Assessing Real Pump Costs

Hidden or unrecognized costs can be significant.

It's Thursday, late in the day, and you are wrapping up some of the final details on a new project. Your supervisor approaches and asks you for a quantitative analysis illustrating how the pumps you have selected match up against the other pumps bid for the job. "Let's look at our projected costs over 10 years," he says. "Can you throw something together by Monday?" Believing that the Maintenance Department, which has long favored the pumps you've selected, will have some data on repair costs and that the pump manufacturers will surely offer some solid information and advice, you quickly reply, "Sure, no problem." Could this happen to you?

Performing a cost analysis for pumping equipment over time is easier said than done.

Performing a cost analysis for pumping equipment over time, frequently called life-cycle costing (LCC) by the accounting people, is easier said than done. Generally, we assume users of industrial pumps have historically used the less scientific, but valuable tools of experience and intuition when sizing up pumps for a particular application. At Ford Motor, *Reliability and Maintainability (R&M) Guidelines* and *Total Productive Maintenance Approach to Competitiveness* focus on equipment life-cycle costs. Success in implementing a more "scientific" approach to evaluating plant pumping equipment depends in large part on tracking repair and maintenance costs accurately over time.

An early effort to this end involved a new engine program at Cleveland Engine Plant #2. This program required the purchase of numerous large industrial parts washers and central coolant filtration systems. In total, 46 pumps (800–1,875 gpm) would be installed on that equipment. To offer a model for determining the relative cost of pumps, we will share the joint approach developed by Ford Motor Company and Process Systems, Inc., a Warren, MI based pump manufacture and repair company that has supplied Ford with more than 1,600 vertical turbine pumps over the past 22 years.

Begun in 1991, the project introduced *Reliability and Maintainability Guidelines* to suppliers. These guidelines differ from traditional preventive maintenance (PM) programs in one important respect: while PM is designed to maximize machinery up-time after purchase, R&M is an integrated approach to maximizing machinery up-time that starts with machinery design. The main benefits to Ford's R&M approach are decreases in life-cycle costs, machinery failures, defective products, speed losses, yield losses, downtime losses, repair time, and downtime frustrations. Essentially, Ford has established performance targets for its production machinery. Two targets are overall machinery availability and reliability. For the machinery to achieve these targets means that its sub-components, such as pumps, must reach 99%+ availability and 95%+ reliability over time. (Ford has its own definitions for availability and reliability, definitions that basically measure up-time.)

Because Process Systems embraced Ford's ideas and the requirements of R&M, Ford was able to see for the first time what it costs on an annual basis to repair vertical turbines used in central coolant and large parts washer applications.

LIFE-CYCLE COSTING MODEL

Our objective was to concentrate on the main pump cost components and not get lost in a myriad of detail. Below is a description of the included components. The basic task is to set up a table that compares each cost component below for the pumps under consideration.

MAIN COMPONENTS TO PUMP LIFE CYCLE COSTING:

1) Initial pump price: The only detail worth mentioning is freight. Make sure that you are including (or excluding) freight costs for all pumps in question. Be consistent.

BY DWAYNE ATKINS AND SCOTT BOONE

[redacted]

2) Motor cost: Because the design and mechanical efficiencies of the pumps will vary, it is important to include motor costs. One pump may require a 75 Hp motor, while another, more efficient pump, may require a 60 Hp motor to get the same job done. To further ensure you are making an apples-to-apples comparison, pay attention to whether the pump suppliers are quoting a pump that is nonoverloading (NOL) over the entire curve for the motor selected. A NOL pump is often specified by the user, but make sure that is what you are getting. Again, you want to strive for consistency.

3) Energy consumption: What is actually measured here is kilowatt hours consumed (KWH) over time. KWH is a function of the total pump run hours, the brake horsepower (BHP) required of the pump, and kilowatt/hour energy cost. In sum, a more efficient pump will require less BHP and therefore use less energy. You must apply two simple formulas for each pump:

1. $$\text{BHP} = \frac{(\text{gpm x tdh x sp. gr.})}{(3{,}960 \text{ x pump eff.})}$$

Where gpm = gallons per minute; tdh = total dynamic head in feet; sp. gr. = fluid specific gravity; 3,960 = constant; and pump eff. = pump efficiency at the point on the pump curve that pump will run.

2. $$\text{KWH} = \frac{(\text{BHP x } 0.746 \text{ x run hours})}{(\text{motor eff.})}$$

Where BHP = result of Equation 1; 0.746 = constant; run hours = estimated annual run hours for the pump; and motor eff. = the manufacturer-stated efficiency of the motor you plan on using.

The final step is to multiply the KWH consumed by each pump by the cost of energy per kilowatt hour (around \$.06). This yields an annual energy cost to operate each pump.

