

Using DFMA to Evaluate Your Designs and Your Supply Base

Abstract:

In all industries pressure is increasing to deliver competitive products quickly to the market place. The cost content of a product is always under scrutiny by senior management. This paper explores the use of the DFMA software as a benchmarking tool to establish the best possible cost structure during design development. It provides for existing designs to be evaluated for potential negotiation opportunities with your supply base. In addition, cost information can be used by Design Engineers to identify trade offs in the early stages of design to reduce cost. It can also be used to predict the cost of a part prior to that part being produced for the first time. We will discuss calibration of the Boothroyd and Dewhurst's DFMA software to your supply base and the benefits gained by this action.

Introduction

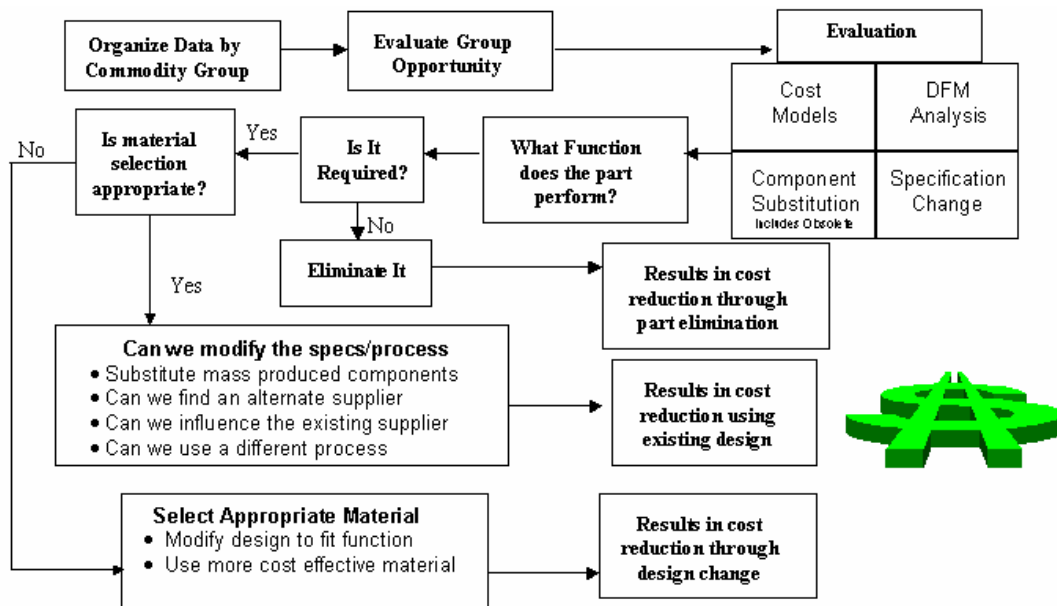
Teradyne is the world's largest supplier of automatic test equipment and a leading supplier of high-performance backplane assemblies and connectors for the telecommunications and electronics industries. Teradyne has:

- 40+ year history of meeting or exceeding customer expectations.
- Technology leadership in long term, high growth businesses.
- Strong market share position.
- Worldwide manufacturing, sales and engineering support.

Teradyne recently began evaluating product cost structure in a different way. Cost estimates were traditionally the responsibility of system developers. Estimates were not confirmed until drawings had reached the preliminary drawing phase. Final product costs were not confirmed until all parts were loaded into the MRP system. Many times desired cost reduction changes could not be made due to product introduction schedules. With the pressure of the competition increasing, a plan was established to begin adding capability to manage product cost while the product was under development. The program began by establishing the capability of evaluating the cost structure of an existing product line. If these techniques could be demonstrated on existing parts the same process could be implemented on parts during the development process.

