Integrating P2 into the Inspection Process

Printing Industry

Background

The printing industry Standard Industrial Classification Code (SIC) series (2700's) represents a significant business interest in the state of Kansas with over 900 print shops. The following breakout shows the types of printers in Kansas by SIC code:

- newspapers: 229
- periodicals: 70
- book publishing: 41
- book printing: 5
- miscellaneous publishing: 86
- commercial lithographic: 306
- commercial gravure: 11
- commercial (nec): 226
- greeting cards: 5
- bankbooks and looseleaf binders: 6

It is estimated that there are 70,000 printing establishments employing 1.5 million people in the U.S. However, almost one-half of all printing facilities have fewer than five employees, and approximately 84% employ fewer than 20 (EPA744-R-94-003).

The five most common printing processes, in order of their market share, are lithography, gravure, flexography, letterpress, and screen. Presses are also categorized by the form of paper, fabric, metals, or other substrates used. Web presses, which are used for larger printing runs, print the image onto a continuous roll (web) of paper. After printing, the paper is then cut and trimmed to the preferred size. Sheet-fed presses print on individual sheets of paper or other substrate. Screen printing involves single-image printing on one substrate at a time, but printing can be done on almost any kind of surface.

Lithography is the predominant printing process in use today. Sheet-fed lithography is used for printing books, posters, greeting cards, labels, packaging, advertising flyers and brochures, periodicals, and for reproducing artwork. Web offset lithography is used for periodicals, newspapers, advertising, books, catalogs, and business forms.

Gravure printing is used for large-volume and high-speed runs for printing high-quality publications, magazines, catalogs, and advertising. It also has large-volume applications in the printing of flexible packaging (polyolefin packaging), paperboard boxes, and labels. It can print glossy ink films effectively.

Flexography, a form of letterpress that uses a flexible plastic or rubber plate in a rotary web press, is used primarily for packaging, such as plastic wrappers, corrugated boxes, milk cartons, shower curtains, foil, and paper bags.
Screen printing can be done on virtually any substrate, including wood, glass, fabrics, plastics, and metals. It is used for specialty printing, T-shirts, posters and banners, decals, and wallpapers. This type of printing makes up a small but growing segment of the printing industry. Screen printing is also used to print patterns on electronic circuit boards prior to etching.

Raw Materials and Process Descriptions

The printing process begins in the pre-press area with preparation of artwork or copy, which is photographed to produce an image. A proof is then made as a control to compare with the printed product to make adjustments to the press. The photographic image is then transferred to a plate or other image transfer vehicle. In the printing step, ink is applied to the image transfer device or devices, and then to the substrate. The substrate accepts the ink, reproducing the image. The substrate then goes into the finishing area to be cut, folded, and bound to produce the final product.

Printing can be divided into three processes: prepress, press, and postpress. The operations involved in these steps are detailed below.

Pre-Press

Image Processing

Most printing operations begin with art and copy (or text) preparation. Once the material is properly arranged, it is photographed to produce transparencies. If an image is to be printed as a full-color reproduction, then color separations are made to provide a single-color image or record which can then be used to produce the single-color printing plate, screen, and cylinder. The photographic process consists of the following stages: developing, which begins the negative-making process fixing, which stops the developing process by chemical neutralization; silver metal accumulates in fixer baths wash bath, which washes off the remaining fixer chemicals.

Proofing

A proof is produced after the image processing step as part of internal job control, and it may also serve as a communication tool between printer and client. It is used for both single-color and multi-color printing. Electronic imaging technololgy has eliminated the proofing process in some companies, but it is currently an indispensable step in commercial printing to produce accurate reproductions of the original artwork.

Image Transfer Systems

The printing process revolves around the intermediate image carrier, a plate, cylinder, or screen that transfers the image to another image carrier or to the substrate. Each printing process uses a different type of image carrier. The type of ink and press used, the number of impressions that can be printed, the speed with which they are printed, and the characteristics of the image are all determined by the type of image carrier used.

Press

Makeready

Preparation for printing begins by attaching the image carrier or plate to the plate cylinder of the press. Since litho plates are typically made of thin flat aluminum sheets, they can be wrapped around and attached to the plate cylinder. Virtually all presses print from a plate cylinder, as opposed to a flat plate, except screen printing. Each unit of a printing press prints a single color. To print a full color illustration, four separate units are typically required, one unit each for magenta, cyan, yellow, and black.

