

## DESIGN TO COST LESSONS LEARNED

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### ABSTRACT

Design to Cost (DTC) is a cost control method used by Texas Instruments that puts cost on the same level as all other design parameters. DTC falls under the Value Engineering umbrella because it emphasizes meeting a cost goal through design during the concept and engineering phases of a program. This paper describes the 15 essential lessons learned for a successful DTC program.

### INTRODUCTION

In 1985, Texas Instruments formally organized DTC under systems producibility. During the past eight years, dozens of programs have followed the still-developing DTC methods. Many of these programs have successfully addressed cost as a design parameter; other programs have tried and failed. This paper is to explore those items that the successful programs had in common.

At Texas Instruments, DTC starts with this Government definition of Design to Cost:

*An acquisition management technique to achieve defense system designs that meet stated cost requirements. Cost is addressed on a continuing basis as part of a system's development and production process. The technique embodies early establishment of realistic but rigorous cost targets and a determined effort to achieve them. (MIL-STD-337, "Design to Cost")*

All DTC efforts focus on this definition, which contains four concepts that are paramount to the success of DTC. These four concepts are:

1. DTC is a management technique
2. DTC is part of the development and production

3. DTC requires early establishment of realistic goals
4. DTC is a continuous process.

### MANAGEMENT ASPECTS OF DTC

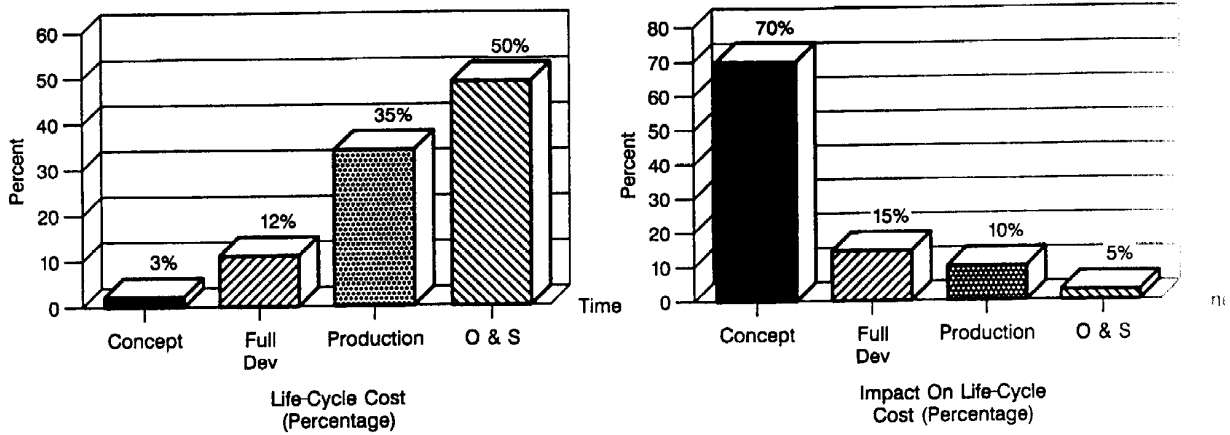
DTC is foremost a management tool. It is a process that has to be managed to be successful. Program management must make a commitment and become intimately involved in the DTC process. This involvement takes the form of oral and written commitment to the DTC process and method, establishment of cost goals for design teams, creation of a DTC controlling agency, and requiring cost to be addressed at all design reviews. Management involvement and commitment are primary ingredients of successful DTC efforts.

Management must encourage an environment that considers cost as a design parameter from the inception of the program. In such an environment, the designers will give cost the same consideration they give performance and schedule. This is the heart of DTC. When cost is treated as a design parameter, cost reduction invariably takes place.

Management must present sensible and achievable goals to the design team. Goals that are obviously too low do not elicit commitment to achieving them. Impossibly high goals will be ignored. Set goals at reasonable levels that are achievable

For the maximum benefit that DTC can produce, management should establish these goals early in the concept/design phase of the program (Figure 1). This is because the design decisions made during this phase impact and obligate 70 percent of the program's total cost. In contrast, the concept phase itself uses only 3 percent of the total budget. It is extremely important to establish goals early in the design phase, ensuring that cost is accepted as an important design parameter throughout the life of the program.