Cost models and benchmarking techniques were used to determine if opportunities existed. Our tactics were to evaluate the value of the parts being used in our products. In evaluating the "value" of the parts we removed the notion that we were focused on the "cheapest" solution. Over the next nine months alternate sourcing or process changes were explored. In addition, changes in material were reviewed and part redesign opportunities were highlighted. Working in conjunction with the Supply Line Management Organization and with the Design Engineering Community potential opportunities were evaluated from both a supply base and technical perspective. This cross-functional approach allowed us to explore all aspects of the potential changes to the parts. Approved re-designs were initiated and supplier quotes obtained confirming we could indeed deliver the parts as specified for the costs projected. New suppliers were

evaluated using Supply Line Management criteria to insure these suppliers fit the corporate profile. Parts could be delivered for the predicted values. Unfortunately, adding new suppliers increases in the number of suppliers the company must manage. This was clearly not the direction the company wanted to head. We began a process to work within the existing supply base to increase the value of our parts. Our process of evaluating parts is outlined in the flow diagram below:



In our evaluation we discovered a redesign a part can take up to nine months to verify the functionality of a new design. Implementation of the redesign can be delayed based on existing inventory levels, which must be used up prior to realizing any cost reduction. With technology driving shorter and shorter product life cycles this translates into missed opportunity. The earlier this information could be made available the greater the benefit to the company. A decision was made to apply these concepts earlier in the product development process. Limited resources and the need for consistency demanded we look for a software package that would allow us to analyze a larger quantity of parts.

After evaluating several cost modeling tools, Teradyne decided to purchase Boothroyd and Dewhurst’s DFMA software. Since implementing the tool we have seen a four times reduction in the time it takes to estimate the cost of a part. This allows us to evaluate more designs with the same level of resources. In order for the tool to be useful, we had to gain confidence in the tool’s ability to accurately predict the cost of our parts. From a management perspective we had to demonstrate that the software would accurately predict the cost of a part using the existing supply base.

Using internally developed cost tools and Boothroyd and Dewhurst’s DFMA software we began evaluating design concepts as they were being developed on a product scheduled to be introduced in the near future. Key components were evaluated for opportunities in

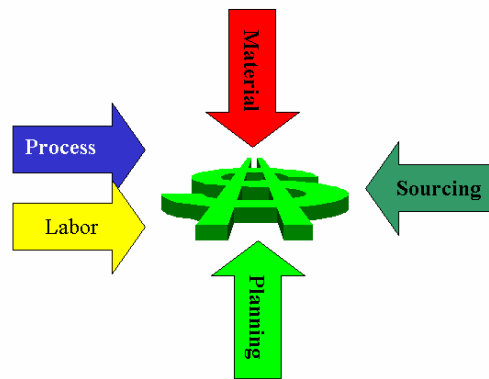
material selection and process selection. The result of the analysis was used to highlight re-design opportunities or negotiation opportunities with the existing supply base. Preliminary quotes were used as the comparison vehicle to the modeled results.

If the tools used are calibrated to the existing supply base then the results of the evaluation will drive the decision making process. Trade offs can be made as to the pay back of investing in a new design or if it is possible to reduce the cost of the existing design by changing the part specifications. Form, fit, function, quality, and reliability are always the first priority.

Application of Principles

We have chosen to focus our efforts on material cost. Evaluation of product structure has shown us that a majority of the cost of our products is in the material. A small percentage of the overall product cost is associated with the labor content to put all of the material together in the final product. .

Part volume is critical to the application of cost principles. At Teradyne the volume case is much lower than say the automotive industry. This creates a supply chain specific to Teradyne's industry. Material choices, processes and tooling are driven by this volume case. In order for the program to be successful in influencing the cost structure of a new product the cost tools have to be calibrated to the existing supply base. The critical variables in cost are are:



Material Selection is the responsibility of the design engineer.

The material selected and the tolerances on the drawing, which are also the responsibility of the design engineer, dictate the process.

Labor is the responsibility of the manufacturing engineer since they own the manufacturing process development.

Sourcing is the responsibility of SLM since they manage the supply base.

Planning determines how many we order at one time (lot size). It is the responsibility of NPP.

The critical cost variables in the DFMA software are:

1. Raw Material Cost – in the part description
2. Process Time – from the process evaluation
3. Dollars per Hour – in the machine set up table
4. Shop Efficiency – in the machine set up table
5. Mark Up – added after the fact or as part of the Dollars per Hour

The calibration process begins with a part drawing and a quote from the supply base with the batch size specified. If the final cost numbers match the addition of the five elements above we have a good start in understanding the cost structure. Care must be taken to further evaluate the components since the elements may not be aligned. The total may be correct due to elements offsetting each other. The only way to obtain alignment is to sit with the supplier and go through the process capturing each element. Working with our Supply Line Management Organization we found key suppliers willing to sit with us and go through each element of the cost process.

