Quick Start Print System of Commercial Offset Press

SHIGEO MAKINO*1
MASAKAZU AKATSUKA*1
TATSUO FUJIKAWA*2
SHINICHIRO SENOO*2
HIROSHI KOBARA*2

Most of the printed matters including folded leaflets of newspapers, catalog magazines and books displayed in the bookstore shelves are mass-produced using commercial offset presses with printing capacity of approximately 50 000 copies per hour, with the amount of paper consumed being huge. About 10% of the consumed paper is laid on the shelf (as waste) because of the difference in the color of the sample, which mostly occurs during the printing start time, i.e., in the quasi-printing stage. The "Quick Start Print System of Commercial Offset Press" is equipped with a system capable of reducing the said time zone by half, contributing to the saving of resources and improvement in productivity.

1. Introduction

The diversified market needs for the conventional commercial offset presses used mainly for large-lot printing are shifting towards medium-and-small lot printing and short-term delivery production while maintaining the rapid printing speed. In order to meet this demand, it is necessary to improve the production efficiency by drastically reducing the waste paper generated at the time of printing start in addition to shortening the start time after the exchange (switching) of printing job. However, there was some limit with the conventional drive system and operation control method in achieving the aforesaid goals.

Hence, several types of new mechanism and new systems adopting independent drive motor and shaft-less system were developed to allow wider option to the operating method in order to respond to the market need. These technologies developed ahead of the German makers, which had taken lead in the field of shaft-less drive, are used in new commercial offset presses, MAX and SSS, and are already in operation in the market.

2. "MAX-Saver" for Realization of Higher Productivity

2.1 Need for shortening the (printing) start time

As shown in **Fig. 1**, printing is carried out by a group of ink rollers that make a thin film of ink, a plate cylinder equipped with a press plate with the pictures (images) printed on it, a damping roller device that supplies water to the surface of the press plate and a blanket cylinder that once transfers the pictures on the press plate. The printed paper (web) is then dried with a drier and is cut into specified sizes and folded before being discharged.

In the case of color printing normally 4 colors (black, indigo blue, red and yellow) are mixed to provide different color tones, with the color tone of the transferred pictures, printing positions of the 4 colors (register), cutting position and folding accuracy counted as the factors most influencing the printing quality. These factors delicately react to the changes in printing speed and tension at the time of paper traveling depending on the quality of the paper, and cause difference between the printed paper and the proof sheet, resulting in generation of waste paper that cannot be counted as a product. Various adjustments of the aforesaid color tones are carried out during the time zone of printing start in order that the printed paper conforms to the proof sheet. However, the longer the time taken for these adjustments, the larger the waste paper quantity. Hence, shortening the start time is an important factor leading to the reduction in the waste paper quantity and to improve the productivity.

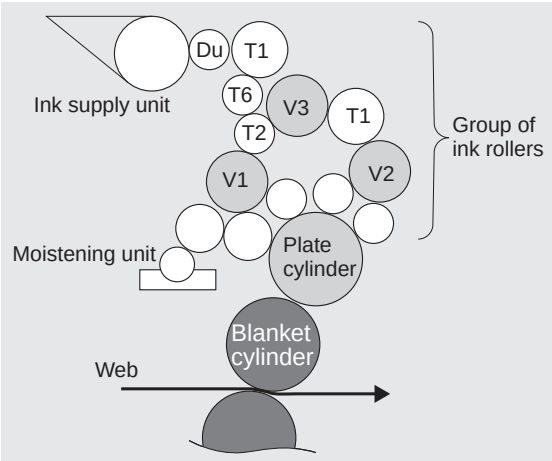

Fig. 1 Principle of printing
Shows ink and moistening water used for printing.

*1 Hiroshima Research & Development Center, Technical Headquarters
*2 Paper & Printing Machinery Division

Further, since job changeover in printing is generally carried out by the unit of several hundred thousand copies, and since a commercial offset press is capable of printing five hundred thousand copies per hour, one job has to be completed in less than 1 hour at the shortest. Making changeover of jobs dozens of times a day is not a rare case, so that shortening the changeover time leads to improving the operating factor of the press, which is desired by most customers. In order to meet with this demand, we have developed MAX-Saver by making use of the shaft-less technology.

2-2 MAX-Saver and shaft-less drive

MAX-Saver is composed through organic combination of a large number of functions required for printing such as various automated devices and press control devices (IPC: Intelligent Press Control), etc. in order to improve the stability of the press and to respond to the demand of skill-less operation in addition to "shortening the printing start time" and "reducing the waste paper," and is a system that aims at comprehensive improvement in productivity.

