PROCESS MAPPING EXERCISE

Instructions:

In this exercise, you will work together as a team to prepare a ***process map*** for examining a sheet-fed lithographic printing case

A ***top-level*** process map of the printing process has been provided (See Figure 1) along with the ***second-level*** process map of each of the three work steps in the top level-level process map (See Figures 2 and 4). As you will note, the second level of the ***press operation*** (**Figure 3**) has been left blank. This is what you will focus on in this exercise.

Right after the process maps is a section called "**Press**." This contains a written description of the press operation. Using this detail, determine 3 to 6 steps that describe this process and prepare the process map. A diagram of a lithographic press operation is provided to help you visualize the operation.

Place the process map on the flip chart paper. It is all right to mark it up and cross things out. It is the discussion between the team members that is important. The process map is a *tool* to help focus this discussion on understanding the process. Make sure the ***perspective*** in the process map is consistent (i.e., we are following the image from the original art work to the image in the final product). Make sure you agree on the boundaries that are placed on the process by the work steps.

There is also a description of the ***make ready supporting process***. This supporting process accounts for the plate being placed on the plate cylinder.

Ask the instructor if you require any help to get started or during the exercise.

Figure 1. Top Level Process Map - Lithographic Printing.

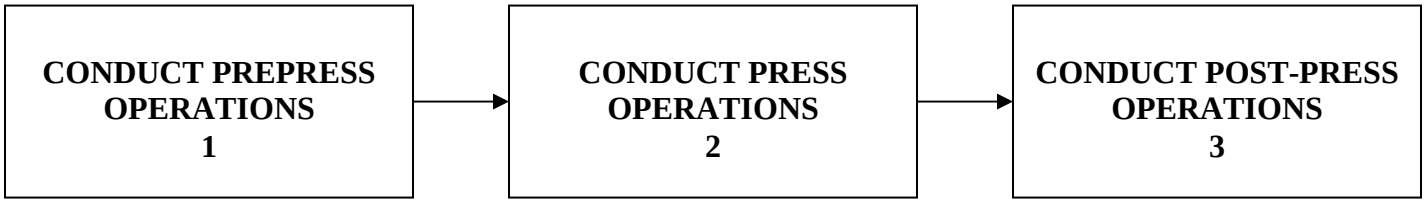


Figure 2. Second Level Process Map – Lithographic Printing: Pre-Press.

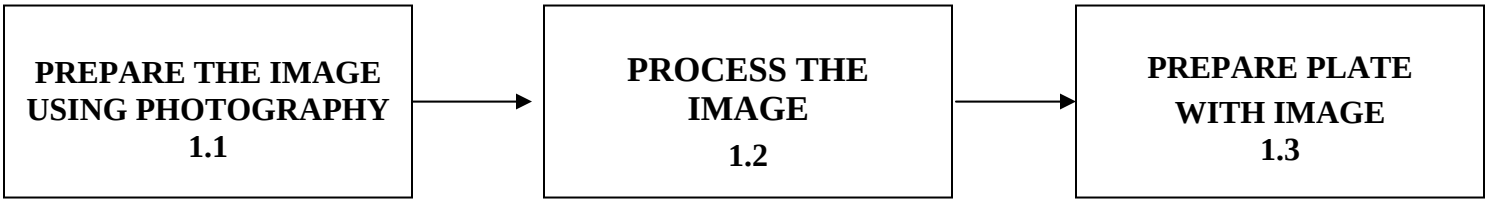


Figure 3. Second Level Process Map – Lithographic Printing: Press

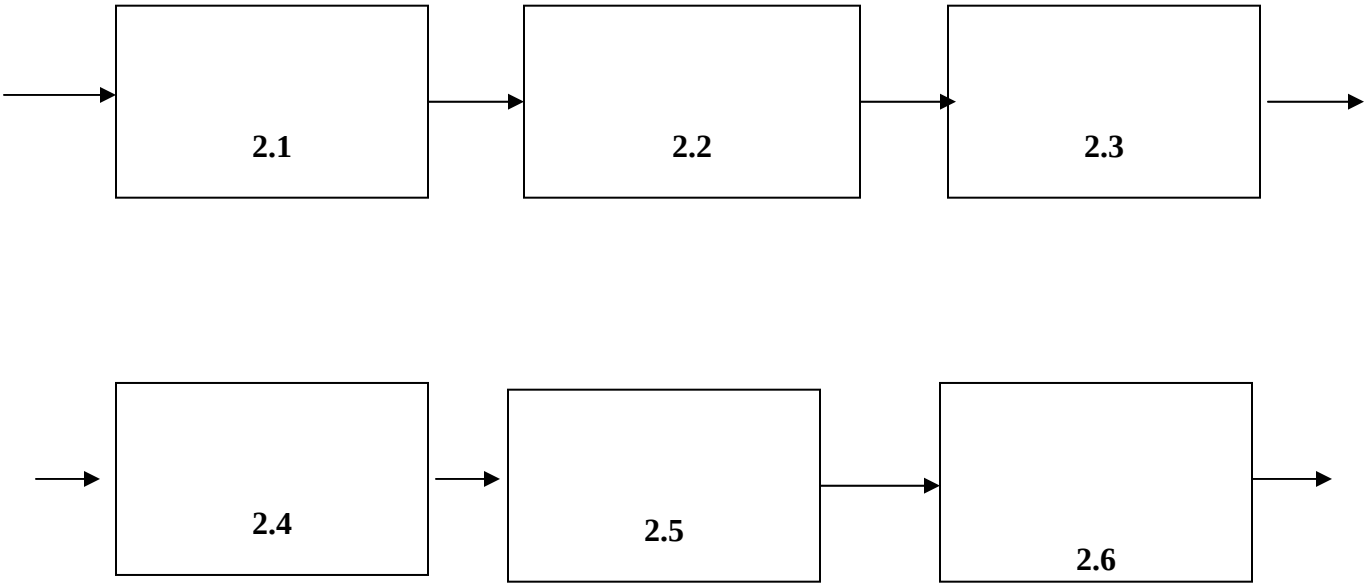
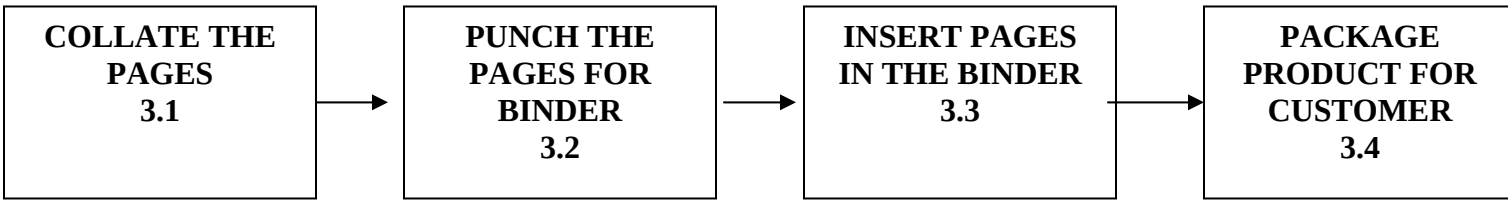


Figure 4. Second Level Process Map – Lithographic Printing: Post Press.