Using our Boothroyd and Dewhurst evaluation we were only single percentage points off from our suppliers actual purchase price for the raw material. This confirmed our material libraries were correct. Evaluating the drawing and correctly translating the process steps required, we discovered we were again single percentage points different on the actual number of hours to produce the part on the machine. Confirming our process evaluation was correct. Finally, we obtained the dollar per hour rate for this specific supplier. Shop Efficiency and Mark Up assumptions from previous experience allowed us to validate the price we were paying. We have gone through similar exercises in different commodities to validate our cost tools. We believe we understand the cost structure at work in our specific supply base. Since we can accurately predict what a design will cost in the supply base, we can begin evaluating alternatives.

Using DFMA as a Benchmarking Tool

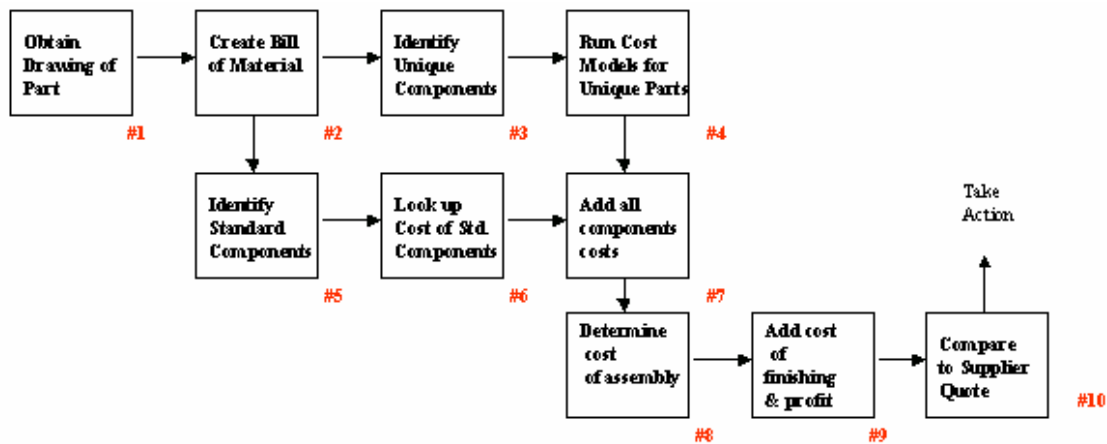
Once there is confidence in the calibration process, you can begin to apply the data to early part designs. Most of the DFM literature you read these days will tell you that as much as 70% of the part cost is fixed in the early design phases. How is this useful in the early design phases? Most early designs exist in a solid model format only. Tolerances have not been determined and dimensions may not even be visible.

Without complete part drawings how do you validate the cost of a part? Using DFMA software as a benchmarking tool this becomes possible. Since the tool has been calibrated to the supply base it can be used to predict the cost at a conceptual phase. Using overall dimensions and assumptions on material and standard processes, different design alternatives can be compared. Data is presented to the design engineer to assist in

technical trade offs that occur during development. For example it becomes an easy matter to change material from steel to stainless steel and evaluate the cost impact.

The design process continues to develop the tolerances and the material selections are finalized. The drawings are released from design engineering for production. At this point we are ready to go for preliminary quotes with the supply base. Before we receive the quotes, we run key parts through the DFMA software. We compare the quotes obtained to the values created using the software. Large discrepancies are addressed by requesting detail behind the quotations from the supplier. Detailed quote information is compared to the detail in the model. Deltas are evaluated and the suppliers are engaged to reconcile the differences. This opens a positive dialogue with the suppliers related to process and operations performed on the parts. Expensive operations are highlighted and become the focus for discussion. Specifications are challenged and changed as required by the function of the parts. In all cases the feedback is used to further refine the performance of the model.