"Pumping purists" may argue that true energy costs would require factoring in pump wear and efficiency losses, and they would be right. Pump wear over time negatively effects efficiencies. Furthermore, the efficiency number most commonly communicated to end-users and contractors is *bowl efficiency,* which differs from pump efficiency. Pump efficiency is slightly less than bowl efficiency because pump efficiency takes into account losses due to pipe friction and elbows. However, because all pumps suffer these losses and all pumps wear over time, a very good approximation of the *energy cost difference* of competing pumps can be made by using the stated bowl efficiencies. For most applications the resulting increase in accuracy is not sufficient to justify the extra time and effort to adjust for minimal losses. What we are after is the energy cost difference to run competing pumps, and that difference may be virtually the same with or without wear and pump losses factored in.

[redacted]

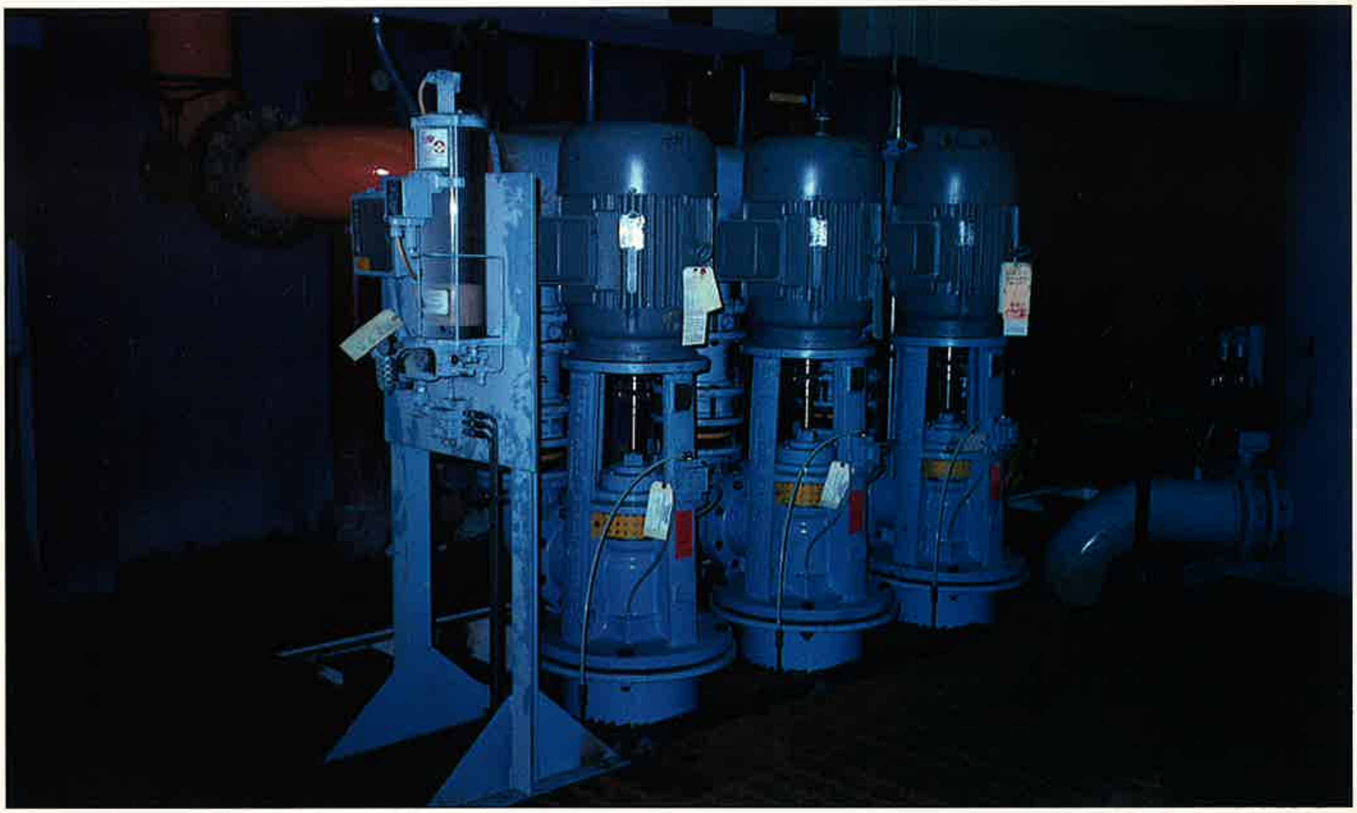

PHOTO COURTESY PROCESS SYSTEMS INC.

Three vertical turbine pumps on central coolant service.

4) Repair and maintenance costs: This is arguably the trickiest piece of the puzzle. Unless your maintenance area keeps accurate time sheets on R&M activity or your purchasing people have a data base that can easily retrieve pump parts orders and service call costs, this all-important piece of the puzzle may create a big headache. A full estimate of this cost should include the cost of replacement parts and the labor hours involved in both repair and maintenance activities. If you really want to dissect LCC, labor hours should also include time spent on parts procurement, parts receiving, and other indirect efforts.