Fig. 2 shows the configuration of MAX-Saver. It is equipped with a shaft-less drive system indispensable to improving the productivity and the "MAX-Expert" function that makes the most of the shaft-less drive system.

The shaft-less drive system replaces drive transfer shaft, connecting in-feed (feed control) unit, printing unit, cooling cylinder (for cooling printing paper), web-pass (paper transfer) unit and folding (paper cutting and folding) unit that conventionally required synchronized driving, with independent motors for the aforesaid units to ensure synchronized driving.

The basic technology for this system is the conventional "multi-shaft simultaneous control technology" used in machine tool, with the substantial differences between the two being as follows: the phase synchronization and speed tracking synchronization of the various units for driving the whole printing machine operate under the command of Virtual Master that creates the virtual synchronizing signal (SYN); the motors used need high power and further the printing machine as a load has an extremely large moment of inertia. Hence, the motors are appropriately used according to the functional requirements of the units and the drivers are provided with drastically rapid processing capability through high-speed digital technology.

Further, the mounted encoder for feeding back the motor position is capable of processing the optical signal electrically and then fragmenting the one turn into one million divisions to ensure accurate and precise phase indexing. In this way, the deviation between command signal and actual phase is instantaneously calculated to carry out a constant correction in order to allow the motor to run according to the command signal with the synchronization accuracy within 10 μm.

MAX-Server makes the effective use of the independent shaft-less motor and the synchronization control technology to actualize the "shortening of printing start time" and "reduction of waste paper" in the following manner.

(1) MAX-Expert

MAX-Expert is a system for reducing the waste paper generated at the time of exchanging the printing job, and is composed of the SPE (Smart Print End) function to remove the excessive ink in the inking unit after the job mounted on the aforesaid IPC ends, the QSI (Quick Start Inking) function to optimize the ink quantity at the start of job in addition to the BRC (Blanket Liquid Reducing Control) function to reduce the waste paper at the time of blanket washing and the web pre-tensioning function, etc.

(2) High-speed, semi-automatic plate exchanger

The plate exchange of each printing unit can be carried out in parallel by using the shaft-less technology capable of independent drive, ensuring the reduction of time from conventional 12 min to 4 min. The independent drive of each printing unit causes the phase deviation of colors to get automatically synchronized at the time of printing start.

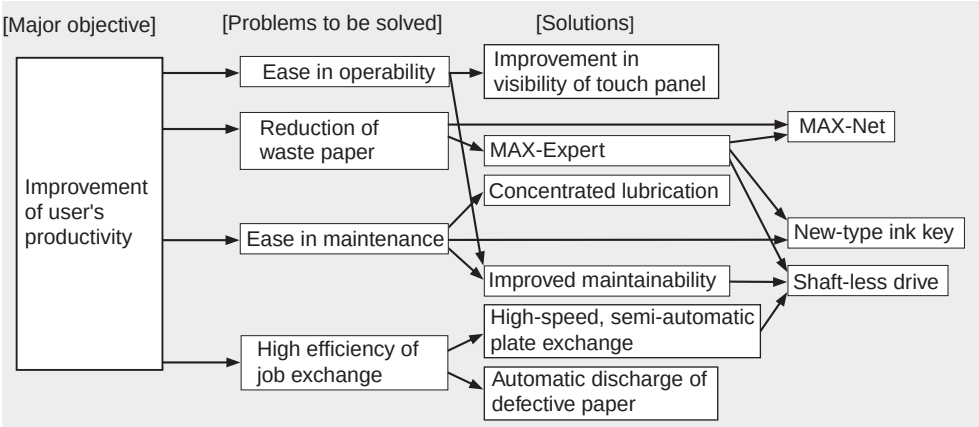

Fig. 2 Configuration of MAX-Saver
A system for comprehensive realization of improved productivity.

(3) New type ink key

The ink sticking in the piano-type keys arranged in 28 rows to feed thin film of printing ink (30–50 μm) is prevented by using the Teflon coated tray, while the key opening accuracy is maintained to reduce the color adjusting time at the printing start time.

(4) Automatic discharge mechanism for defective paper

A printing operator had to discharge the paper and make other confirmations before changing the folding style in order to prevent the paper from getting jammed in the folding section, which was a burden at the time of job exchange. This burden has been reduced through automated mechanism.

Besides, a large-size touch panel with enhanced visibility and operability, a network of peripheral machines for the press connected to the management system and pre-press system of the user, a digital work flow system enabling presetting of the printing machine based on printing conditions and picture (image) information are also available.