PRESS

Once the plates are prepared, the actual printing can begin. Sheet-fed presses can print up to 3 impressions per second. Preparation for printing begins by attaching the plate to the plate cylinder of the press (make ready supporting process). 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. 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 (**See Figure 5**). We will assume a ***black and white*** run is being made (i.e., a single unit as shown).

As the plate rotates on the cylinder, water-based mixtures, referred to as fountain solution, are applied to the plate to enhance the non-image area's ability to repel inks. Fountain solutions may contain 5 to 10% isopropyl alcohol or they may contain alcohol substitutes that meet the same needs but with a lower VOC content.

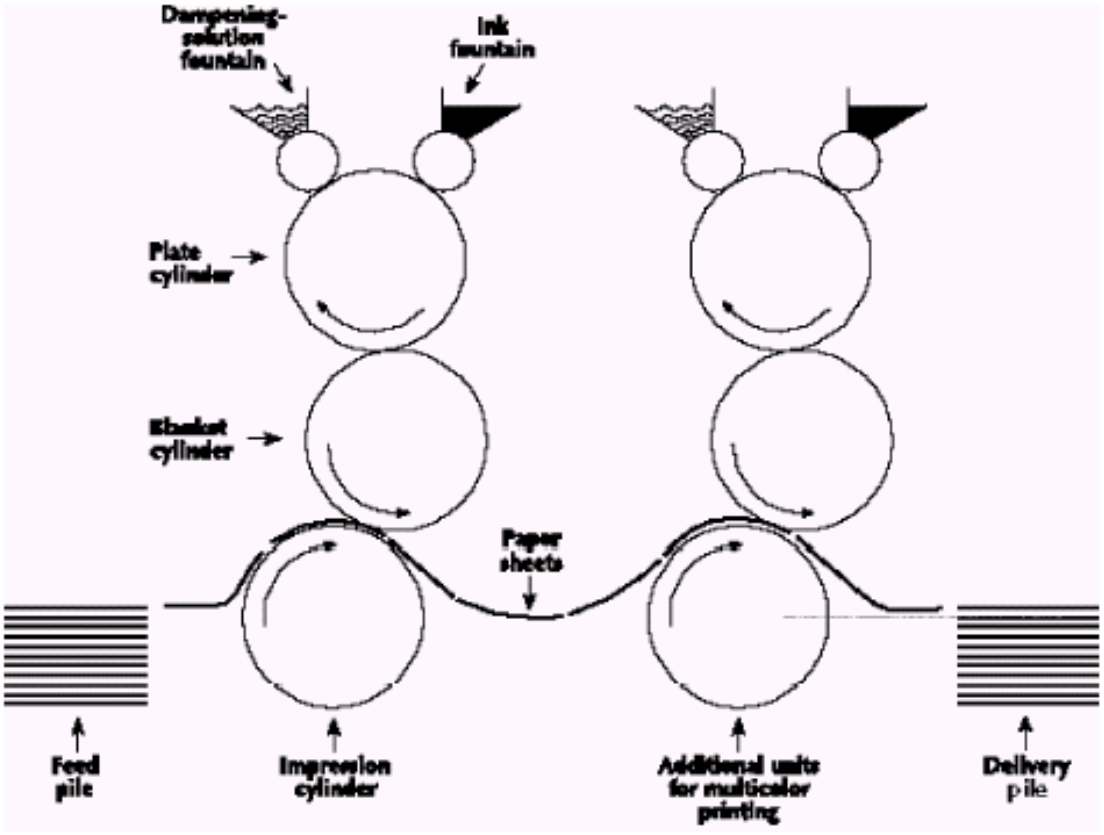
Through the use of inking rollers, ink is applied to the plate, adhering only to the image area. To accelerate drying and control ink flow characteristics, lithographic inks contain solvents.

As the cylinder continues to rotate, the inked image is transferred or "offset" from the plate to a rubber roller called the blanket.

The blanket transfers the image to the substrate (e.g., paper). With non-heat-set lithography, the ink normally dries by absorption.

The paper is then removed from the press.

Figure 5. Diagram of a Lithographic Press Operation.



MAKEREADY

Make ready is the supporting process 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. The plate is applied to the plate cylinder in the make ready process. All the fountains are filled making the press ready to operate. This supporting process may be the major source of waste from the printer's point of view. Make ready times can last from a few minutes to many hours. Make ready can be conducted at low speeds or at press production speeds. The printer's objective is to minimize both the time involved in made ready and the number of waste sheets or signatures coming off the press. The major wastes associated with make ready are paper and air emissions.

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 make ready is frequently the largest waste a printer generates and is non-hazardous. Paper waste at this step is determined by the efficiency of the quality control press adjustments needed to achieve the desired pant quality, specifically through proper ink density and accurate registration. Both in make ready and printing operations, printers need to know how much waste paper is generated relative to the quantity of acceptable pieces. One method that can be used by both sheet-fed and offset printers is to weigh discarded paper and discarded product signatures and express the weight of waste as a percent of total paper used. Press counters are available, but under some circumstances, such as when a jam occurs on the press and the counter is not turned off, the count may be inaccurate. A number of specific devices have been developed to automate press adjustments. With proper use, most of these are promoted by manufacturers as speeding up the make ready step and thus saving paper and ink. However, their direct benefit is to increase quality control.

USING RESOURCE ACCOUNTING AND INFORMATION ACCOUNTING SHEETS EXERCISE

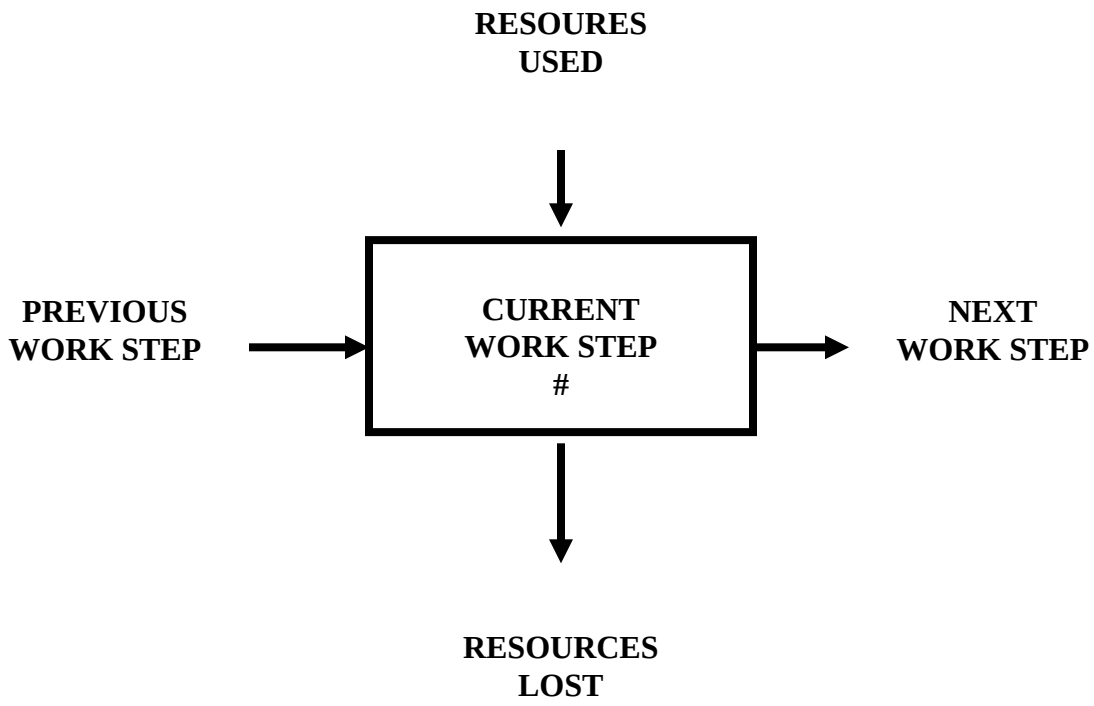
Select the work step where the ink is applied on the plate. Prepare a ***resource accounting sheet*** on your flip chart using the template in the first figure. Use the inputs and outputs to get an idea of what resources may be added to the work step and what resources are lost from this work step. Add the supporting processes to the resource accounting sheet. All of the losses from the make-ready and press cleaning that may be associated with the "application of the ink" should be added to the resource accounting sheet since it is responsible for these supporting processes in proportion to its use of these processes.