Makeready is the procedure in which all the adjustments are made on the press, including proper registration and ink density, to achieve a reproduction equivalent to or comparable to the proof, or acceptable to the pressman or customer's representative. This step may be the major source of waste from the printer's point of view. Makeready times can last from a few minutes to many hours. Makeready can be conducted at low speeds or at press production speeds. The printer's objective is to minimize both the time involved in makeready and the number of waste sheets or signatures coming off the press. The makeready step is more complex for perfecting web offset presses than for sheetfed offset, because eight press units are involved and must be adjusted properly: there are units on top of and beneath the web, two for each of the four process colors.

Once the makeready has successfully generated an acceptable signature sample, the actual printing run starts. The printing operations are generally the same for each of the major processes, with the exception of screen printing. The two common types of presses are sheet-fed presses and web presses. Sheet-fed presses can print up to three impressions per second. Web presses typically print at a rate of 1000 to 1600 feet per minute. Screen printing operations can be automated, but since they involve one image per screen, production rates are much less than cylinder-plate press operations.

Paper represents the largest supply item that a printer buys and is probably the most expensive component of this work. The printed paper produced in makeready is frequently the largest waste volume a printer generates. Paper waste at this step is determined by the efficiency of the quality control press adjustments needed to achieve the desired print quality, specifically through proper ink density and accurate registration.

Press Process Differences

In lithographic printing, the plate is mounted to a rotating cylinder. As the cylinder rotates, a water-based dampening solution followed by an oil-based ink is transferred to the plate's image area. The inked image repels the fountain solution and accepts the printing ink, while the non-image area accepts the dampening solution and repels the ink. As the cylinder continues to rotate, the inked image is transferred to a blanket and then onto the substrate. The two major forms of substrates used in lithography are single sheets of paper (sheet-fed lithography) and continuous rolls of paper (web lithography).

In gravure printing, the cylinder is placed in the press and partially immersed in an ink bath or fountain. Solvent is added to the ink to maintain the proper level and viscosity of the bath. As the cylinder is rotated, ink coats the entire surface. Next, a metal wiper (doctor blade) presses against the surface of the cylinder and removes ink from the nonetched (non-image) areas. The substrate is then pressed against the rotating cylinder and the ink is transferred from the depressed areas etched with the image. After printing, the substrate may pass through a drying operation depending on the type of ink used.

Screen printing uses a porous mesh screen with an ink-resistant image on its surface as a template to transfer ink to substrates. The type of material used to make a screen depends on the substrate being used as well as the desired appearance of the product. Screen preparation begins by tightly stretching and securing the material in a rigid frame so that it is level and smooth. Non-image areas of the screen are blocked by an emulsion and the exposed image areas are washed off to open the screen to allow ink to pass through to the substrate.

Lithography can use heat-set and non-heat-set inks. In heat-set lithography, the substrate is passed through a tunnel or floater dryer, which utilizes hot air or direct flame or a combination. With non-heat-set lithography, the ink normally dries by absorption. Gravure printing utilizes inks that dry by solvent evaporation. Screen printing inks include traditional solvent-based inks (which include enamels), ultraviolet (UV)-curable inks, water-based inks, and plastisols (for textile printing). The most common screen printing inks are solvent-based and are usually heat-set inks such as plastisol ink.

Post Press

Finishing

The term "finishing" refers to final trimming, folding, collating, binding, laminating, and/or embossing operations. A variety of binding methods are used for books, periodicals, and pamphlets. These include stitching (stapling), gluing, and mechanical binding. These finishing operations are frequently accomplished by an outside service organization.

Regulatory Issues

Air: VOC emissions from inks and solvents are the primary concern, although fountain solutions may also be a high VOC emitter. Printers must calculate VOC, HAP, and other related emissions that may require an operating permit. Non-attainment areas may impose emissions restrictions through a MACT to further reduce releases from sources in non-attainment areas.

Hazardous Waste: Waste film may be considered a hazardous waste; businesses must make a hazardous waste determination or have a letter from their film supplier stating that the film is NOT a hazardous waste before it can be sent off site for silver recovery. Waste fixer from the imaging processes is considered hazardous unless a silver recovery system is hard-piped to the process for silver recovery. If fixer is shipped off site for recovery, it must be counted towards the monthly hazardous waste generation rate.

The cleanup solvent waste stream consists of waste ink, ink solvents, lubricating oil, solvent, and solvent-contaminated rags. Most blanket cleaning materials are hazardous; screen cleaning solutions may or may not be hazardous waste, depending on the type of reclamation system used. Contaminated cleaning rags may be considered a hazardous waste if contaminated with a listed solvent or still maintaining an ignitability characteristic.

