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# TOTAL COST OF OWNERSHIP AND PRODUCTIVITY ANALYSIS FOR EDM

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## Introduction

In the competitive moldmaking industry, throughput is the key to keeping production costs competitive. Shops want to increase productivity while maintaining profitable margins on their sinker EDM-related operations. Part of management's strategy is often the inclusion of new equipment and technology. Investing in technology is as important to global competitiveness as optimizing asset ownership.

## The TCO Analysis

The Total Cost of Ownership (TCO) model and analysis is commonly used to make decisions when purchasing new equipment. Part of this evaluation process should include an audit: an evaluation of current equipment and manufacturing operations to determine the capacity or capability for meeting present and future operational requirements. *Figure 1* illustrates the events taking place during a TCO audit.

**An audit is used to do the following:**

- Compare actual performance versus benchmark performance of the equipment
- Examine areas to improve productivity
- Look at lost revenue due to inability to quote desired new business
- Evaluate slow production and inability to meet deadlines
- Check scrap rates due to out of tolerance cavities and flaws in the cavity
- Track servicing and maintenance of out of warranty equipment
- Analyze economics of upgrading, refurbishing, or disposing of existing equipment as opposed to replacement

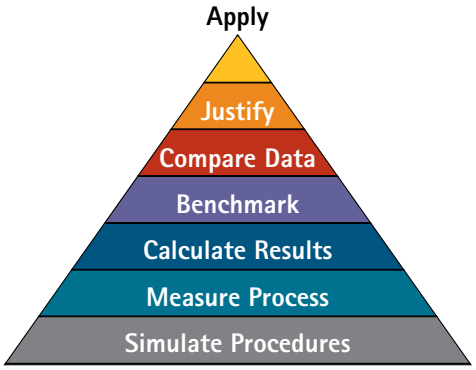


*Figure 1 - TCO Events Matrix*

For capital equipment, the main cost elements are purchase, energy, maintenance and repair. Secondary costs that have a bearing on the overall value are productivity, risk and disposal. A value assessment reflects all costs associated with a capital purchase, including owning and operating the asset over a given period of time. This information is a useful tool in optimizing asset ownership and determining the best value between several alternatives.

A good TCO analysis should fit the business plan and identify the best solution to match the business goals; for example, adding capabilities in order to service new customers or expand into different markets. Using new technology can often eliminate some of the processes and take a fresh approach to jobs. Additional capacity and improved machine performance are often the drivers in the decision to look at equipment changes.

## TCO and EDM Equipment

When cost of ownership principals are applied to major elements associated with the operation of the sinker EDM equipment, such as graphite materials, costs associated with the value proposition and productivity start to impact profitability of owning and operating the equipment.

Using benchmark data from equipment and graphite vendors, an audit of the EDM process helps identify areas of potential savings by comparing actual costs against accepted benchmarks. Using

the TCO model to audit the process may show that additional capacity can be gained from the existing equipment and the EDM machining hours can be reduced, thus increasing productivity. Once opportunities for improvements are identified, the TCO process is then used to identify the alternative with the lowest total cost, or best value, based on the needs of the company as identified in their business plan.

## Electrode Material

The audit also shows that one of the most critical elements of operating EDM equipment is the electrode material because the material's performance affects the productivity of each job and the capacity of the shop. Each equipment manufacturer publishes charts that show typical metal removal rates and percent electrode wear for specific machine settings, work metal and electrode materials when EDMing under optimum conditions. One can use the same parameters and measure the actual metal removal rate and percent electrode wear to compare how close the machine is performing to the benchmark. If the operation cannot achieve the benchmark numbers then the shop may have slower production cycles than other competitive shops. Using this benchmark data combined with actual machine performance will indicate if the current capacity of the machine has been reached. If the current machine is not reaching the benchmarked production stated by the manufacturer, there are often productivity gains to be made by changing to a high-performance electrode material. These benchmark settings could be related to speed, wear or finish, depending on the requirements of the work performed in the shop.