Prepare an ***activity accounting sheet*** on your flip chart using the template in the second figure. Some of the activities are mentioned in the description of the press cleaning operation.

Prepare an ***information accounting sheet*** on your flip chart using the template in the third figure. Describe the information that might be required in an ISO 14001 EMS and for other purposes.

RESOURCE ACCOUNTING SHEET

Description of the Work Step



Supporting Processes

Other Information

PRESS OPERATION
INPUTS AND OUTPUTS

Ink
Waste ink
Empty ink containers
Ink cleaner
Sheetfed ink remover
Plate preserver
Roller lubrication
Rubber rejuvenator
Blanket hardener
Metering roller cleaning solvent
Anti-setoff powder
Unacceptable prints
Volatile organic carbon (VOC) air emissions
Cotton rags
Soiled rags
Paper wipes
Soiled paper wipes
Unusable plates
Fountain solutions
Fountain solution concentrate
Spent fountain solutions
Empty fountain solution containers
Defoamer
Used or damaged blankets
Equipment oil
Spent equipment oil
Paper scrap
Used parts washer solvent
Floor cleaner
Ink remover
Empty aerosol cans
Packaging waste

PRESS CLEANING

A press in good repair is essential to meeting pollution prevention goals. In addition to preventative maintenance, regular cleaning is also necessary to keep the many moving parts operating. While it is easy to collect and recycle the used press oil for re-refining or energy recovery, minimizing solvents from press cleaning presents more of a challenge.

The Role and Composition of Press Cleaners

Cleaning solutions are predominantly petroleum based, are often mixed with detergents and water, contain up to 100 percent VOCs and can be used as a multipurpose press-wash or for cleaning just one part. One general cleaner is not always effective for cleaning rollers, blankets and the outside of the press.

Blanket cleaning consumes approximately two-thirds of cleaners used on a press and is performed once or twice a shift, between jobs and as needed to improve print quality. These cleaners must remove excess ink and dry quickly without leaving any oil residue. Remaining cleaner is used for cleaning press rollers.

Cleaners used on chain and ink rollers should be less volatile so solvent moves over all rollers before evaporating. For metal press parts, slower working solvents are as effective as a general press wash. Stronger solvents are needed for intermittent cleaning of hardened ink, or for specific purposes such as etching the chrome roller.

Cleaning Wastes and Alternatives

Cleaning the press generates several wastes:

* Waste cleaner with residual ink
* Waste ink from the ink fountain
* Rags containing cleaner and ink
* VOC emissions from cleaners

Manage petroleum-based solvents and inks as hazardous waste. Some inks may not be hazardous when discarded but are unacceptable for landfill disposal because they are viscous. Most states require that a waste be tested to verify that it is non-hazardous and also solid for landfill acceptance.

Disposable rags may be landfilled if laboratory testing demonstrates that they are non-hazardous. Launderable rags are not typically subject to hazardous and solid waste regulations because they are reused after cleaning.

Press cleaning releases VOCS. Intentionally evaporating used solvent is illegal disposal of a hazardous waste and subject to penalty. Additionally, it exposes employees to hazardous working conditions.

Chemical manufacturers are developing low VOC cleaners. just as there are many different presses, there are many different cleaners. Most low VOC cleaners still contain naphtha and average 3.5 pounds per gallon of VOCs and have a flashpoint greater than 200 deg F. "Quick drying" cleaners may have slightly higher VOC content and usually have a flashpoint below 140 deg F, making them hazardous waste. Some substitutes present a two step approach, using a cleaning solution with a higher VOC content as step one to be immediately rinsed with a low VOC cleaner as a second step. Consult proposed and enacted regulations regarding low VOC cleaners to ensure compliance.

Low VOC products continue to clean more effectively, but because the first cleaners performed poorly, the industry has not readily accepted them. EPA research has demonstrated successful substitution of low VOC cleaners using an integrated approach. Cleaning equipment, targeted product substitution and changing operator practices can reduce VOC from cleaning.

On-Site Cleaner Recycling

Some printers use a solvent sink to wash sink trays. These sinks circulate a solvent (generally naphtha-based) for quick, complete removal of residual ink. These sinks are usually serviced by a hazardous waste management company that replaces the used solvent with new solvent according to a set time schedule. The hazardous waste management company may recycle the solvent through distillation, reclaiming the purified solvent and disposing of the hazardous still bottoms.

Distillation involves heating the dirty solvent to its specific boiling point, converting it into a gas, leaving behind the impurities (ink, paper-dust, lint) that were dissolved in the solvent. The gas is then cooled, condensed into a liquid and collected in a separate container. This solvent is ready for reuse on the press or in an ink tray solvent sink.

Companies can purchase small distillation units that reclaim 3-5 gallons within eight hours or large units that process more than 100 gallons per hour. Companies that use 10 gallons or more of solvent per week could significantly reduce raw material purchases and hazardous waste disposal with a distillation unit (Iowa Waste Reduction Center, 1992).

On-site solvent distillation can also save waste solvent from launderable rag waste streams. One company reduced the amount of solvent in its rags by using an explosion-proof centrifuge to remove excess solvent from the rags. This company recovered 2-4 gallons of spent solvent from 220 rags (US EPA, 1993). Over time, this adds up to a substantial amount of solvent. Coupled with a distillation unit, the recovered solvent can be refined on site and used as a primary press wash or parts wash solvent suitable for cleaning ink trays.

An explosion-proof centrifuge and distillation equipment can be a substantial investment. The payback period for a small distillation unit can be one to two years, but the centrifuge is much more expensive. Investigate purchasing equipment through a trade association and sharing the equipment among members. The equipment can be transferred from business to business for on-site use of the centrifuge and distillation unit. Hazardous wastes must remain on-site and be managed accordingly. Scheduling must be responsive to hazardous waste storage time limits to maintain compliance with the hazardous waste regulations while allowing small printers to remove excess solvent from rags for reclamation and reuse.