Wastewater: Ink-contaminated waste-waters may need to be permitted through the local POTW and may require on-site treatment before being discharged. Storm water requirements in Kansas require submission of an Notice of Intent form with KDHE at this time or the company may file a statement that there are no storm water issues at its facility because all process materials are under roof.
Spill Prevention Control and Countermeasure (SPCC): SPCC regulations apply to those facilities that have oil-related materials, including petroleum solvents, in a tank greater than 660 gallons or more than 1320 gallons total volume in any size storage containers in an aboveground storage area.

Solid Waste: Almost 98% of the total waste volume generated by printers is spoiled paper and paper wrap. Waste paper comes from rejected print runs, scraps from the start and end of runs, paper at the end of the web, and overruns. Overruns are the excess number of copies that a printer makes to ensure that he has enough acceptable copies. Other paper includes the paper wrappings, cardboard cores, and scrap from finishing operations. Most paper is recycled, incinerated, or disposed of as trash. Scrap photographic material and aluminum plates are sold for metal recovery. Empty ink containers are normally scraped clean of ink and discarded. Damaged or worn rubber blankets are also discarded with the trash.

Where's the P2 Potential?

Change the Material

Image Processing Area

- Avoid chrome-based film cleaners.
- Use photographic materials that do not contain silver such as diazo and vesicular films. These films are processed in a weak alkaline solution that is neutralized prior to disposal. As such, they produce a non-hazardous waste.

Image Carrier Processing

- Use presensitized aqueous plates.
- Use nonhazardous plate developers.

Press

- Use a low-vapor pressure cleaning solvent (65% aliphatic, 30% aromatic). A local blender can often provide a cleaning solvent at less cost than one of the national brands.
- Use a low-VOC content solvent. This characteristic of low-vapor pressure will lower evaporation rate and will dramatically improve the facility's indoor air quality.

- Consider a blanket wash that can be mixed with water to reduce VOC.
- Use a combination of cleaning solvents. Some shops have retained a low-flash solvent for periodic cleaning of metering rollers and other hard-to-clean press components where there would be dried ink, varnish, and other debris. A higher flashpoint, or low VOC blanket wash is used for daily cleaning.
- Use mineral oil or other ink-compatible material to prevent ink skinning waste.

Change the Process

Image Processing Area

- Optimize an automatic film processor operation. Does it continuously discharge rinse water (even when no film is being processed through the unit)? To conserve wash water, an intermittant control may be installed to regulate and conserve its flow.
- Recover silver from waste fixer. The National Silver Council funded the Code of Management Practices document that outlines the best management practices available for shops choosing to recover silver.
- Segregate waste film into high- and low-imaged film, if recycler will offer more for low-imaged film with greater silver content.
- Extend the life of fixing baths. Techniques include (1) adding ammonium thiosulfate, which doubles the allowable concentration of silver buildup in the bath; (2) using an acid stop bath prior to the fixing bath; and (3) adding acetic acid to the fixing bath as needed to keep the pH low.
- Optimize silver recovery systems. Establish a regular testing procedure to determine percent silver recovery. The practices recommended in the Code of Management Practices (CMP) for silver dischargers can help reduce photo developing waste while increasing silver recovery to save costs from this operation.
- Maintain rubber rollers and squeegees on automatic film processors. Maintenance of squeegees and rubber rollers is essential to minimize chemical carryover from one processing tank to another, increasing the longevity of all image processing chemistries.
- Reuse de-silvered fixer, if using an electrolytic silver recovery unit.
- Closely monitor chemical bath parameters and replenishments.
- Use non-mercury or cyanide photographic intensifiers or reducers.
- Keep lids on solutions to avoid contamination and oxidation.
- Segregate spent fix bath solutions from rinse waters.

Image Carrier Processing

- Reduce solution loss in plate-making processes with traditional metal finishing methods (countercurrent rinsing, dragout reduction, etc.).
- Recycle aluminum plates.
- Recycle metal etching developer.
- Extend life of plate developer through use of monitoring and replenishing.
- Use a commercial recycling service for depleted plate developer.
- Save water by using intermittent rinse water flow (no flow when processor is on idle).

- Properly maintain and adjust equipment. Properly calibrate replenisher and washwater using a fixed-volume container and a stopwatch.
- Use chemicals as long as they are sufficiently reactive. Use a plate control target to measure activity. Some manufacturers recommend testing conductivity as a means to define reactivity.
- Visually inspect the plate for a high-quality image.

