ABSTRACT

Don't you just hate it when they say it can't be done . . . and you have a week to do it? This Material Estimating (MEST) System was developed under critical time constraints due to user requirements for the product. Additionally, it suffered from the common dilemma of flexibility vs. applicability and ease of use for non-computer-oriented technical personnel. These problems were resolved utilizing a combination of PROC TABULATE, PROC FSEDIT, a few macro variables, some well-placed screen messages, and CLIST menus. (Note that SAS/AF® was not available at the time, but could easily be used here to replace the CLIST menus and other selection functions).

BACKGROUND

Among many other functions, the Material Organization of the Northrop Aircraft Division provides material estimates for proposed projects (i.e., the government or other customer asks what we think it will take to accomplish a certain task). The Division receives a Request For Quote (RFQ), and in turn sends information requests to various functional organizations within the company (see Figure 1). In this highly simplified example, Material receives a request for material usage estimates on a proposed aircraft project. The Material Estimating department then performs the necessary calculations and summarization and submits the final estimates, with supporting documentation, to the requesting organization. Information from this input and from other functional organizations is then compiled, and the completed bid is submitted to the customer.

Figure 1

Material estimating becomes a problem when the calculations required to provide the estimates are so complex or so numerous, that even if manpower limitations were not a factor, dozens of analysts/statisticians would be required in order to complete the request in the time allotted (turnaround is generally very short). With an RFQ on the doorstep, management requested an automated solution.

DESIGN CONSIDERATIONS

One design factor is the way in which the data must be presented. It may be necessary to provide an estimate for an entire aircraft, by sections or by material categories, or for a wing section only, or fuselage only, etc. We wanted to provide enough flexibility so that the system could be used for any future project, of any size, with any number of material categories, material types, sections, and section categories. Additionally, the system should be flexible enough to handle certain "what-if" problems, requiring any requested combination of weights to "T" values.

Naturally, in providing this powerful flexibility, we did not want to lose sight of the users, who are non-computer-oriented techni- cians. It is important that the user not be left hanging at any point during the process (user-friendly is not dead!), and that the flexibility provided by the system not be so complicated that ease-of-use is forfeited.

TERMINOLOGY

Note that there are three terms with which the reader may not be familiar:

- "T" Value - commonly known as the "Tail" Value or tail number; this is the order in which the airplanes are built (i.e., T1 is the first one built, T250 is the 250th aircraft built, etc.).
- Material Weights - the amount of 7050 aluminum (or whatever type of material) that is required to build one aircraft or one section.
- Learning Curves - Commonly accepted statistical methods allow us to calculate how much material or how much time it will take to build the Nth aircraft ("T" Value), based on how much it took to build the first aircraft of the same type. It takes more material and more time to build the first one than the tenth one, and so on.
SYSTEM DESCRIPTION

The system was designed to be menu-driven, and is accessed through the Main Menu shown in Figure 2.

![Menu Options](image)

**WHAT WOULD YOU LIKE TO DO?**

- **CODE ACTIVITY**
  1. UPDATE/ADD TO THE WEIGHTS DATA SET
  2. UPDATE/ADD TO THE T1 DATA SET
  3. PRODUCE PROJECTIONS
  4. ESTABLISH A NEW PROGRAM/PROPOSAL
  5. CHANGE REQUESTED PROJECT NAME
  6. LIST EXISTING PROJECT NAME FILES
  7. GET OUT OF HERE

**TYPE THE DESIRED CODE AND PRESS ENTER.**

### Figure 2

Note: The first time the user selects Option 1, 2, or 3 from the Main Menu, the NAMEDS screen (Figure 3) is displayed, and the user fills in the existing PROJECT name (dataset name) to be worked with during this session. This could also have been accomplished using macro variables or SAS/AF.

![Named Project Input](image)

**Menu Option 1**

Upon selection of Main Menu Option 1, the Figure 3 PROC FSEDIT screen is displayed from the following code:

```
DATA ONE; SET T1S.NAMEDS;
CALL SYMPUT('NAME',PROJECT);
PROC FSEDIT DATA=T1S.&NAME SCREEN=T1S.CAT.TONES.SCREEN;
```

As you can see, the NAMEDS one-observation dataset (see Figure 3) is read in and the PROJECT name which was entered there is established as a macro variable utilizing the CALL SYMPUT function. This macro variable is then used within the PROC FSEDIT statement to call in the desired WTS dataset.

![Edit Screen](image)

**Menu Option 2**

Upon selection of Main Menu Option 2, the Figure 5 PROC FSEDIT screen is displayed from the following code:

```
DATA ONE; SET T1S.NAMEDS;
CALL SYMPUT('NAME',PROJECT);
PROC FSEDIT DATA=T1S.&NAME SCREEN=T1S.CAT.TONES.SCREEN;
```

As with Menu Option 1, the NAMEDS one-observation dataset (see Figure 3) is read in, and the PROJECT name which was entered there is established as a macro variable utilizing the CALL SYMPUT function. This macro variable is then used within the PROC FSEDIT statement to call in the desired T1S dataset.
The user then adds/updates information including: the material category and material type, which must match the material category and material type on the WTS entries; and the T1 amounts and the associated slopes for net bill, material usage allowance, and supplier services, which will be utilized in calculation of the material estimate for that material category and material type. Note that there is only one entry in this T1S dataset for each material type used in the associated WTS dataset.

