Whether you are starting a new metallurgical plant such as a concentrator, pressure oxidation process, CIP plant, leach/SX-EW facility, smelter, or refinery, or need to improve performance at an existing one, you are faced with one major challenge: **Optimize plant operator and maintenance personnel performance**! Once the plant is designed, the control logic implemented, and the equipment procured and installed, **the only significant variable affecting plant performance is the effectiveness of plant operators and maintenance personnel.**

Operations

In a typical process-plant operation, plant operators:

- ***Develop home-grown strategies for controlling the process***. In fact, it is very common for different crews on different shifts to use entirely different methods for controlling the plant during their shift. Of course, this causes varying recoveries and yields for different shifts. Also, obviously, the strategies used by some crews will be better than others. This differential represents lost revenue. In most cases, even the best crew can dramatically improve performance given the tools and training necessary.
- ***Do not have a good understanding of the fundamental principles of the unit operations within their control***. A basic understanding of each unit operation provides the operator with knowledge that can be used to optimize performance, troubleshoot process problems, and when necessary, provide maintenance with the necessary information to minimize required downtime while problems are small, before they become major and cause significant outages.
- ***Do not have the knowledge of interlocks necessary to minimize downtime***. Process plants tend to be complex with respect to inputs necessary to satisfy motor control logic. Lack of knowledge of the interlock logic can result in short shutdowns becoming extended outages.
- ***Do not take representative samples in accordance with a strict procedure***. It is impossible to optimize a process unless highly accurate measurements are taken at appropriate points in the process. These measurements require good samples.
- ***Can damage equipment since in many cases standard procedures are not used for plant start-up and shutdown***.

To optimize plant performance, operators must be thoroughly familiar with thousands of technical details related to plant performance, and they must use that knowledge to optimize the process, react effectively to process upsets, implement control strategies, and react appropriately to alarm conditions. Considering that in most plants, a significant number operators are informally trained by their peers—who in most cases have also not been formally trained—it is no wonder that there is significant potential for improving performance.

In a start-up situation, during the critical early days of start-up, operators can become overwhelmed with problems if they have not been through a comprehensive training program covering all details of the plant design and the myriad procedures that are needed.

In the absence of a good, formal operator training program, the only way that operators can achieve the necessary knowledge is through trial and error during operation. We have seen many organizations attempt to start-up metallurgical plants using this technique; almost all of them resulted in protracted struggles with design production levels not being achieved for many months; some not at all. The cost of the lost production resulting from these poor start-ups dwarfs the original cost of preparing materials necessary for properly training operators. The costs of an under-trained workforce in an existing plant can even be higher than for a start-up, given the extended duration of operation at less than achievable performance levels. Plants using Performance Associates training programs eliminate these drags on performance.

To effectively train operators and optimize performance, requires the preparation of first-class process operating manuals, training modules, and conducting on-site operator training covering the key concepts of the process and its unit operations, process variables, control loops, interlocks, alarms, and operating procedures. For a plant start-up situation, this work cannot commence until most of the engineering is done and must be completed a few weeks prior to the introduction of feed. For a start-up, there is never again an opportunity to do this kind of preparation since your operators will be in the midst of start-up after this window closes. The whole process usually takes about seven or eight months. For an existing plant, many times a computer-based, multimedia version of the process operating manuals provides the best approach for training since operators can train via the computer when schedules permit.

We believe that the correct question to ask, when considering either start-up preparations or improvements to existing plant performance, is: *"How will our operators get all of the information they need to adequately run the plant and optimize performance"?* The answer is: there is no substitute for combining all of the process and operating information into a comprehensive set of manuals—either hard-copy or computer-based, or both—along with on-site training instruction by an experienced plant specialist.

Training operators to do a better and more consistent job of controlling the process can achieve dramatic results. If we look at a typical copper concentrator—very minor improvements can provide very significant financial results.

Example 1: Improving Recovery

40,000 ton per day copper concentrator.
Ore grade = 0.7% copper.
Price = 90 cents/pound
Training has resulted in improving recovery from 80% to 81% through improved process control in grinding and flotation.

Results:

80 Percent Recovery:

40,000 tons / day	0.70% grade	2,000 lbs. / ton	80% Rec	360 days / yr	$0.90 / lb	= $145,152,000 per yr

81 Percent Recovery:

40,000 tons / day	0.70% grade	2,000 lbs. / ton	81% Rec	360 days / yr	$0.90 / lb	= $146,966,400 per yr

Potential increase in sales revenue (assuming 100 percent recovery in the smelter and refinery): $1,814,400 from the production of an additional 2,016,000 lbs. of copper per year.

Almost all of the costs associated with this increase have already been absorbed. All of the mining, comminution, and most of the flotation costs have already been absorbed. Only the filtering, drying, and smelting costs remain to be absorbed. Assume that the remaining costs are $0.20/lb. Therefore, the potential increase in profit from the one percent increase in recovery is:

$$\$1,814,400 – (2,016,000 \times \$0.20) = \$1,411,200$$

Assuming a recovery of 95 percent through the smelter and refinery, the actualized profit increase is

$1,411,200 x .95 = **$1,340,640 per year—every year!**

Example 2: Increasing Production Rate

40,000 ton per day copper concentrator.
Ore grade = 0.7% copper.
Price = 90 cents/pound
Training has resulted in increasing production from 40,000 tons per day to 41,000 tons per day through the concentrator.