### Leveraged Effect of Design Phase on Life-Cycle Costs



Source: Military Electronics/Countermeasures, August 1990.

Figure 1.

Establishing cost goals is important at whatever point a program adopts DTC. The ability to reduce cost continues throughout a program. The earlier DTC is started, the better. Once DTC is begun, it should continue from that point to the end of a program. There is always an opportunity to realize cost reduction even during the production and operation and support phases of a program. However, programs receive the maximum benefit when goals are set early.

Texas Instruments has developed an iterative DTC process (Figure 2) that requires the partitioning of the design and

program cost goals down to the Line Replaceable Unit (LRU). Management assigns each LRU and its DTC goal to a Concurrent Engineering/Integrated Product Development (IPD) team. The motivation supplied by identifying all teams by name establishes commitment to and ownership of that DTC goal.

The IPD team is responsible for achieving its assigned goal. At all team meetings and design reviews, team members are required to address their goal and the activity taking place to reach that goal. Management is responsible for monitoring progress toward meeting DTC goals.

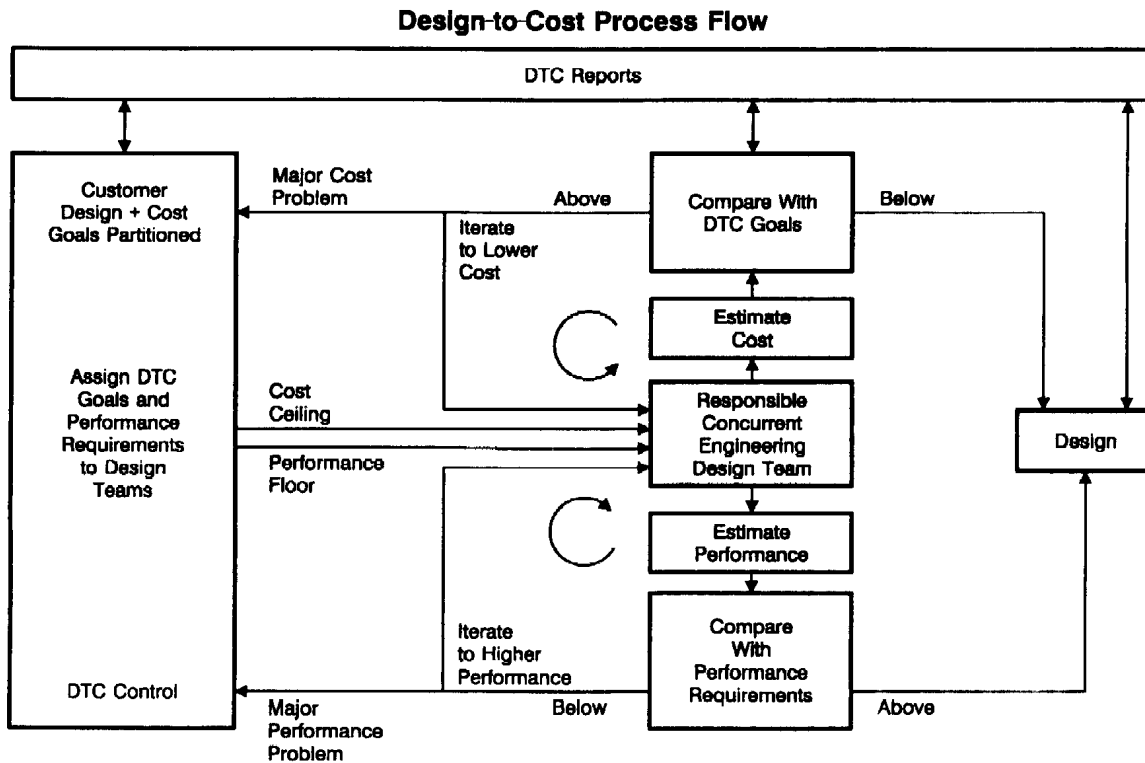


Figure 2.

### THE DTC PROCESS

A quality design must conform to customer requirements. This obviously includes cost. Most contracts today have cost goals as part of their terms. Cost is crucial in the defense industry as the defense budget continues to shrink. Defense customers are value shopping and now demand that contractors treat cost as a requirement. The design team must consider cost as important as any other design constraint.

When setting up the Design to Cost process, the IPD team must start with the customer as the focal point. By focusing on the customer and their requirements, the designer can build the process around these requirements. Treating cost as a required design parameter is important to both the customer and the company.

The DTC process requires sequential application of the following tools and procedures during the iterative design of each LRU:

1. Variance Analysis — Compares high-level design cost goal and the current cost roll-up
2. Pareto Analysis — Focuses the design team on those items that have the greatest cost impact (also known as cost drivers)
3. Function Analysis — Analyzes cost drivers. Focuses on replacing them with something that performs the same functions at less cost
4. Brainstorming/Selecting Alternatives — Brainstorm alternatives to cost drivers
5. Trade Study Analysis — Evaluates alternatives with respect to all design team requirements, including cost

6. Rebaselining — After selecting an alternative, resets the design and starts the iterative process again

A haphazard approach to DTC guarantees a failed cost reduction effort. Some programs treat DTC as a one-time roll up of cost to find the current estimated design cost. Those programs do not apply the sequential, iterative process listed above. Because this approach, commonly called "Costing the Design," does not focus on cost as a design parameter, it results in unsuccessful cost reduction.

### Team Members

Collocation of IPD designers with program designers is crucial to the successful application of DTC. During trade study analyses, team members must discuss how alternatives affect their specific disciplines. Collocation encourages open communication and understanding. During brainstorming sessions, ideas from the design team cover all areas of expertise and experience. In the final analysis, cost will be considered with and against all other design parameters. Collocating the design teams encourages the reasoned selection of the best design option, including cost.

Texas Instruments subcontracts the parts of many designs with outside vendors. When we subcontract the manufacture or design of an item, cost reduction is flowed down as part of the design requirements. All suppliers and subcontractors must follow our cost reduction methods. Subcontractors are taught these methods and provided with needed help. Subcontractors share in all cost reduction incentives.

### Cost Reduction Techniques

Trade study analyses are most successful when the program investigates multiple design solutions. Design teams should compare at least three design alternatives for each cost driver. This approach forces the evaluation of alternatives whose value may not be obvious. It also validates the approach as truly focused on obtaining the best solution. Programs that perform only one trade study on a cost driver are exhibiting a limited commitment to reducing cost.

One often-overlooked area for cost reduction is the use of existing facilities and tooling. A program can minimize production cost by using existing manufacturing and tooling

capabilities during the design phase. Low recurring production cost designs that require the purchase of nonrecurring capital equipment are usually not low cost options. The manufacturing community must actively participate in the IPD design process to achieve maximum use and cost effectiveness from existing production capabilities. Using existing capabilities can lead to lower overall cost. Whenever possible, build design products on existing equipment and assembly lines.

Use competitive business strategies in cost reduction efforts. Assume that your competition will

try to build your design at a lower cost to get business away from you. In the defense industry, The Government owns most designs. Those designs can be given to a competitor to build. Continually striving to reduce cost and improve the design will give you a competitive advantage in the market for future business. Having a reputation as a company that actively pursues cost reduction is an invaluable asset.

Cost estimation is an important part of the DTC process. DTC cost estimation does two things: (1) compares design costs against the DTC goal, and (2) evaluates design alternatives against each other. During the iterative design process shown in Figure 2, cost comparison must be made between the estimated cost of the current design and the DTC goal. This reveals any cost problems. Once a problem is identified, DTC tools and procedures help identify a less costly option. When evaluating design alternatives, cost estimation is used as a method of finding the *relative* cost difference between design alternatives. (DTC is *not* a cost estimation technique!) To make sure that decisions are based on the best cost estimations possible, use only valid and accepted estimating tools to predict cost. This ensures that a design decision based on relative cost differences is made from the most reliable information available.

Schedule is often a constraint on effective design. Reusing previous designs helps reduce design and production cost by minimizing time required for the design effort. Databases that store design and cost history are invaluable for reducing design cost. Make sure that previous cost histories for designs are stored and accessible for use by all design teams.