The 80-20 rule probably applies here: You will get 80% of the information in 20% of the total time it would take to get all the information. It may take so much time to get the remaining 20% of the information that it's not worth it unless you are set on adopting LCC as a long-term priority. If no repair history is available, a logical alternative would be to ask the pump supplier the cost of a standard repair kit (if ones exists) and his best estimate for frequency of repair. Then, ask to speak to at least five other users of the pump being considered and get their feedback on estimated repair frequency and required time to repair. Factoring in the similarity of their applications to yours, you may want to average out their data to give you a slightly refined estimate of repair costs.

5) Incremental installation costs: These are extra costs associated with one pump but not with another. For instance, we have run into the situation where two pumps are being considered for a large industrial washer. One pump requires a 100 Hp motor and uses a size 4 electric motor starter; the other needs a 125 Hp motor and a size 5 starter. The additional cost for the larger starter can run upwards of $1,350—a cost that should not be overlooked.

In addition to incremental starter costs, one pump may require more piping, mounting apparatus, or time investment. All significant differences should be accounted for.

6) Opportunity cost of frequent repair: We have not yet quantified this factor, but it is important to note. A hypothetical example will show what we mean by opportunity cost. Suppose you are looking at two pumps with roughly the same life-cycle cost over a period of seven years. One pump has a price tag almost double that of its competitor, but may require a repair only once in seven years. The other pump may require repairs every year or two, thus offsetting its low initial price. By choosing the pump that breaks down less, you provide your maintenance people with more time to perform preventative maintenance. Therefore, the *opportunity cost* of frequent repair is *less time available* to perform PM. This is a real cost, albeit a hard one to quantify fully. It certainly could serve as a tie-breaker for pumps with near-equal life-cycle costs.

7) Salvage value: If it is possible to re-sell used pumps after the

[redacted]

project has run its course, proceeds from the sale will obviously offset pump costs. For instance, Process Systems has often offered to re-purchase used pumps from Ford. The basic requirement for the sake of a life-cycle cost analysis, of course, is to find what the salvage value might be ahead of time.

INTERPRETING THE BOTTOM LINE

Many manufacturing operations have historically used payback period to determine whether a project is worth pursuing. For instance, if the "more expensive" product can deliver a payback period of three years or less, then its purchase might be made. What payback period misses is the fact that the ultimate objective is to increase the value of the company. To measure this, you have to determine what option will provide the firm with maximum cost savings (or return on investment). In absolute terms, a net present value (NPV) comparison of the total projected future costs of each pump would have to be made. NPV requires that future cash outflows are discounted back to the present—a way to make a true apples-to-apples financial comparison. Without turning this article into a lengthy discussion on finance, it is probably safe to say that the pump that is best for the company will be the pump that delivers the least cost over time and meets your criteria for maintainability and reliability.

Overcoming your company's reluctance to purchase a reliable but more expensive pump may hinge on your ability to make a reasonable stab at an LCC comparison of competing pumps. Because the cost of down-time can be tremendous and maintenance manpower is limited, many of us can't afford to buy the "cheaper" pump. The converse is also true. While the example provided with this article (page 31) suggests the superiority of the vertical turbine over a vertical chairmount, in no way are we advocating a turbine for all high-flow applications. There are many applications where the vertical chairmount is preferred because of features unique to that pump and the variables of the pumping application. We should also make it clear that Ford plants purchase many different styles of pumps, not just vertical turbines and centrifugals.

SUMMARY

As you can see, Ford Motor Company was unable to compile and analyze all the life-cycle cost components that are offered in the model. A little guesswork was also needed. We believe this will be true to life for many pump users. The point is that good decisions can be made with only a portion of the data. Often, the time and effort needed to generate accurate repair and maintenance figures may not be worth it. Installation times between competing pumps may vary by only an hour or two and therefore become a nonissue. When in doubt, it is always good policy to ask the people who work with and repair the pumps. They may have the breadth of experience to make a good guess at R&M and installation costs. Life-cycle costing has other limitations that require the decision-maker to look past the numbers. For instance, a prudent buyer will also carefully look at the warranties and commitment to service of the companies supplying the pumps. It especially pays to read the print of competing pump company warranties because differences in what is covered and what is not can be significant. Like opportunity cost, a superior warranty may be the deciding factor when two pumps have roughly the same LCC.

Because more and more industrial manufacturers and other large users of pumps are placing a premium on up-time, searching for every conceivable way to become more efficient, and paying closer attention to energy consumption, life-cycle costing for pumping equipment is a concept that will surely become more popular in the future. The model presented in this article is intended to give the project planner and pump buyer a road map for determining the relative cost of pumps. Furthermore, by having a greater awareness of the energy costs involved, you may better appreciate the potential savings that accrue from variable speed drives. The road to life-cycle costing can be bumpy, but with a little planning and attention to capturing repair and maintenance costs you will get to where you want to go. For many, that road also leads to world class manufacturing. ■

Dwayne Atkins is a Manufacturing Engineer with the Ford Motor Company at the Cleveland Engine Plant #2.

Scott Boone is a Marketing Specialist with Process Systems.