2-3 Shortening of the start time and reduction of printing waste paper

Described below is the effect of the functions of the aforesaid MAX-Saver. **Fig. 3** shows an example of the start time shortened by MAX-Saver, with maximum shortening seen at the time of plate exchange where the work can be carried out in parallel and at the time of folding style exchange. As a result, the start time has been shortened from 24 min to 9 min as compared with conventional Mitsubishi printing machine. The start time in actual printing, however, differs according to the proficiency of the operator and other unsteady factors. Nevertheless, the time needed conventionally for preparation and start has obviously been reduced to half.

Next, we would like to describe the problem of how to reduce the printing waste paper (paper to be abolished because of defective color tone, deviation of register, defective cutting and folding. It is necessary to consider from the stage where printing jobs ends in order to take measure for reducing the waste paper. An operation chart aimed at reducing the waste paper is shown in **Fig. 4**, where preparation for the next job is made at the stage when the equipment is shut down after preceding job comes to an end. This is the print reducing function (SPE) and the blank paper reducing function (BRC2).

The SPE function irons out the uneven ink film on the roller depending on the presence/absence of image (picture) and reduces the required ink level to the minimum level, so that if the next job is started without carrying out SPE, a substantially long time is required for stabilizing the color tone.

The BRC2 is an operation of cleaning the ink left as picture on the blanket, i.e. the plate cylinder, and must be carried out in order to prevent the waste paper generation due to the picture of the preceding job. The blanket cleaning was conventionally carried out at medium-speed (200 rpm) zone with the paper running,

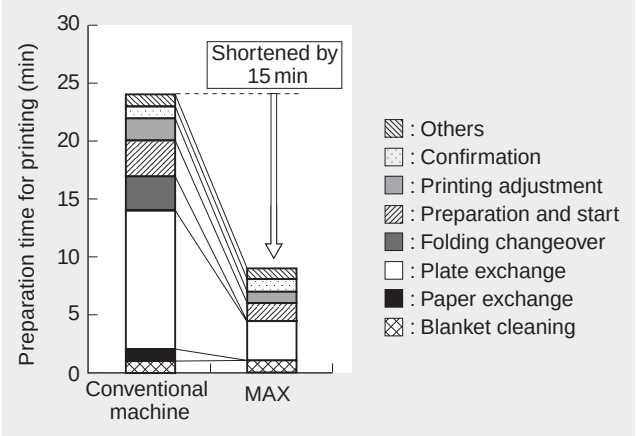

Fig. 3 Effect of shortening the preparation time for printing start
Indicates the preparation items before printing start and effect of shortening the time by MAX-Saver.

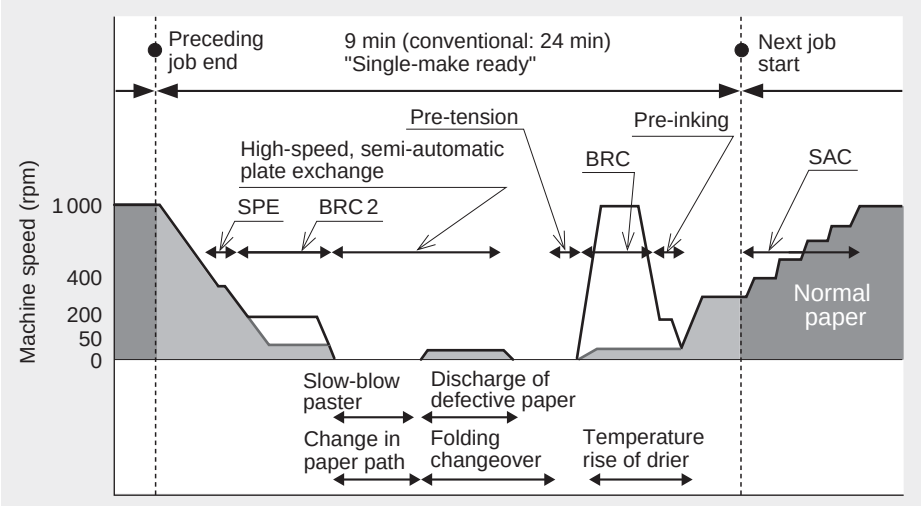

Fig. 4 Operation chart for waste paper reduction
Indicates the flow between "end of preceding job" and "start of following job."

turning all paper during the cleaning process into waste paper. The adoption of shaft-less function, however, allows different-speed control to feed paper at the lowest speed (10 rpm) although the blanket cleaning is carried out at the conventional medium-speed zone, keeping the waste paper generation to minimum level.