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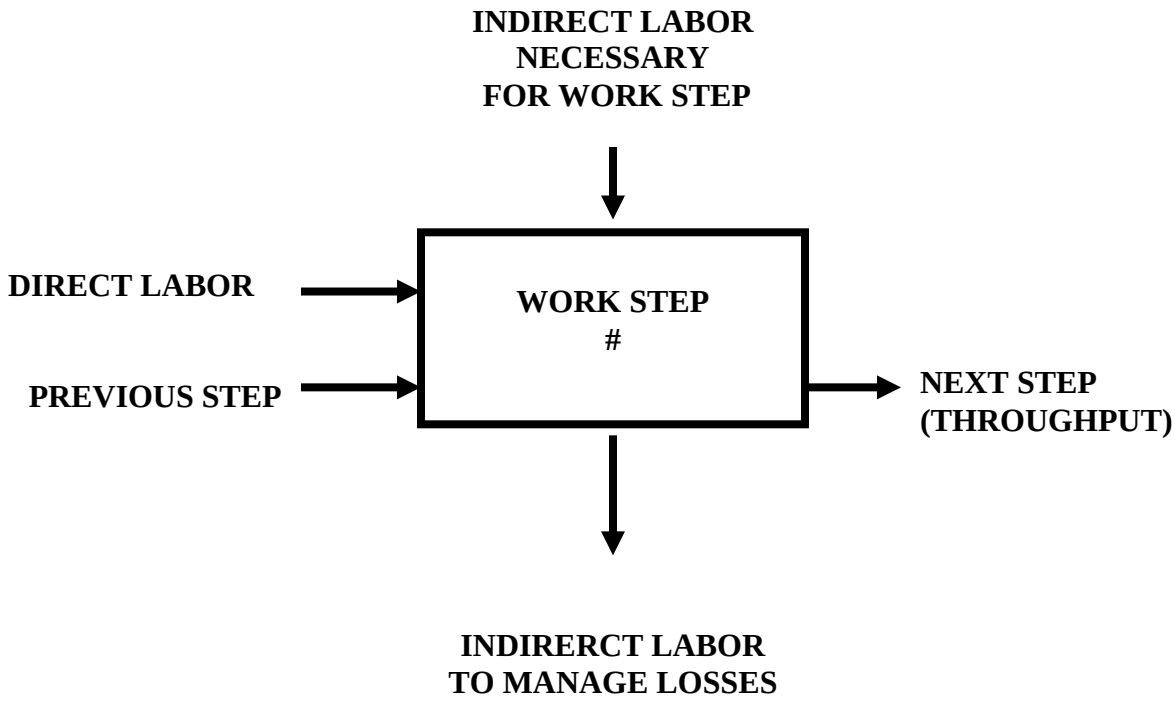
ACTIVITY ACCOUNTING SHEET

Description of the Work Step



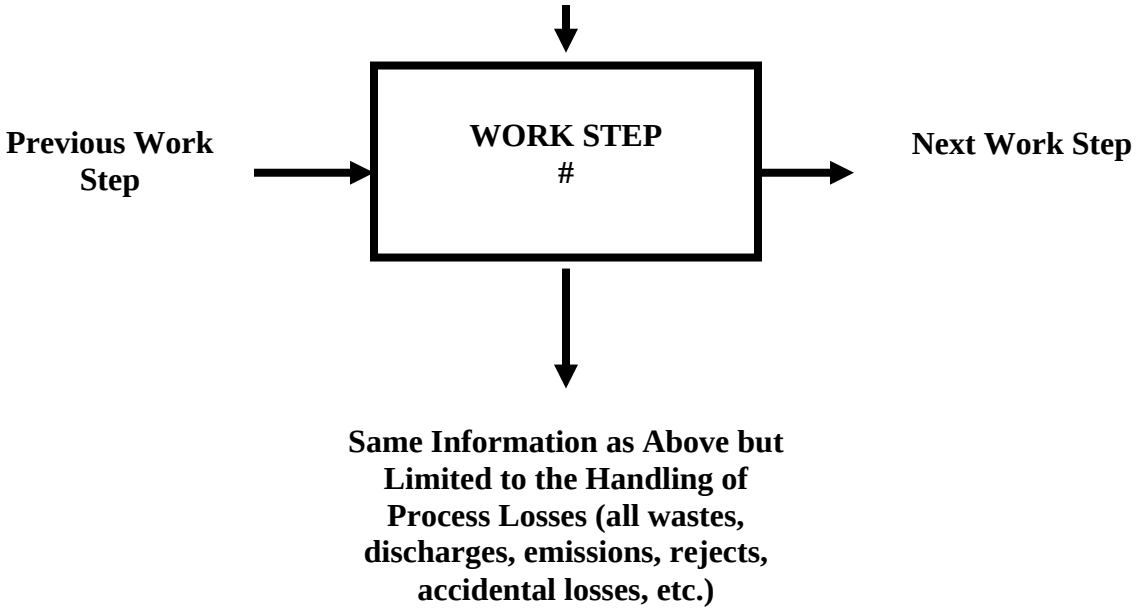
Supporting Processes

Each supporting process is a "process" with its indirect labor for work step management and indirect labor for the management of the losses. It can be one step or multiple work steps. The cost of these activities may be charged back to the main process work steps.

Other Information

INFORMATION ACCOUNTING SHEET

Description of the Work Step Information Requirements



Supporting Processes

All the business processes that support the information handling and maintenance of the documentation

All of the operational processes that support collecting and storing the information.

Other Information

LESSONS LEARNED: HIERARCHICAL PROCESS MAPPING

The purpose of taking the time to discuss the ***lessons learned*** is to learn to apply the knowledge that we have acquired to the process of continuous improvement. Let's look at what we have learned to this point in the course:

Process maps have two purposes:

1. Help the process team understand the main process and the associated supporting processes
2. Enable the process team to effectively communicate this information to others.

It is important to have **BOTH!**

Process flow diagrams, flow charts, value stream maps and pipings & instrumentation diagrams (P&ID's) are not as useful for the second goal listed above. They are too complex to view.

Process mapping is a ***skill*** that takes time to master. The test of an effective process map is to see the viewer put a finger on the page and move it along the flow line. Keeping the process maps to 3 to 6 boxes on a page is a key to its understandability. It is best to prepare at least a couple of process maps and submit them for a review to determine the best way to depict the process. The time invested in preparing and verifying the process map is an investment in the process of continuous improvement.