Press

- Adopting a standard ink sequence can reduce the amounts of waste ink and waste cleaning solution. If a standard ink sequence is employed, the ink rotation is not changed with the job and you do not have to clean out the fountains in order to change the ink rotation.
- Keep ink closed unless the pressman is adding or removing ink from the can. Coat the rim of the can with petroleum jelly or a similar product to form an air-tight seal on the can, while the lid remains easy to remove. This will prevent air from getting into the can.
- Apply a thin layer of waxed paper over the top of the ink so a skin does not form (this replaces the oil or aerosol anti-skin product).
- To prevent excess ink loss due to skinning, the press operator should smooth out the surface of the ink in the can. This helps reduce the surface area that can skin. Using a spray mister, apply an ink-compatible oil over ink to prevent skinning.
- Explore cost/benefit of recycling ink waste. Most inks can be recycled, either on site or off site. A common technique is the blending of various leftover colored inks to produce black ink.
- Clean ink waste out of buckets with a squeegee or rubber spatula and use for intended purpose.
- If ink dryers are added to inks, consider buying the ink without dryers and add them only as needed to help control skinning and related ink at the press.
- Test and maintain fountain solution conductivity.
- Establish optimum pressure settings for all rollers and keep a log to track and adjust/maintain settings for optimum performance.
- Continue to use dauber cans to dispense cleaning fluid. I recommend using this dispensing mechanism in all areas using solvent cleaners.
- Use recyclable shop rags for cleaning purposes.
- Reuse press wipes as long as possible. Use a dirty wipe for the first pass and a clean one for the second pass. This will reduce rag and solvent use significantly.
- Keep all used rags in a sealed fireproof container.
- Use and maintain roller wash-up blades and ink blades to remove residual ink from rollers
- Clean presses only when needed, not according to a preset schedule.

Change the Technology

Image Processing Area

- Use a computerized "electronic pre-press systems" for typesetting and copy preparation. Only the final edited version is printed out as a proof.
- Use an automatic photographic film processing unit.

- Consider direct-to-plate (computer-to-plate) systems.
- Consider digital proofing technology.
- Recover silver from fixer on site using metallic replacement cannisters, electrolytic units, or a combination of both.

Image Carrier Processing

- Replace metal etching or plating processes wherever possible. Alternative processes include presensitized lithographic, plastic or photopolymer, and hot metal which do not present the hazardous material problems associated with metal etching and plating operations (as those used in gravure cyclinder processing).
- Automatic plate processors can maintain bath conditions. Presensitized plates should be stored at the recommended conditions to maintain effectiveness. The used plates are not a hazardous waste and should be collected and sold to an aluminum recycler.
- Consider digital printing systems (direct-to-press). These systems digitally image a plate on the press with an electrostatic charge, can use dry or liquid toner, and are both web and sheet fed.

Press

- Consider an automatic blanket cleaner retrofit for presses to reduce cleanup solvent.
- Install a web-break detector device to detect tears in the web as it passes through a high speed web press. It will automatically shut down the press to prevent damage to it.
- Automatic web splicers have become almost standard on web offset presses. The splice can be made while the paper is running at operating speed (flying-web splicer) or while the paper is stationary (zero-speed splicer). Either option can result in significant savings in time and paper waste reduction.
- Use an automatic ink leveller. Ink waste and spoilage is reduced by maintaining the desired ink level in the fountain for optimum inking conditions.
- Explore use of a UV ink systsem. Since the inks do not "cure" until exposed to UV light, they may be left in the ink fountains and on the plates for long periods of time, thus the need for clean-up is drastically reduced. UV inks are particularly recommended for letterpress and lithography.
- Explore water-base or water-born inks, which are usualIy composed of pigmented suspensions in water and film formers. These inks find their greatest application in flexographic printing on paper substrates, and their use has been recommended for gravure. Several factors stifling the development of water-base inks is that they require more energy to dry than solvent inks; when water-base ink dries, water is not a solvent for the dried ink, therefore more frequent equipment cleaning is required; and water-born inks are low gloss and add to paper curl.
- Automated plate benders are designed to prevent all or some of the problems that occur in fitting a plate to a cylinder: plate cracking, non-straight plate bending along the length of the bend, curvature of the plate differing from that of the cylinder, and other plate-fitting parameters that affect proper registration.