This completes the preparation for the next job before the equipment is started again. At this stage, however, phase focusing of all units (paper traveling, infeeding, printing and folding units) as well as web tension control (pre-tension function) is carried out. This completes the mechanical preparations, when the BRC function gets activated to discharge the cleaning fluid from the blanket. The cleaning fluid is removed by using the turning force, while suppressing the waste paper generation by keeping the paper traveling speed at the minimum level as in the case of the aforesaid blanket cleaning. After printing starts, the color tone, register, cutting and folding are adjusted before accelerating to the normal speed. The conventional acceleration at 20–30 rpm/sec caused the color tone and register to differ from the proof sheet because of the delay in ink supply and change in tension during paper traveling, resulting in the generation of waste paper.

This waste paper generation can be prevented through step acceleration control (SAC). The SAC is a control system where the printing speed is increased stepwise to enable the automatic control units for ink supply, register and cutting to follow accordingly, with the accelerating speed remaining the same. In conventional case, acceleration of printing speed to maximum level immediately after printing start caused phase deviation between printing units and folding units because of the distortion of drive shaft and backlash of gears, resulting in deviation of register and cutting position and leading to the generation of waste paper. In the case of SAC system, however, the waste paper generated at the time of acceleration can practically be prevented, in spite of the time needed until the normal speed is gained.

Fig. 5 shows the effect of SAC system, indicating that no waste paper is generated during acceleration, whereas the production quantity for the same time gets reduced. However, the time needed for making up for the inadequacy in production quantity is estimated to be 2.5 min, which can be accomplished through normal-speed printing. Thus, through adoption of the automation technology making use of the shaft-less technology and innovated MAX-Saver, the preparation time could be drastically shortened, contributing to reducing the printing start time by half and improving the productivity by reducing the generation of waste paper.

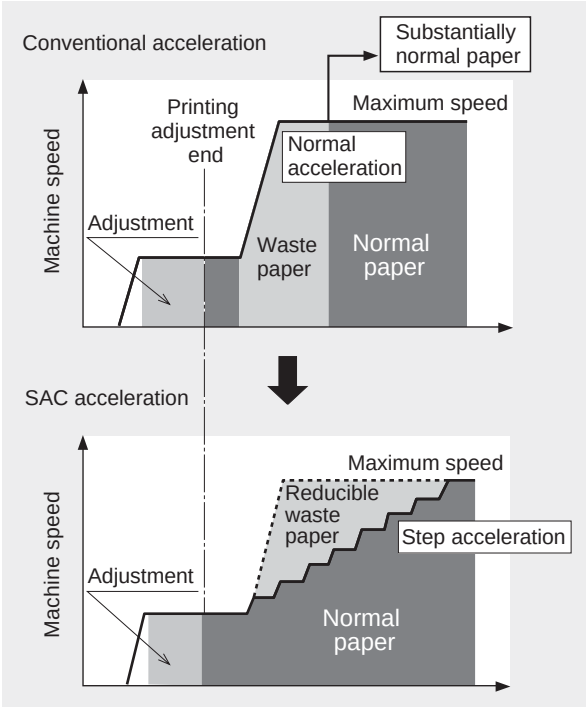

Fig. 5 Effect of SAC control adoption
Indicates the waste paper generation as compared with the conventional method.

3. Practical Effect of MAX-Saver

3.1 Waste paper reduction and productivity

All functions were independently verified during the process of development to confirm the practical effect and to judge the productivity. However, in order to confirm the serviceability during commercial operation at the user side, it was necessary to install the system to the user's printing machine. Therefore, MAX-Saver was actually installed to the user's printing machine to confirm the performance in actual commercial operation. MHI conventional printing machine was used as an object of comparison.

Fig. 6 shows the comparison per waste paper cause, with the waste paper generation rate expressed in terms of 100% of the conventional printing machine. The difference between actually measured and estimated (estimated at the verification stage) values of waste paper rate at the start of printing is considered to be caused by the difference in waste paper criteria between the user

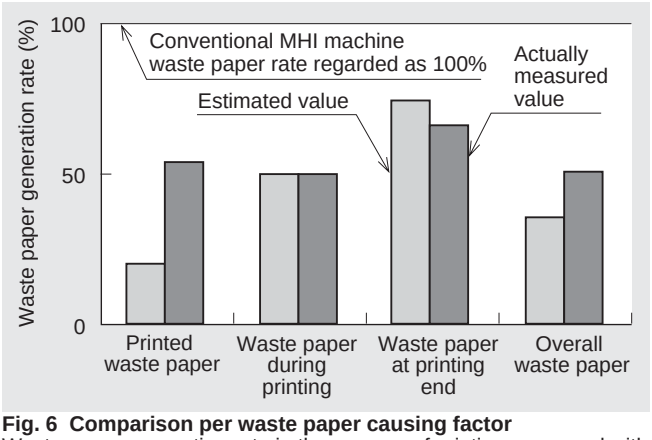

Fig. 6 Comparison per waste paper causing factor
Waste paper generation rate in the process of printing compared with that of conventional MHI machine.