Process maps are generally in the following forms:

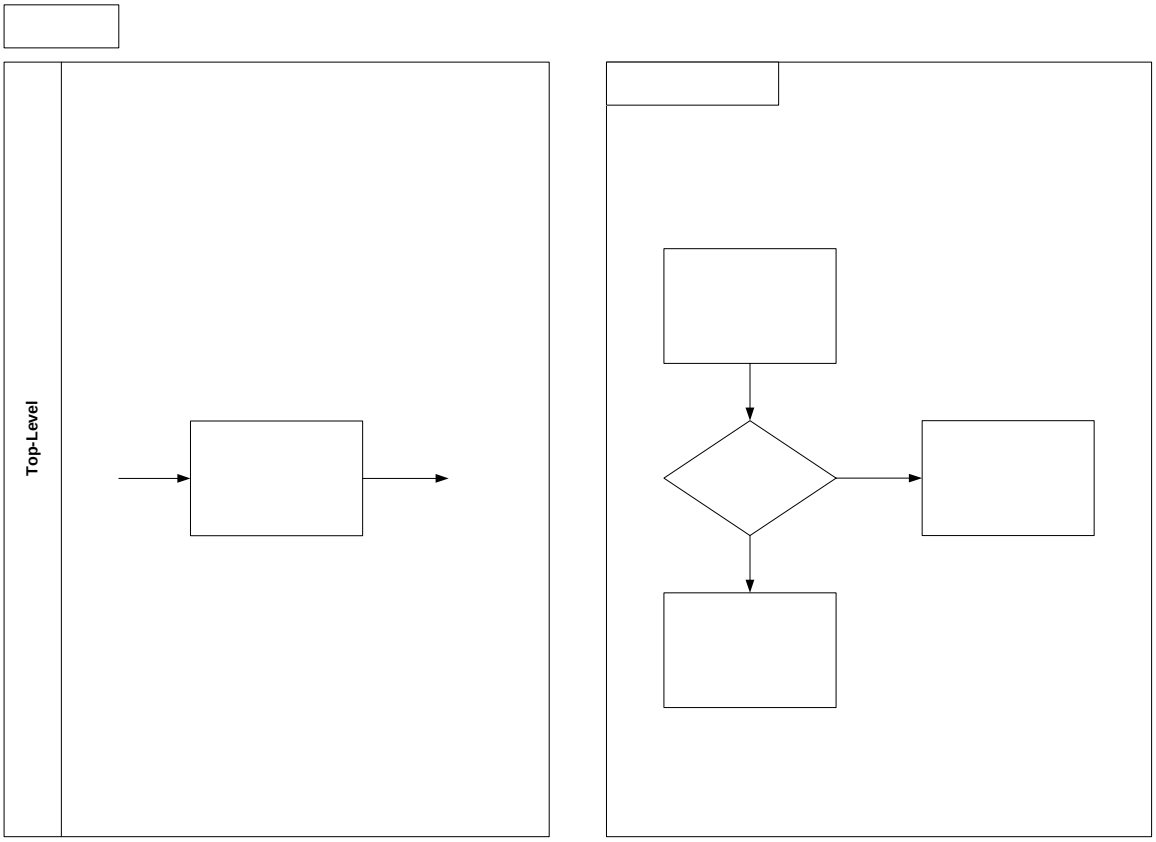
1. Things people do – service and design processes
2. Resources flow – production processes.

The "outline-form" work step numbering scheme is very important. The user will always know where they are by the numbers depicting the work

step. Different people view the information at the different levels of the process map:

1. Top level – leadership
2. Second level – supervisors
3. Third level – workers
4. Fourth level – use only when necessary for detail.

If a decision is required in a process map, a decision diagrams can be inserted at the next lower level. The decision outcomes will refer them to other boxes in the hierarchical process map. This is how you can combine the best advantage of a flow chart with the simplicity of a process map.



You must first prepare preliminary process maps and use them to view the process as a ***verificatio***n exercise. People who operate the process should be directly involved in this verification activity.

The process maps can be used to understand ***systems*** questions. They are the key to the Systems Approach as they visually show how every work step is connected to every other work step and how the main process is connected to the supporting processes. The process maps are the ***foundation*** for the entire process improvement effort. Supporting processes are linked to the main process at the lowest level using the resource accounting sheets.

Process improvement typically occurs at the work step level (lowest level). The process map is an opportunity-finding (or problem finding) tool. All opportunities to improve the process are noted on the process map through the use of resource accounting sheets. Process maps enable the users to leverage opportunities (e.g., energy conservation, water use reduction, waste (loss) reduction, etc.).

Process maps can be drawn with a pencil and paper. They can also be prepared using MS VISIO™, WORD™, or PowerPoint™ software. All resource accounting and other process information can be ***object linked*** to work steps using software that is currently being developed by ***Pojasek & Associates***. WORD and Excel files can be stored within the process map's template.

Process maps can be for the process "***As-Is***" or can be for proposed changes or design as "***To-Be***" process maps.

You can prepare a ***book of maps*** for an organization for each main process or family of main processes (i.e., similar products or services).

Other lessons learned?

What is your reaction to this form of process mapping?

What general advice would you now give to others about characterizing processes?

Do any questions remain?

LESSONS LEARNED: RESOURCE ACCOUNTING

The purpose of taking the time to discuss the ***lessons learned*** is to learn to apply the knowledge that we have acquired to the process of continuous improvement. Let's look at what we have learned in this section of the course:

There are four type of accounting sheets:

1. Resource Accounting Sheets
2. Activity Accounting Sheets
3. Information Accounting Sheets
4. Cost Accounting Sheets

Resource accounting sheets capture all the resources used and lost for each work step at the lowest level of the process map. There should be only one resource accounting sheet for each of these work steps.

It is **not** important to capture all the amounts of resources at the time the process maps are prepared and verified. Mass (resource) balances will be conducted only on work steps that have projects focused on them. This mas balance will comprise the first and the next to the last step in all of the action plans. However, it is good to know generally how the resources are flowing through the process. It is possible to automate the resource accounting by linking the accounting sheets to the materials resource planning (MRP) system.

Resources for the supporting processes can be allocated back to the work steps in the main process using the 80/20 Rule to limit the effort.

Every use of a resource represents an opportunity to conserve the use of that resource. Every loss of a resource represents an opportunity not to have that loss. In this manner, the process maps helps identify all the opportunities available for process improvement.
All regulatory compliance activities create activities. It is possible to assign these activities to the work steps that require them. This is done on an

activity accounting sheet. Above the box are the activities required in order for the work step to function. Below the box are the activities required to manage the wastes. When the waste is eliminated, the activities to manage the waste (and the cost associated with these activities is also eliminated.). The cost of the activities can be tracked using the computerized maintenance management system (CMMS). This is typically done in conjunction with each of the projects in the process improvement program. The supporting processes for the activities are different than the activities for the resource accounting sheets. These supporting processes involve departments where the supporting activities take place as well as those supporting activities.

All process information can be tracked on an **information accounting sheet**. The information above the box contains the information needed for the work step to proceed. The information below the box contains the information needed to manage the waste.

Cost accounting can be summarized on a **cost accounting sheet**.

Other lessons learned?

What is your reaction to this form of process mapping?

What general advice would you now give to others about characterizing processes?

Do any questions remain?

