets over the average. According to current paper prices the average cost for an 80lb. coated text weight sheet is $0.23. At this price the total savings for those in the 25% quartile is $112.50 per form. If three forms can be printed per shift (6 makereadies) this is a $337.50 cost savings per shift or $84,375 per year based on the press being operational for 50 weeks out of the year.

Beyond looking at time, material, and cost factors driven by the makeready process, there is the fact that the total cost of the job includes the actual time beyond makeready until the last good impression comes off press. In fact, the job and costs associated with production start adding up from the time the job is received until the last print lands in the delivery pile.

Total production time for this project is based on the total time the job was worked on by either prepress or the pressroom department. This time also includes additional time noted by those individuals filling out the questionnaire that noted additional time for specific reasons.

Analysis of the total production time based on the average printer showed the job took 203 minutes to complete, Figure 9. The printers in the 25% quartile were significantly faster, as these printers were 65% more efficient completing the job one hour faster.

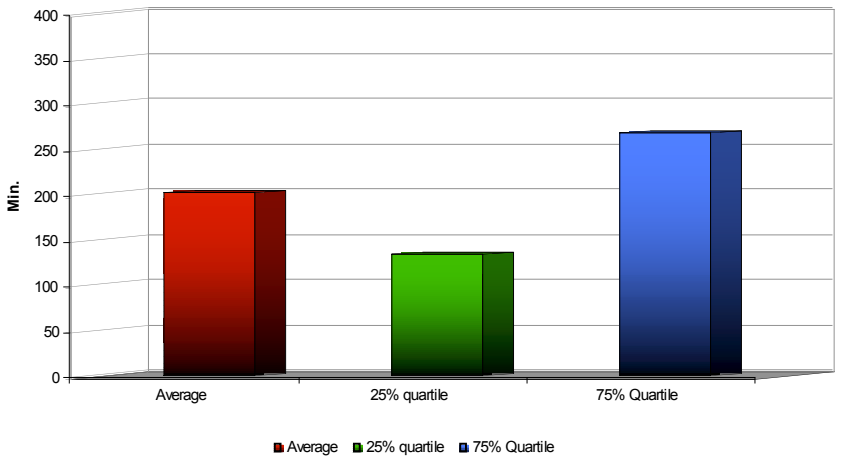

Figure 9. *Total production time.*

Those printers in the 75% quartile had severe productivity issues as the average printer in this category required over an hour in more time than the average and more than two hours more than those in the 25% quartile. The cost of this excess time based on the average and producing 3 two-sided forms per shift at a labor rate of $40 per crew working 50 weeks per year is approximately $30,000 per year in lost productivity time. For reasons explained in this section of the report, benchmarking and defining productivity are invaluable. The cost savings factors and knowledge of competitive profit margins is the simple reason why benchmarking should be carried out annually within an operation.

Correlations

In addition to analyzing the productivity of the supplied job and analyzing the costs associated with poor productivity, correlations were made based on several factors that have a significant impact on the productivity of an operation.

Makeready time based on the age of the press has been a selling point for press manufacturers for many years as increased automation on press has provided increased efficiency. Key automated features like automatic plate mounting, blanket washers, and automatic impression cylinder cleaning are now a necessity on a press rather than a luxury.

Devices on press that free up the operator's time to perform other tasks are directly related to efficiency. This can be correlated to press age by the fact that these technologies are moderately new (within the past 12 years).

Results from this study showed the presses with the fastest makeready times were those between 2 and 7 years old, Figure 10. No new presses (less than 1 year) were included in the study. There were some outliers that had moderately longer makeready times with the presses being relatively new. When asked, these operators identified the automation was either not used or was not purchased for this particular press.

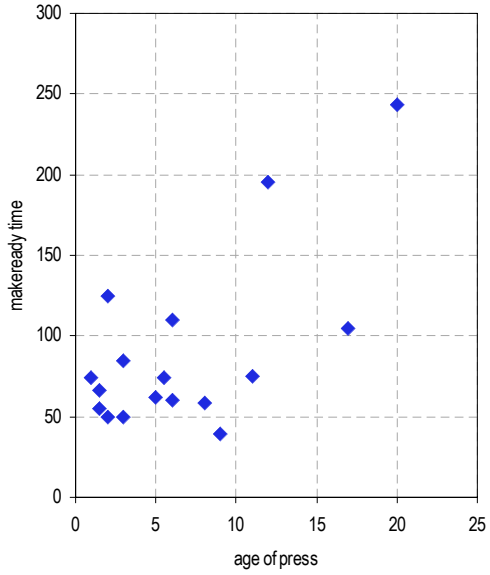

Figure 10. *Makeready time based on age of press.*

Those presses exceeding 10 years in age all had a clear distinction as to if the press was equipped with automated features or not. Discussions with those printers revealed that management, for reasons unknown' decided at the time of purchase not to buy the additional automated features, which years later have become the norm on many of the newer presses. This dates the equipment and makes it less efficient.