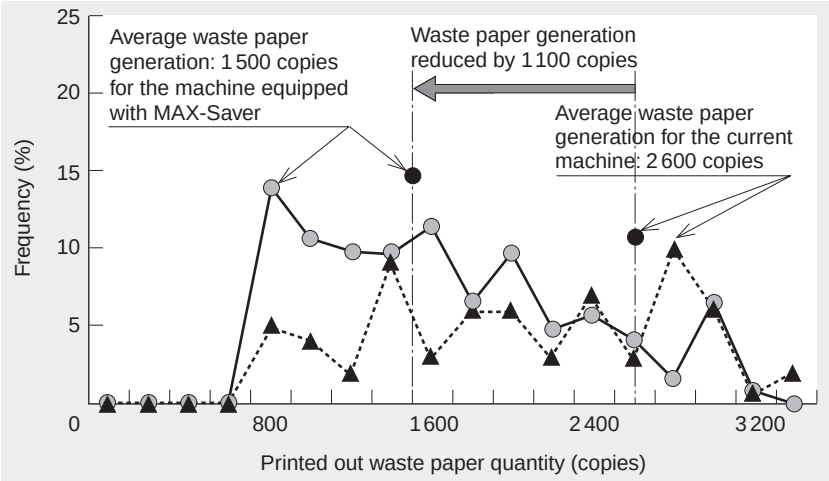

Fig. 7 Histogram of printed waste paper quantity at user side
Indicates the waste paper generation frequency per job during a period of 1 month.

Table 1 Estimation of productivity

Number of product copies for 1 job (copy)	Effect of saving through waste paper reduction		Effect of shortening the operating time		Productivity of MAX-Saver (yen)
	Quantity of annually reduced waste paper (copy)	Annual saving amount (yen)	Ratio of reduced time (%)	Annual saving amount (yen)	
20 000	3 242 000	9 730 000	36	5 840 000	15 560 000
60 000	3 322 000	9 970 000	25	3 770 000	13 730 000

(Estimation conditions)
Waste paper unit price: 3 yen, Number of personnel: 3 persons,
Annual reward: 4 million yen, Machine running cost: 255 000 yen per month

and MHI. The average waste paper rate at the user side is reduced to 51%. The average waste paper quantity for the press equipped with MAX-Server is found to be 1 200 pieces against 2 400 pieces of the conventional press, with the annual reduction of waste paper generation amounting to 3 million pieces (sheets).

Table 1 shows the productivity estimated on the basis of small- and medium-size lot production based on the aforesaid results. The estimation shows that the effect is particularly large for small-lot production, which is apparently attributed to the features of MAX-Saver—"shortening the printing start time" and "reduction of waste paper"—acting more effectively because of the higher frequency of printing job (in the case of small-lot production).

3.2 Record at the customer side

A total of 23 units of shaft-less commercial offset prints have so far been delivered since the first offset print was launched in April 2001, and after its development and research MAX-Saver has been successively mounted to the prints. The investigation on records was carried out for one month at the customer side to reconfirm the effects. **Fig. 7** shows the histogram of printing waste paper quantity for each printing job, where the printing waste paper immediately after the changeover (exchange) of printing job is summed up, indicating that, compared with the conventional offset print, an average waste paper reduction of 1 100 pieces/job has been confirmed through IPC and SPE.

4. Conclusion

The shaft-less technology has become indispensable to commercial offset prints. MAX-Saver making most effective use of the technology largely contributes to saving resources and improving productivity, the common objectives of users as well as manufacturers. By shortening the printing start time by half and reducing the quantity of waste paper, the operating factor of the printing machine can be increased to improve the productivity. This in turn leads to reducing the annual cost estimated to more than ten million yen. We are planning to improve MAX-Saver to make it easier to use, to develop the acceleration system at printing to step-less acceleration control from step acceleration control (SAC) in order to make further reduction of time and to save resources. Further, we are determined to continue our research and development on commercial offset prints to meet the demand for multi-type, small-lot production without waste in order to respond to the expectation of our customers.


Shigeo Makino


Masakazu Akatsuka


Tatsuo Fujikawa


Shinichiro Senoo


Hiroshi Kobara