PRINTING ROOT CAUSE EXERCISE:
USING A CAUSE AND EFFECT DIAGRAM TOOL

Instructions:

Your team will need to select a problem that you identified as being important in the Pareto analysis. I might suggest that you consider the following problem: ***"The waste ink at the end of the press run has to be managed as a special waste in your state. This is costing a lot of money. How can you manage the inks better to help reduce the organization's cost and provide less of an environmental impact?"*** You have been provided some information on inks in the exercise. See Figure 2 for some information that may help you look at the root cause of this problem. You need to find a single work step that has a connection with this problem at the lowest level in the process map. What is it in this work step that is ***causing*** this problem? ***Do not try to solve the problem at this point!***

Elect a scribe (i.e., someone who did not draw the process maps or Pareto chart) to take the marker and draw a large cause and effect diagram on the paper. Write the ***problem*** in the box on the right. Pick your cause categories (you might wish to stick with materials, machines, methods and people).

On a separate piece of paper, list all the things from that work step that would fit under each of these categories. One at a time, place these items on the cause and effect diagram while asking the question: "What is it about _____ that causes the problem (written in the box on the right)? Write the answer on a side ***"bone"*** that is perpendicular to the cause bone. Continue until the fishbone is complete. Take a look to make sure nothing was over-looked. If you had time, the diagram should sit for a day or two before it is revisited. Could you use this diagram to explain causes to the owner of the printing company? What would you say?

When your team has completed the diagram, count the total number of causes. Circle 20% (i.e., one fifth) of them that are the most probable causes. Can the team agree to eliminate one of these circled causes as being much less significant that the others as a likely cause of the problem? Can the team agree to eliminate another one? Can you find the ***root cause*** of your problem? In the next step, you will begin to find ways to solve the problem.

SOME INK FACTS GARNERED THROUGH INTERVIEWS WITH EMPLOYEES

You have interviewed an number of employees. They are very anxious to help you solve the problem. However, you are very patient. You want to look at the causes before you attempt to solve the problem. Take a look at their suggestions. What do these tell you about each of the four cause categories (i.e., materials, machines, methods and people)?

Printing inks may contain material that makes them hazardous, such as metals used for coloring and solvents used to accelerate drying. In addition, because most printing inks are petroleum-based, they may have significant volatile organic compound (VOC) content. The Clean Air Act Amendments regulate overall VOC emissions from printers, so the extent to which inks contribute to VOCs is important. In response to increased demand and more stringent regulations, ink manufacturers are making a concerted effort toward eliminating VOCs.

Printing inks are expensive and any opportunities to minimize waste ink can help save money. Waste ink is generated through color changes, press cleaning and poor ink management, which allows drying and skinning. But effective management techniques can help reduce waste ink. Don't treat excess ink as waste instead, manage it like a product that should be reintroduced into the system when possible. Best management practices to help avoid waste include:

- Help press operators accurately estimate the amount of ink needed for each job through training in ink estimating techniques. Keep accurate records of the quantity of ink that is used for specific jobs, particularly for reorders or repeat customers.
- Keep ink containers sealed and contents level; place plastic or wax paper on top of the ink to prevent drying; use anti-skinning sprays.
- Scrape as much ink from empty containers as possible prior to disposal or recycling.
- Use a standard ink sequence and try to schedule print runs from light to dark, if possible.
- Carefully monitor inventory to ensure a "first in-first out" strategy.
- Donate off-spec ink to schools or give it to another printer rather than paying for disposal.
- If the firm is large enough, presses can be dedicated to specific colors or as "hazardous inks" only presses, decreasing the number of cleanings needed for each press.

Excess ink is the result of overestimating ink usage at the press or at the time of ink purchase. Whenever possible, return unopened cans of excess ink to the supplier. Reusing excess ink can reduce both disposal and purchase costs. Some options:

- Mix excess ink, including black or colored inks, on-site to produce black ink. Many printers like the quality of the black ink produced from mixing colored inks because of the high quality of colored inks.
- Mix non-contaminated excess ink with virgin ink of the same color.
- Use a computer-controlled mixing program in conjunction with a digital scale for mixing PMS colors. Mixing programs range in price from $300 $2500. Many printers find the systems very user friendly and are satisfied with the inventory reduction they achieve.
- "Prethink" printing jobs and counsel customers about the environmental impacts associated with particular color, paper, or printing method choices. Make sure that print jobs reflect the true cost of doing business and disposing of hazardous wastes.

Testing, monitoring, assuring proper disposal and completing the paperwork related to waste management activities requires significant employee time and managerial support. This can contribute to overhead costs, which must be considered in addition to the waste ink disposal expense.

Good operating practices (GOPS) are often the most cost-effective way to decrease the amount of waste ink generated. Using careful and consistent GOPs requires building employee commitment and interest in pollution prevention as well as managerial support to encourage employee participation in pollution prevention programs. GOPs include careful inventory control, and careful scheduling and managing of jobs. Most GOP approaches focus on wise raw material management and careful pre-thinking prior to running print jobs, so work is accomplished with a low margin of error, decreasing waste generation. A variety of GOPs are applicable to ink management.

Don’t be afraid to add some of your own ideas. You would have these ideas when you watch the operation. Because we cannot take you to see the press in operation, you can assume some ideas just for the purpose of learning about this root cause analysis tool.

ALTERNATIVE SOLUTIONS EXERCISE: USING THE BRAINWRITING TOOL

With the process map and cause and effect diagram in view, your team is ready to use brainwriting to generate a number of possible solutions to the ink problem. Remove a brainwriting sheet form your training manual. Put it into a pile at the center of the table so that all team members can reach them. One of the team members should place a second sheet in the pile so that there is one more sheet than there are people on the team. The sheets can be ***face up*** in the pile.

Each person should pick up a brainwriting sheet and write a way to solve the problem ***or*** make it less severe in box #1. Write another way to solve the problem or make it less severe in box #2. Take your time. Then place your sheet back into the pile and take another sheet and repeat the process in the lowest numbered boxes available to you. ***Don't forget to be provocative!*** When you cannot think of any more alternative solutions to the problem, read what the others have written and see if it triggers another idea. You can build on other peoples' alternative solutions by adding things to what they said. Keep the sheets moving until you have read everything and just do not have any more ideas. It is all right to talk during the exercise and ask questions when you do not understand an alternative solution on one of the pages.

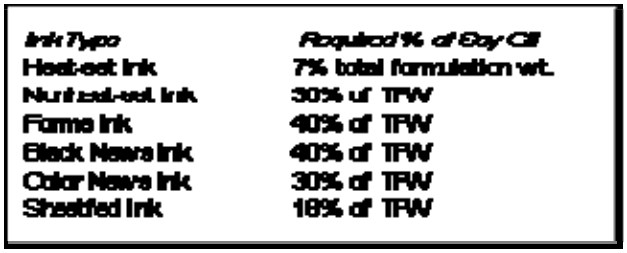
When activity has stopped (i.e., usually about 15 minutes), elect a team member to use the flip chart paper to write down the alternatives as read by the team members who have divided up the sheets among them. Make sure the scribe captures the idea as read. Leave space between the items because the sheets will be cut into strips for the next exercise. Once an item is placed on the flip chart, the members of the team should check their sheets to see if there is a similar item listed. It should be read aloud and the team will decide if it is the same or if it is slightly different. If it is different, it should be added to the flip chart list. Cross off all items on the brainwriting sheet that have been considered. Do not try to combine alternatives now. Keep going until all the alternatives are listed. ***Quantity counts!!*** Cut them into strips with one alternative on each strip.