- Automated plate scanners have been developed for both web and sheet-fed offset presses that scan the finished plate to determine the relative density of the printing image across the plate's surface. This information is then used to set the ink fountain flow to compensate for variations in image density.
- Automated registration: Optical scanners and microprocessors look for registration marks and make automatics adjustments to maintain registration during process.
- Ink/water sensors automatically adjust the ink/water ratio. This ratio must be optimal to produce a sharp dot and strong contrast without the risk of tinting. Both water feeds and ink keys are linked to the system, so both can be modified and any deviation in the ink/water ratio can be corrected at once.

Notes Page

Printing Industry P2 Checklist:

Image Processing

Use electronic imaging and laser platemaking to avoid photoprocessing
Material substitution – use diazo or vesicular films where possible
Extend bath life by keeping it covered, testing, and reducing chemical carryover.
Use and/or properly maintain squeegees for better chemical recovery and maintenance
Employ countercurrent washing.
Recover silver from waste fixer; test and monitor for recovery efficiency; and recycle de-silvered fixer if feasible.

Plate Processing

Reduce solution loss through dragout reduction, etc.
Replace metal etching/plating operations with non-hazardous materials where possible.
Use non-hazardous developers and finishers.
Recyle aluminum plates.

Makeready

Use automated plate benders.
Use an automatic ink key setting system with an image density scanner to control ink fountain.
Use computerized registration controllers.
Use an ink/water ratio sensor for optimal image quality.

Press

Install web-break detectors.
Use automatic web splicers and ink levelers.
Store ink properly: keep covered, flatten surface, cover with film or oil to prevent skinning.
Use less hazardous inks; buy inks with less drying agents in them.
Recycle waste ink.
Collect and reuse solvent. Dedicate cleaning solvent by color to promote reuse; centrifuge cleaning rags, etc.
Recycle cleaning solvent on site .
Use an alternative fountain solution.
Use an alternative cleaning solvent.
Reduce the need to clean by covering inks with anti-skinning material and leaving in fountains, employing alternative ink use (UV or plastisol), reducing color changes, and by cleaning before ink drys.
Improve cleaning efficiency by using rags twice.
Use an automatic blanket washer.

Finishing

Reduce paper use and recycle waste paper.
Reuse waste paper and boxes for shipping outgoing products.

Case Studies

Reduce Solvent and Ink Waste:

One company used a protective film sprayed over each of four ink fountains on a small offset printing press at the end of each work day. The waste ink was reduced by five pounds per day. Based on a disposal cost of 70 cents per pound and 250 operating days per year, the savings in disposal costs are $875 per year. The need for new ink was reduced by five pounds per day. At a cost of $2.00 per pound, the savings in raw material costs are $2,500 per year. The total operating cost savings are $3,375 per year. The cost of the spray is relatively low. A significant labor savings was also realized, but not quantified.

Begin In-Process Recycling

A new plant engineer who arrived in 1986 brought with him an idea for reducing Romo's consumption of screen-cleaning product. His idea was to recover screen-cleaning solvent for reuse through an in-process recycling still. At that time, Romo was using between 20 and 40 gallons of solvent per day. Management decided to act on the plant engineer's idea and install a still at a one-time cost of $2,900. This investment was recovered within seven weeks through reduced solvent costs. The new still is a closed system that utilizes a heating and filtering system to remove pigment before pumping solvent back for reuse. The five-gallon still is cleaned once or twice per week; although the solvent becomes discolored over time, the same 55-gallon solvent container lasts for three to four weeks. When the solvent becomes too dirty to clean effectively, Romo disposes of the ink-contaminated solvent as a hazardous waste. Through use of the still, Romo was able to reduce its consumption of cleaning product to only one 55-gallon drum every three to four weeks (even in conjunction with an increase in facility production). This saves the company $83 per day or $20,750 per year in solvent procurement costs alone. The decreased consumption in screen-cleaning product also contributes to a healthier working environment, since employees are no longer exposed to large quantities of evaporated solvent.

Additional Resources

The Small Business Environmental Assistance Program, SBEAP, is a confidential non-regulatory program funded by the state in an effort to assist small business with environmental concerns. P2 manuals will be available in 2002 for the lithographic and screenprinting sectors and can be obtained by contacting the SBEAP at 800-578-8898 or http://www.sbeap.org.

Printers National Environmental Assistance Center (PNEAC) is an environmental assistance center for the printing industry which includes compliance assistance and P2 information. PNEAC also coordinates the printech and printreg listservs for interactive discussions and information sharing. http://www.pneac.org/.

Graphic Arts Technical Foundations is the world's leading technical association for the graphic communications industries. GATF/PIA now provides the industry with a single source for technical and management solutions. View their Web site at www.gatf.lm.com/.