Once the reason for the new equipment is identified, the audit may show that there is extra capacity to be gained and productivity issues that need to be explored without adding new equipment. This is particularly true if the graphite electrode material is the root cause of productivity issues. Productivity can reduce in a number of ways if the best graphite material for the job is not used: unstable cutting extends the time the job will remain in the tank, material is unable to produce the desired surface finish efficiently and scrapping parts due to out of spec tolerances or surface pitting. Purchasing new equipment may improve these problems, but using the best graphite for the job is the best solution.

The characteristics of the electrode material also affect other shop operations or cost centers, such as electrode fabrication and mold polishing cells. Additional electrodes or redressing of electrodes due to high electrode wear also shortens the tool life and increases job costs. The material's inability to produce the desired surface finish can increase the amount of polishing necessary to finish a cavity, which also increases job cost.

Using high-performance electrode materials increases profitability while decreasing electrode fabrication time, EDM machining time and polishing time. Shops that only look at the cost per cubic inch of graphite, rather than the total production costs associated with the job, may actually be losing money because they are not purchasing the best material for the job. Even if there are no problems with capacity, an inefficient machine is still consuming electricity, reducing the dielectric fluid and filter life in addition to the added labor costs.

## TCO and Electrode Material Selection

When TCO principals are applied to major elements associated with the operation of the sinker EDM equipment, such as graphite electrode materials, the value proposition and productivity of these elements start to impact profitability of owning and operating the equipment.

Productivity can be reduced in a number of ways if the electrode material used in the EDM application is not optimized to the application. This reduction in productivity includes unstable cutting speed that extends the time of the EDM burn, the inability to produce desired surface finishes efficiently and increased potential of scrapping a part due to out of spec tolerances and pitting in the cavity. The characteristics of the electrode material also affect other shop operations or cost centers, such as the electrode fabrication or mold polishing areas. With increased electrode wear, additional electrodes or excessive electrode redressing may be required that extends production times and increases costs, not to mention added requirements for cutting tools.

The performance of the electrode is largely influenced by the grade of graphite selected. Selecting a graphite material without considering the properties of the individual grade can result in poor EDM performance. Choosing optimal electrode materials often result in faster metal removal rates, less electrode wear, improved surface finishes, increased cut stability and reduced potential for pitting and EDM arcing.

The ability to achieve maximized efficiencies in an EDM application is facilitated by the microstructure of the electrode material in use. Consistency in the material structure is paramount to minimize efficiency losses due to difficulties in the EDM cut. Materials with an inconsistent structure will have varying uniformity in regard to particle size and porosity. This causes the adaptive control technology of the EDM machine to continually adjust itself to overcome issues with flushing and keeping the gap clear of contamination. Each correction of the adaptive control results in reduced efficiencies of the EDM process. Excessive correction is generally an indicator of instability in the burn and is often rectified with consistent materials. This lessens the requirements of the EDM sinker to continually alter the program in order to stabilize the burn and allows the sinker to perform at much higher efficiencies.

Just like equipment manufacturers, graphite manufacturers can supply models and benchmarking data to aid in the TCO analysis. Using this benchmark, an electrode material should be selected on the ability to operate at optimum efficiency rates while achieving a specific surface finish, reproduce critical detail in the cavity or attain sufficient metal removal rates. This information can be used as a benchmark when comparing various grades of graphite.

Another tool to use when comparing electrode materials is a photomicrograph of the microstructure of the graphite. Because the sinker EDM process is designed to produce a mirror image of the electrode shape in the work metal, the quality of the graphite is an important part of the process. Materials that have uniform structure and small grain typically run more stable and often are capable of providing a fine finish with fewer electrodes. However, electrode materials with large grain particles and non-uniform structures are often unable to produce fine finishes and will require polishing.

## TCO Performance Model

The (TCO) model allows a quick and simple overview to fully ascertain the effect of the electrode material on the efficiency and profitability of various aspects in the EDM process.

The TCO model can be used in two ways. The first would be as an estimation model. This method allows the input of data derived from several resources available that indicate an estimation of EDM performances at varying machine parameters.

One point to keep in mind with this method is that the grade of electrode material used for the testing to gather this data may or may not be the same material currently in use on the shop floor. In this regard, the output of the data could be skewed and therefore may not reflect the most accurate estimation.