SOME INK FACTS GARNERED THROUGH INTERVIEWS WITH EMPLOYEES

The employees had yet other ideas for prevention pollution prevention with the inks. Some of these ideas came from some literature prepared by their state pollution prevention technical assistance provider.

Soy- and vegetable-based inks were popular during the oil crisis in the early 1970s. But as presses became faster, petroleum-based inks displaced slow-drying vegetable-based inks. Now increased emphasis on improving worker safety and reducing environmental emissions has sparked renewed interest in vegetable oil-based inks, and many printers and suppliers are trying to address quality concerns found in early versions of these and other alternative inks. Vegetable oils can reduce total VOCs in an ink formulation. Among the vegetable candidates for oil base in ink, soybean oil is the most promising. Some advantages of soy-based inks:

- Some printers, especially newspaper printers, have managed to achieve high quality with all color soy inks except black. Newspaper inks can contain a high vegetable oil content due to the absorbency of newspaper. Because the ink dries solely by absorption, it is possible to substitute all of the petroleum and 100% soy formulations are available.
- Soy inks are less likely to build up on the plate, have less tendency to skin over, and have greater stability.
- They permit greater latitude in ink-water balance, allowing more flexibility in press settings, and provide greater coverage per pound of ink.
- Soy oils tend to be clearer than petroleum oils, so the colors can be brighter. Also, some printers claim that soy ink pickup and transfer is quicker, resulting in shorter start-ups and less waste.
- Many printers claim that soy inks are more forgiving and thus make it easier to run a high quality job on older equipment. It is sometimes easier and faster to change from a dark to a light color ink with soy than with petroleum-based inks.



Ink Type	Required % of Soy Oil
Heat-set Ink	7% total formulation wt.
Nonheat-set Ink	30% of TFW
Forms Ink	40% of TFW
Black News Ink	40% of TFW
Color News Ink	30% of TFW
Sheetfed Ink	18% of TFW

Table 1: Certified Soy Inks. The percentage of soy content for certified soy ink varies depending upon the process type. (Source: NAPL, July 1991).

- Soy inks tend to work well with recycled paper. Because of the flow of ink, soybean inks don't pick out the fibers of the paper and they adhere better.

- Soy-printed products are easily deinkable by wastepaper processors and they produce a less hazardous sludge, making them more recyclable than petroleum-printed products.

But there are drawbacks. Soy ink often costs more than conventional inks, but the cost is expected to decrease. The drying times for soy inks are considerably slower, particularly on coated paper. Thus, pure soy-based inks cannot be used in the heatset process. As a result, soy-based oils still contain a certain percentage of petroleum. The American Soybean Association (ASA) has developed a "Soy Seal" certification program. The table summarizes the percentages of soy content necessary for qualification. Another disadvantage is that soy inks may still contain small quantities of hazardous substances, and may have to be managed as hazardous waste.

SUMMARY OF PRODUCT SUBSTITUTION ALTERNATIVES TO SOLVENT-BASED INKS

Alternative	Applications	P2 Benefits	Operational Advantages	Operational Disadvantages	Cost	Product Quality	Limitations
Vegetable Oil Heatset Inks	Lithographic web presses	Reduced VOC emissions and worker exposure to petroleum oils	Less ink build-up; greater stability; increased flexibility	Slower drying time; poor drying can result in set-off, marking and poor rub resistance	No capital cost; ink cost can be 5%-8% higher	Similar quality	Heatset requirements limit replacement of petroleum oils; ink dryer contributes to VOC emissions; ink waste may still be hazardous
Vegetable Oil Non-heatset Inks	Lithographic non-heatset web and sheet-fed presses	Reduced VOC emissions and worker exposure to petroleum oils	Can provide better print quality, brighter colors, better pickup and transfer	Slower drying time	No capital cost; ink cost slightly higher	Similar quality; brighter colors and improved clarity	Usually some petroleum oils; ink waste may still be hazardous

Vegetable Oil Newspaper Inks	Lithographic web presses	Reduced VOC emissions and worker exposure to petroleum oils; 100% replacement o petroleum oils possible	Better color reproduction; better color control; less rub-off; less tendency to build up or skin over; greater stability; smoother flow; better coverage; greater ink-water balance parameters permit greater flexibility	Usually slower drying time	No capital cost; higher ink cost may be offset by reduced newsprint spoilage	Higher quality color printing; similar quality black printing	May contain some petroleum oils; ink waste may still be hazardous
Vegetable Oil Form Inks	Lithographic non-heatset web presses	Reduced VOC emissions and worker exposure to petroleum oils	Smoother flow; better coverage	Slower drying time	Slightly higher ink cost	Higher quality color printing	May contain petroleum oils; ink waste may still be hazardous
UV Curable Inks	Lithographic web and sheet-fed presses	No ink-derived VOC emissions or worker exposure to petroleum oil; reduced process waste	No ink drying on press reduces frequency of press cleaning; rapid curing; no set-off; no need for ventilation of printed sheets		Capital equipment cost; high ink cost; lower energy use than thermal drying; increased productivity	Good gloss and durability; print quality may be less clear; possible adhesion problems on some materials (aluminum, steel, some plastic	Workers must be protected from UV light; some toxic chemicals in inks; may cause skin sensitivity; ventilation needed to reduce ozone buildup; paper difficult to recycle

EB Curable Inks	Lithographic web and sheet-fed presses	No ink-derived VOC emissions or worker exposure to petroleum oil; reduced process waste	No ink drying on press reduces frequency of press cleaning; rapid curing; no set-off; no need for ventilation of printed sheets		Capital cost; considerably higher ink cost	Print quality less clear	Workers must be protected from EB light; some toxic chemicals in inks; may cause skin sensitivity; often degrade paper; paper difficult to recycle
Water-Based Inks	Flexographic and gravure presses	Little or no ink-derived VOC emissions or worker exposure to alcohol; replacement of solvent-based cleaners and fountain solutions with safer substitutes	Hold color and viscosity longer during press runs; more coverage per pound of ink; reduces the need for make-up solvent during printing	More frequent equipment cleaning; less forgiving of equipment imperfections, may cause paper curl	May require new capital equipment; greater energy use; reduced hazardous waste disposal and liability costs	Similar quality with new equipment; low ink gloss on porous substrates	May contain low level of solvent; ink waste may still be hazardous; greater energy use for drying

Don't forget the ideas they gave you before!

Now it is time to be provocative. What are some "outrageous" ideas that just might work? How about printing without ink? Can you top this one?

1	2
3	4
5	6
7	8
9	10

1	2
3	4
5	6
7	8
9	10

1	2
3	4
5	6
7	8
9	10

ALTERNATIVE SELECTION EXERCISE: USING THE BUBBLE-UP/BUBBLE-DOWN TOOL

Take the strips containing the alternative solutions from the brainwriting exercise and place two of them on the table or floor and ask the question, "Which is ***best***?" Take ***cost***, ***ability to implement***, and ***effectiveness*** into account as the team makes a decision. Only a majority is needed to bubble-up or stop. Take the next alternative from the pile and place it at the bottom of the list and start over again. Keep bubbling the alternative up, one place at a time until it can rise no more.