Results:

40,000 tons per day:

40,000 tons / day 0.70% grade 2,000 lbs. / ton 80% Rec 360 days / yr $0.90 / lb = $145,152,000 per yr

41,000 tons per day:

41,000 tons / day 0.70% grade 2,000 lbs. / ton 80% Rec 360 days / yr $0.90 / lb = $148,780,800per yr

Potential increase in sales revenue (assuming 100 percent recovery in the smelter and refinery): $3,628,800 from the production of an additional 4,032,000 lbs. of copper per year.

As in Example 1, most of the costs associated with this increase have already been absorbed. All of the mining and comminution costs have been absorbed but not the flotation, filtering, drying, and smelting costs. Assume that the remaining costs are $0.35/lb. Therefore, the potential increase in profit from the increase in production rate is:

$$\$3,628,800 – (4,032,000 \times \$0.35) = \$2,217,600$$

Assuming a recovery of 95 percent through the smelter and refinery, the actualized profit increase is

$2,217,600 x .95 = **$2,106,720 per year—every year**!

If ***both*** the recovery ***and*** production rate can be increased, the profit increase is further increased in the same dramatic way.

The point of the examples is that very small increases in operator effectiveness can have very large benefits with reference to increase in profits. Our experience is that well trained operators running a plant with good, consistent procedures can achieve these kinds of results.

Maintenance

Generally, the maintenance organization can affect mine and/or plant performance in two ways:

- ***Excessive costs*** due to over-manning, excessive use of parts, out-of-control inventories, and over capitalization necessary because of low availabilities.
- ***Loss of production*** due to low availability of production equipment or instrumentation and/or equipment operating at less than specified efficiency.

The key to eliminating both of these drags on performance is to implement a maintenance management system designed to optimize maintenance performance and to provide necessary basic and specific equipment training to maintenance personnel.

Effectiveness in the maintenance organization must start with a system that allows for scheduling 100 percent of the maintenance work force for a shift's worth of work on every shift. To accomplish this, Performance Associates' maintenance systems:

- Provide weekly work forecasts and shift schedules that optimize manpower efficiency.
- Provide for parts planning and staging.
- Ensure identified work is backlogged and planned.
- Provide the means for tracking equipment history, warranties, and parts usage.
- Provide the tools to analyze wear materials and procure the best materials of construction.

Effective maintenance also requires first-class preventive maintenance (PM) and predictive maintenance programs. It is essential that the maintenance organization is provided with good PM sheets to ensure each item of equipment and instrument is properly inspected, adjusted, calibrated, and/or lubricated as required by industry standards, the design criteria, and the manufacturers instructions. Availability and reliability cannot be optimized without good, comprehensive PM sheets and schedules. The PM program provides the most important means of identifying necessary maintenance work to be planned and scheduled via the maintenance system. If this work is not identified and completed via the PM program, it will identify itself via equipment breakdowns.

For a start-up situation, it is imperative to have all of the PM sheets, along with the maintenance system, complete and ready to go prior to plant start-up. Ideally, punchlist items resulting from preoperational testing that are assigned to the owner's maintenance organization can be tracked and controlled using the maintenance system.

The final piece of the performance puzzle is maintenance personnel training—basic training and specific equipment training. Typical symptoms of a maintenance workforce needing training is recurring failures and excessive parts usage. A common theme evident in an under-trained maintenance workforce is troubleshooting by changing parts. In cases like this components and parts are changed until the problem resolves itself. Effective troubleshooting requires basic, fundamental knowledge of the equipment and a high-degree of training.

Performance Associates' programs tackle the maintenance performance issue from three sides:

- Effective maintenance management systems, including, if appropriate, Performance Associates' computerized maintenance management system, *Performance Manager*. However, Performance Associates works with any and all computer systems to improve performance.
- Comprehensive preventive maintenance programs for mine and plant equipment.
- In-depth maintenance personnel training for basic trades knowledge and maintenance requirements for specific equipment.

    Basic training includes training in the maintenance trade. This training includes such topics as:

    - Rigging and hoisting
    - Shafts, keys, hubs, and fits
    - Lubrication
    - Friction and anti-friction bearings
    - Couplings
    - Aligning drives
    - Dial indicators
    - Etc.

    Specific equipment training is necessary even if your maintenance personnel have a solid trades background in the basics. Specific equipment training includes training on the maintenance requirements and procedures for specific vendor-supplied equipment such as:

    - A FFE Minerals SAG mill and lubrication system
    - A Micropul baghouse-type dust collector
    - A Lurgi roaster
    - Etc.

Consider the effect on performance once highly trained personnel, operating within a good PM and maintenance management system, are maintaining your mine or plant. The effect can easily represent millions of dollars per year based on direct maintenance costs and the lost production associated with equipment reliability and availability.

Conclusion

Performance Associates can assess your performance improvement opportunity through an on-site survey and/or training needs analysis. Contact Performance Associates today for more information on improving performance at your plant.