The correlation between makeready time and total waste was unexpected. One would assume that makeready time would increase as total waste increased. This was not the case as evidenced by the three primary groups defined. They are those taking approximately 60 minutes consuming less than 1,000 sheets, those taking 60 minutes consuming more than 1,000 sheets, and those taking over 100 minutes consuming anywhere between 400 and 2,250 sheets.

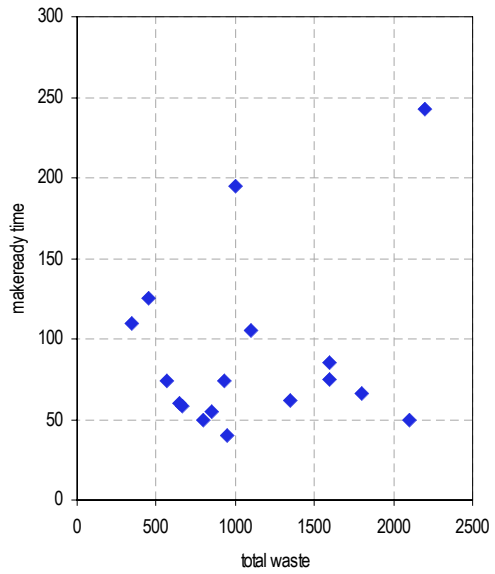

Figure 11. *Makeready times impact on total waste.*

Another group would classify those printers that completed the makeready in the same amount of time (40 and 75 minutes), but consumed well over 1,000 impressions. The cause of the excessive waste was attributed to the sheets per pull count as many of these operators allowed a substantial number of sheets to pass through the press before making a pull but ended up taking fewer pulls in come cases.

The final grouping of printers is those that took over 100 minutes to complete the makereadies. Among these printers the total waste varied significantly.

Reasoning of the excessive makeready times, for example only consuming a minimal amount of waste, was attributed to excessive setup time or an operator who shutdown the press after making a pull and took a substantial amount of time getting the press back up in preparation of making an additional pull or starting the job. In a very limited situation there were printers that took over 100 minutes to makeready consuming over 1,500 sheets of waste. These operators were plagued with issues to include operation issues, equipment, and skill set.

Conclusions

The benchmarking evaluation proves that there are significant differences in imaging, platemaking, production speeds, waste levels, and downtime between the printers that participated in the study.

The study covered a wide range of commercial printers, with the printing sales volume varying between $10 million and $50 million. The files to be printed were provided as PDF and InDesign files, but the majority of the participants used the PDF files for the file preparation. There were many different RIP systems, and the users predominantly used a 175-lpi screening, although both higher screenings and stochastic screenings were also used.

There was a large difference in the reported prepress production times. This was an indication of the differences between systems and also the accurate tracking of information in this department. The average time has improved since the 1998 study with a significant reduction in time taking place. A significant saving has been achieved from the faster imaging speeds that are currently available.

The print job was specified to produce 1,000 good sheets. Five press manufacturers were represented in the study, and the presses ranged image from slightly over one year to twenty years, with the average age being approximately six years. The makeready times were on average 90 minutes for the job (to print both sides), a reduction on average of 28% compared to those in 1998. The top performers in the study were considerably better, with the fastest being completed in 40 minutes, while the top quartile performers were all less than 58 minutes. The top performers were generally those that carried out inline perfecting, did a work-and-turn on a 40-in. press, or had a structured makeready procedure. This can be identified by those whose makeready times were similar for both sides of the print run.

The total waste produced for the print run was on average 1,115 sheets, while the top quartile performers were all less than 665 sheets. This is, on average, a 40% reduction in the waste levels from the average. Several printers had very high waste, with four companies having 2,000 or more waste sheets, which affected the average. The best performers wasted fewer than 400 sheets, which was a 55% reduction on the waste generated during the 1998 study. The sheets

per pull varied, and in certain cases, this is an easy and effective method to reduce the total waste. The high waste numbers impact the ability to compete with short-run digital, especially when the waste numbers are almost twice that of the job itself.

The total production time was calculated by adding the prepress time, make-ready time, and running time for the print job. It is worth noting that the production speeds used for the evaluation were low, with an average speed of only 10,000 impressions per hour. This was influenced to some degree by the short run length of the print job. The total production times varied from 79 minutes to 450 minutes, with an average time of 203 minutes.

This study provides an invaluable insight into short-run production on a sheetfed press and indicates the wide variance in production times and methods being employed. It provides real data, based on an actual job, by which to identify areas that you can increase productivity and reduce waste.