The second and most exact approach to the accuracy of the TCO model would be to record the performance of a controlled test or an actual EDM application. This bypasses any estimation of performance and assesses the true data input on the performance actually experienced. *Figure 2* illustrates the TCO model of an actual EDM application where a company using one type of electrode material evaluated a material considered to be more applicable. Initially, resistance was met in this move as the recommended material was found to be at a considerably higher cost. After much deliberation, the decision was made to record the performance variances of these two materials in order to determine future profitability of this application. As can be seen in this instance, the use of the more applicable material actually reduced the total operational costs and ultimately resulted in a cost savings even though the cost of the proposed electrode material was higher than the material currently being used.

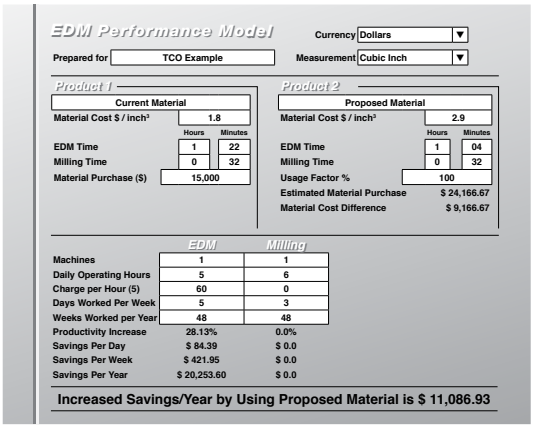


*Figure 2 - Cost of Ownership model was developed using data of actual EDM performance using different electrode materials.*

It is important to use actual conditions rather than an estimate based on short test cuts. Although test cuts are fine for benchmarking or estimating performance, they don't reveal the true cost of the graphite in EDM machining time and price of the material when wear and number of electrodes are considered. Comparing two grades of graphite

under the actual shop environment shows the impact that graphite performance has on the job.

The TCO model examines the impact of the graphite material on the EDM related operations in the shop from electrode fabrication through the mold polishing operation. The goal is to identify productivity increases to reduce production costs. If the graphite grade is the limiting factor in the operation, this factor will continue to affect the operation when new equipment is purchased.

## Comparing to the benchmark

With the use or benchmark data from equipment and graphite vendors, an audit of the EDM process helps identify areas of potential savings by comparing actual costs against accepted benchmarks. Using the TCO model to audit the process may show that additional capacity can be gained from the existing equipment and the EDM machining hours can be reduced, thus increasing productivity. Once opportunities for improvements are identified, the TCO process is then used to identify the alternative with the lowest total cost, or best value, based on the needs of the company as identified in the business plan.

In the case illustrated in *Figure 2*, the shop owner was assertive enough to see that performance advantages may not occur with the most economical material. This testing showed that the EDM equipment was not being utilized to its fullest capacity. The audit showed that one of the most critical elements of operating EDM equipment is the electrode material because the material's performance affects the productivity of each job and the capacity of the shop. Each equipment manufacturer publishes data that show typical EDM performances for specific machine settings, work metal and electrode materials when EDMing under optimum conditions.

With the TCO model, one can use the same parameters and measure the actual EDM performance to compare how close the machine is performing to the benchmark. If the operation cannot achieve the benchmark numbers then the shop may have slower production cycles than other competitive shops. Using this benchmark data combined with actual machine performance will indicate if the current capacity of the machine has been reached. If the current machine is not reaching the benchmarked production stated by the manufacturer, then productivity gains may often be realized by moving to a higher performing electrode material. These benchmark settings could be related to speed, wear or finish, depending on the requirements of the work performed in the shop.

Regardless if an estimation or actual data is used for the TCO model, shop owners must at some point review their EDM operations in order to fully determine if the equipment is running at full potential and the EDM process has been optimized to provide maximum efficiency and profitability. The time spent conducting a TCO audit often discovers areas where significant process improvements can be achieved and increased competitiveness is realized.

Shops that only consider the cost of the graphite alone, rather than the total production costs associated with the job may actually be losing money because they are not optimizing the material to the application and taking advantages of maximized efficiencies.

## For More Information

Please call your local distributor to learn what POCO can do for you. Visit *www.entegris.com* and select the EDM Distributors link for the location nearest you.



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