The following flow chart illustrates the process used to benchmark material costs during development:



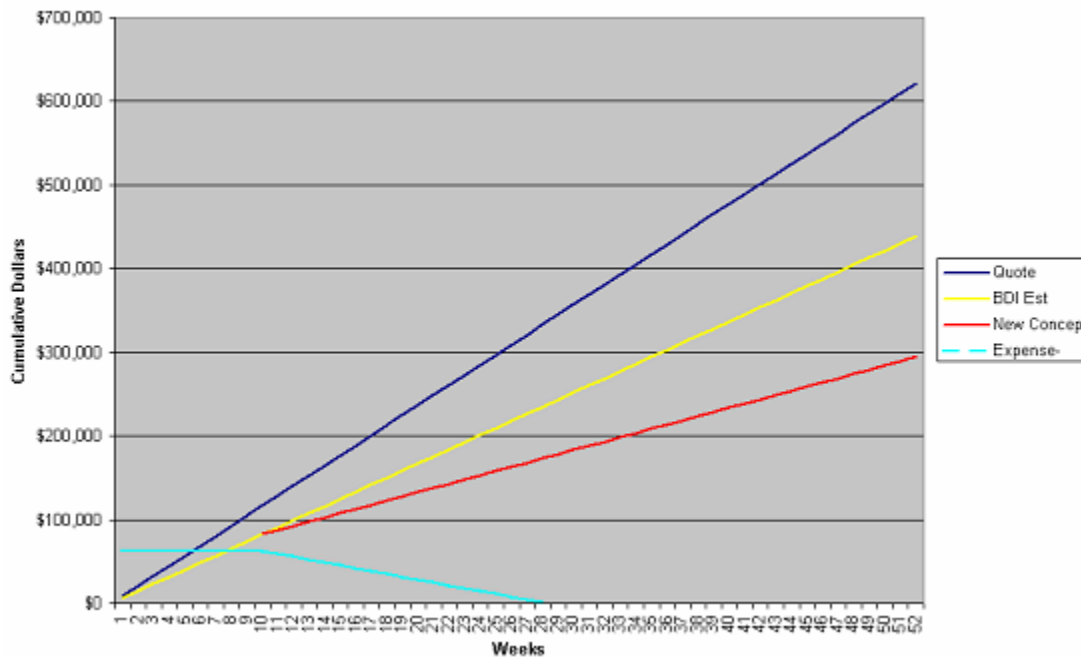
We have also found the software useful in breaking down high-level assemblies (HLAs) into their basic elements. Suppliers often give quotes on multiple parts being assembled together as one price. Once all of the components are modeled, the information can be used to evaluate the large portions of the cost in a similar manner as described above.

Evaluating a Change in Design

Since the tools represent what you can expect from the supply base, we can model the cost of a part before we complete the design cycle. A critical business question is always: “Is it a good investment to redesign a part that already exists?” By modeling the re-design this question can be answered. One element of the evaluation is the cost of the part. Costing the re-design part is exactly the same as costing an existing design. We begin with the design concept or drawing. In many cases elements of the design may already exist in the models developed in the initial evaluation. If this is the case the

information is ported to the new model. When completed, the costs of the two designs are compared. The other pieces are the cost of the tooling and the time and money required to complete the re-design effort. Estimates are made of the amount of time to accomplish the redesign, test the new parts, phase the new part into the supply chain and write the ECOs. The DFMA software can assist in tooling charges on parts requiring extensive tooling changes.

Since all of the cost components are available we use a simple spreadsheet model to evaluate the business decision.



The top line on the graph represents the cumulative dollars the company will spend on the original design over the course of 52 weeks. The middle line represents what the company will spend over time, if specifications or process changes can achieve the predicted cost reduction. The third line from the top represents what the company will spend over time on the re-designed part. The fourth line from the top represents the spending required to accomplish the redesign. This line includes tooling and salaries of individuals involved in the redesign effort. The spending line is flat for a period of 10 weeks. This provides the supplier enough time to complete the tooling for the re-design. When the new parts are introduced a savings is generated from the different slopes shown. The difference between the second and third lines from the top is the amount of savings anticipated. This cumulative savings is subtracted from the spending line. The time in weeks to pay back the investment is shown by the downward slope in the bottom line on the graph. Prior to initializing the redesign we can make a business decision on the value of this proposal. The investment is shown along with the potential payback in weeks after the new part is phased into the supply chain.

Conclusion

Using Boothroyd and Dewhurst's DFMA software allows Teradyne to evaluate design alternatives and to benchmark parts within the existing supply base. This information in the hands of the design engineers allows them to make decisions related to material and process early in design development. Having the ability to predict costs prior to design completion allows alternatives to be evaluated prior to prototypes being developed. Cost structures and content are confirmed long before evaluation parts are developed. Using cost tools we are now able to successfully track the development of a new product through all phases of development.