This tool helps you discuss all the alternatives. You can ask questions of the person that recommended the alternative solution. Do not try to reach consensus on every item. Remember that you can combine items as they are moved up the list. You can simply tape them together or write the combined alternative solution on a blank slip of paper. Do not take short cuts by moving alternative solutions up the list without considering all the other solutions. It is good to have discussions so each team member learns what the others think about each alternative. This discussion will help write a better action plan for the alternative solution(s) selected for implementation.

Here is an important consideration for you to keep in mind during this exercise - Alternative solutions that are cheap and easy to implement usually win out over effective ones that are more expensive or take a long time to implement. Remember how important it is to show progress in this and every program conducted within the organization using the Systems Approach for process improvement.

Once the prioritization has been completed, the team members should feel free to do some shuffling of the order (i.e., move nothing more than two places unless agreed to by a consensus of the team). The ***quick wins*** should be at the top of the list. What is the alternative solution that is closest to the top that is **not** a quick win? This is probably your highest rated ***crown jewel*** or effective alternative solution. You should consider writing an action plan for that alternative solution as well as the one that ended up on top since it will take time to get it implemented.

LESSONS LEARNED:
EMPLOYEES PREPARING ACTION PLANS

Let's take a look at what you learned from root cause analysis (cause and effect diagrams) and alternatives (brainwriting and bubble-up/bubble-down).

CAUSE AND EFFECT DIAGRAM

Root cause analysis is a very important step in the use of the Systems Approach. Many organizations choose to leave this step out. What are the reasons why this is not a good idea?

Do not try to solve the problem at this stage of the Systems Approach! Avoid that temptation.

Teams using root cause analysis will derive more alternative solutions than teams that skip this important step.

It is important to define the ***problem*** in such a way that all team members have a role. There must be a common view of the problem by the team members. There are separate tools to help define the problems. However, it is beyond the scope of this course to cover these in any depth.

There are no rigid rules on what the cause categories need to be. You can select cause categories that fit your problem. The cause categories are selected to get everyone on the team talking about potential causes.

Interpret the cause categories ***broadly***. **Materials** can mean all resources as used in this course. **Machines** can mean all technology. **Methods** are all procedures and policies. **People** are people – usually positions so the diagram does not get personal! If you choose to use the Four P's, **policies** are at the highest level – they are very difficult to change effectively. **Procedures** are more local – they can be difficult to change, but the control is much more local. **Place** is where the problem happens or has its effects.

The busier the cause and effect diagram, the more thought went into the understanding of the problem.

What is the reason you would cite when deciding whether to include the root cause in a process improvement project?

To what extent is the cause and effect diagram understandable by those who are not trained to use it?

ALTERNATIVE SOLUTIONS

We have looked at the way to generate many potential alternatives that could help solve the problem. We have then used a tool that helps select an alternative solution(s). These tools may not have been familiar to you. Certainly other tools can work for these purposes. What is it that helps recommend these particular tools?

Brainwriting needs to be "free form" to work well. It is all right to talk and ask questions. If the group is not chattering, it is probably not using the tool well. Everyone on the team should understand what the others have written on the brainwriting sheets. This discussion will be useful when trying to prioritize the alternatives and prepare an action plan for the selected alternatives.

It is good to have the cause and effect diagram handy when brainwriting. Alternatives do not need to eliminate the problem – only reduce its impact to some extent. The discussion continues as the alternatives are placed on the flip chart and people on the team look for similar alternatives on their sheets. New alternatives can be added at this step if someone thinks of one.

Do not forget to use ***provocation***. It is the only way to force the team members to think "outside the box."

When working with service or design issues, the alternatives often take the form of the order or sequence in which the action will occur. This is a

fundamental difference between this process form and the resource intensive production form.

There will always be more than 18 alternatives on the final list. Do not be quick to combine or eliminate alternatives when using the brainwriting procedure. Remember that quantity counts in brainwriting.

Do not spend much time researching the literature or other information sources until after the brainwriting has been completed for the first time. Always avoid the search for "***right answers***!" Literature information should not generally be used until after the bubble-up/bubble-down has been completed. The workers are then asked if they would raise any of the "success story" alternatives to the top of their prioritized listing.

Some people like ***affinity diagrams*** because it groups the alternatives into similar categories. This avoids having to compare seemingly unlike alternatives in the bubble-up/bubble-down tool. However, this is not like "real life" in the organization. Alternative solutions are complicated and are not so easily compartmentalized. It should not matter which way is chosen.

Do not forget to work on the "crown jewel" feasibility studies early in the program.

Some "quick wins" may need minimal action plans. However, an action plan should still be prepared. It is an accountability document.

Maintain the prioritized listing to allow for continuous improvement.

What else have you observed?

ACTION PLAN CASE

Not that you have some alternatives to reduce the amount of ink waste from the printing operation, it is time to prepare an action plan.

What will you measure in the Baseline Survey in Task 1? Take a look at the accounting sheets before you make this determination.

What is the ***purpose*** of the project? How can the ***project be described*** in a sentence? What will the ***benefits*** be?

How many of the "quick win" alternatives can the employees complete in the first year? In what order should they be presented as tasks in the action plan? Which ones should be done in time for the first report to the management oversight committee at +3 months? Which ones should be done in time for the second report at +6 months? Which ones should be done in time for the third report at +9 months?

Remember that the employees preparing the action plan will be held accountable for the completion of the work that they specify.

ACTION PLAN
(PROJECT)

1.

Purpose:

Project:

Benefits:

WORK TASKS	PERSON/TEAM RESPONSIBLE	COMPLETION DATE	PERFORMANCE GOAL	RESOURCE COST
1.				
2.				
3.				
4.				

WORK TASKS	PERSON/TEAM RESPONSIBLE	COMPLETION DATE	PERFORMANCE GOAL	RESOURCE COST
5.				
6.				
7.				
8.				
9.				

LESSONS LEARNED: A RETROSPECTIVE LOOK AT THE SYSTEMS APPROACH

Now it the time to reflect on what we have ***learned*** from the first two days of training:

- Who has had any experience with similar efforts to use quality tools and formal action plans? How did those efforts differ from those described today?
- What lessons have you learned about how you can have employees work to solve problems using quality tools and to create an accountability document?
- How can you use this knowledge to begin or improve Compliance Through Prevention where you work?
- What is the value of getting the employees involved in this way?
- How did the tools and methodologies specified in the exercises help facilitate this involvement?
- Are there other tools and methodologies that might have worked for this effort?
- Is it possible to these methods to align Compliance Through Prevention with the objectives of the core business practices? What other programs exist in your firm where these methods may be compatible?
- How do you create an institutional memory for lessons learned in such an integration effort and make that institutional memory easily available?
- How do you feel about integrating Compliance Through Prevention into core business practice?
- What were your reactions to the exercises?

Notes

NOTES: