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8.1 (I) Cost Consideration For Aircraft Configuration Changes

R. R. Tumlinson
Beech Aircraft Corporation

Drag reduction, in our industry, is a principle that ranks with Motherhood. There are about as many aircraft engineers who would demean ways to reduce drag as there probably are politicians who would attack apple pie. Most of the people here have spent a great deal of time searching for ways of reducing drag and of trying to convince others of the merits of the efforts required to do so. I am sure that I have a lot of company in the frustration that goes with that search and effort.

We are all members, or supporters, of an industry which is fueled by profit. And that profit is directly dependent upon delivery of aircraft which provide good value for our customers. Or, simply said, the costs of changes and evolutionary improvements must be at least balanced by the benefits.

I'm not an expert by any means on costs, but I have had a lot of experience in trying to overcome the obstacles provided by the cost considerations of proposed changes. So, today, let me take the role of the Devil's Advocate on aircraft costs and cite some of the considerations which must be made and which may outweigh potential performance improvements.

As a means of illustrating both costs and benefits, I'd like to present a very arbitrary example which will touch on many of the important cost considerations which must be made to arrive at a production decision.

Let's say that we have arrived at a modification which will reduce the drag of our airplane so as to provide an increase in cruising speed of 4 mph. In the course of this workshop, we have considered many possibilities for achieving this, so I'm not going to specify how this was achieved. But, as an arbitrary assumption, let's say that we can, in fact, increase our cruising speed by 4 mph; and also, just as arbitrarily let us assume that the resulting changes would net an increase in airframe weight of 5 pounds. This represents a loss of payload of 5 pounds. And, in addition, this will typically require design and production changes to another 10 pounds of the existing airframe weight, although this would depend in a particular case on the nature of the configuration change. For the purpose of this example, we will apply this to a hypothetical turboprop with a cruising speed of 250 mph.

Let me emphasize at this point that the figures I am using have been chosen to be representative for the industry, and I believe they are suitable for this example.

First, let's consider the cost increase for direct labor. The 5 pounds of new and increased weight will be a net increase to the airplane, and an appropriate slope and man-hour/pound figure must be selected for the new effort. The 80% learning curve is found to be fairly typical for the general aircraft industry, and I believe they are suitable for this example. The 5 pounds will be projected from Unit 1000 at 1.0 man-hour/pound to obtain Unit No. 1. This is shown to be an increase of 46 hours at Unit 1 with a cumulative increase of 15 hours for 100 units.

A somewhat different consideration must be made for the "changed" weight of 10 pounds, where there is not the same potential for "learning" improvements. Something less than the 80% slope typical for "new" production would be more appropriate. If we assume a 90% learning-curve slope, using the same factors as before (1.0 man-hours/pound at Unit 1000 for 10 pounds, this time), the cumulative man-hours over 100 units is 16.6 man-hours.

As the changed effort has replaced an existing task at 1.0 man-hours/pound, this 10 hours can be subtracted from the 16.6, leaving 6.6 hours for new learning. Our total direct labor increase now becomes 15 hours + 6.6 hours, or a total of 21.6 hours each for the 100 units.

Next, these man-hours must be converted to dollar costs. The latest figures published by the Bureau of Labor Statistics show that direct labor rate applicable for the aircraft industry as a whole is $5.78 per man-hour. With inflation and differences within the industry, this rate can become obsolete quickly. Overhead and direct expenses plus general and administrative expenses can add a so-called "burden" of 200 to 300 percent to this rate.

TABLE I

Overhead and Direct Expenses Include

Indirect salaries and wages; support labor such as planning, scheduling personnel, etc.; holidays, vacations, sick leave, etc.

Insurance, payroll taxes, social security, group life-insurance, workmen compensation, retirement plan, sales taxes, personal property taxes, and depreciation.

Maintenance and repair on shop equipment and on buildings.

Shop supplies such as perishable tools, office supplies, etc.

Travel, telephone, freight, etc.

Overtime premiums, product liability, etc.

General and Administrative Expenses Include

Executive and management salaries; accounting; procurement; office supplies; and other costs which cannot be directly associated with labor cost - either manufacturing or engineering.

There are two other contributions to the costs: the materials and the development costs. Material costs for an airplane in this category vary with the size and complexity. Development costs also vary with the class of airplane and the accompanying complexity of the development effort and the FAA certification program required. A range of $3000 to $4000 per pound is the general ballpark figure when everything is added up, and in this example 100 units was selected to amortize these costs.

When the pieces are all assembled, a price change can be determined for the improved airplane which adds up to approximately $1600.

The cost to the customer must be weighed against the additional value to the customer. Let's look at it this way: our hypothetical airplane cruises at 250 mph. To keep it simple, I'll use this cruising speed, although it would be more accurate to determine an average block speed based on a customer's particular routes. For a customer's usage, we will assume 600 hours per year. Appropriate operating costs are quoted on Table II. And, as noted on the table, the costs of the modification can be recovered by the savings in operating costs in 1.87 years. After that time, the savings would represent a net gain to the customer which would continue.

TABLE II

Operating Cost Comparison

Before Modification

Direct Operating Costs/Hour			\$ 77.50
Indirect Operating Costs/Hour			13.18
Total Operating Costs/Hour			\$ 90.68
Cruising Speed		250 MPH	
Total Operating Costs/Mile =	$\frac{\$90.68/HR}{250\ MPH}$		\$ 00.3627

After Modification

Total Operating Costs/Mile =	$\frac{\$90.68/HR}{254\ MPH}$		\$ 00.3570
Savings Per Mile			0.0057
Savings Per Year = \$.0057 x 250 MPH x 600 Hours =			\$855.00

$$\frac{\$1600.00}{\$\ 855/YR} = 1.87 \text{ years}$$

I am not going to exercise judgment on the 1.87 years, because of some of the arbitrary assumptions that could drastically affect the results. In estimating costs for a particular project, appropriate values must be used which would not be the same as those used in the examples. The actual special improvement, the weights affected, the cost factors that are current for a particular project, the number of units used to amortize the development costs could each produce significant differences. I believe the figures here are representative, but primarily, I hope they illustrate the key factors which can affect a production decision considering the costs involved.

And, even after this type of analysis, there are other factors which may strongly influence both the costs and/or the decision to proceed. For example, the FAA recertification considerations. If this can be avoided, perhaps by timing the modification with a complete model change, these cost figures would look much more favorable.

In the last analysis, a decision to proceed may depend on the philosophy of the company management. Beauty is in the eye of the beholder, the saying goes. There are many changes made in the name of progress, or to satisfy a dedication for a clean-looking airplane, which might be difficult to justify solely on the basis of this type of comparison. I would not suggest that this would not be desirable. But--- sometimes the stroke of intuition is not enough to convince a cost-minded management --- and that's where this analysis would help.

Thank you.