To assist the user, notes regarding each field were included directly on the edit screen adjacent to that input field, and general notes were placed in the boxes on the left of the screen.

When the user exits the edit screen, the Main Menu is again displayed.

Menu Option 3

Upon selection of Main Menu Option 3, the Figure 6 PROC FSEDIT screen (RANGES) is displayed. User enters the "T" value or range of "T" values for which the estimate is required. If the user enters, for instance, '250' in the FIRSTT and '250' in the LASTT, he is asking what is the material estimate for building the 250th airplane? Note that when a range of "T" values is requested, an average over that range is calculated. For example, the user enters a '50' in the FIRSTT variable, and a '60' in the LASTT. Given the T1 values in the T1S dataset and the weights in the WTS dataset, what is the material estimate for building the 50th through the 60th airplanes?

When the user has filled in the necessary "T" values and exits the RANGES screen, the following code is executed:

```sas
DATA NAMEIT;
SET TIS.NAMEDS;
CALL SYMPUT ('NAME', LEFT(PROJECT));

DATA ONE;
SET TIS.RANGES TIS.NAME;
RETAIN TFIRST TLAST;
IF _N_=1 THEN DO;
   TFIRST=FIRSTT;
   TLAST=LASTT;
   CALL SYMPUT ('TSTART', LEFT(TFIRST));
   CALL SYMPUT ('TEND', LEFT(TLAST));
END;
```

Once again, the NAMEDS one-observation dataset is read in (Figure 3), and the PROJECT name which was entered there is established as a macro variable utilizing the CALL SYMPUT function. This macro variable is then used in the second data step to read in the desired TIS dataset.

First, however, the RANGES one-observation dataset (see Figure 6) is read in and the values contained in the FIRSTT and LASTT variables are RETAIIned for use later in the data step. These two variables are also established as macro variables in order to use their values as part of the PROC TABULATE and PROC PRINT report titles.

(Note that the entire calculation and report program and all report formats were issued as part of the handout provided during the author's presentation of this paper. These may be obtained from the author at the address listed at the end of this paper.)
Following execution of the above SAS® code, the remainder of the program executes, performing the necessary calculations and printing a series of PROC TABULATE and PROC PRINT. The PROC PRINT reports are utilized to provide the user with a listing of all data used to produce the PROC TABULATE reports, and to provide error reports which include duplicate weights entries, duplicate T1 entries, and mismatches (T1's for which there was no matching weight statement, and vice versa).

The seven PROC TABULATE reports include all required combinations of data, from the greatest level of detail through the greatest level of summarization for all material types, categories, sections, and section categories.

Figure 7 shows a sample PROC TABULATE report and its associated SAS code. Note that the ANAME macro variable and the &TSTART and &TEND macro variables are utilized in the TITLE statements, in order to increase clarity of report content to the user.

When the program execution is complete, the user is given the option of viewing the reports on-screen or having them sent to a printer. Following this, the Main Menu is again displayed.

Menu Option 8

Because the Material Estimating group works on many different programs/proposals, the system had to dynamically allocate new datasets (project names) for them to use. This option begins by offering to show the user a list of the existing project (dataset) names. This is done so that the user does not duplicate an existing dataset name. Along with this, a warning is issued that if an existing name is reused in establishing a new project, the old data will be wiped out. If the user opts to view the list, a PROC DATASETS command is issued, and the listing is displayed to the screen.

After the user exits the PROC DATASSTS listing, or upon choosing to bypass the listing, the Figure 8 selection screen is displayed. This menu offers the user the option of starting with empty T1S and WTS datasets, or starting with a copy of either T1S or WTS or both. This copy option was provided in order to allow slight modifications of existing data in "what-if" situations. This is also handy when the user wants to compare a T1S dataset with a WTS dataset of a different name.

While the Figure 8 menu was intended primarily to prompt the user to think about whether they require empty datasets or copies, it also serves to allow the user an escape-exit from setting up a new project name. The remainder of the options all cause a display of the Figure 9 (NAMENEW) PROC FSEEDIT screen.

On this screen, the user enters the new project (dataset) name, and if a copy of an existing dataset is desired, the user also enters that request. (Note that the first variable here is called NEW_NAME, the second is OLDWT, and the third is OLDT1.) When the user exits this screen, the following SAS
code is executed to establish the requested new project (dataset) name:

```
DATA ONE; SET T1S.NAMENEW;
IF OLDT1 NE ' ' THEN DO;
   CALL SYMPUT('OLDT1',OLDT1); END;
ELSE DO;
   CALL SYMPUT('OLDT1' ,DUM); END;
IF OLDWT NE ' ' THEN DO;
   CALL SYMPUT('OLDWT',OLDWT); END;
ELSE DO;
   CALL SYMPUT('OLDWT' ,DUM); END;
CALL SYMPUT('NEWDS' ,NEW_NAME);
DATA T1S.&NEWDS;
SET T1S.&OLDT1;
DATA WTS.&NEWDS;
SET WTS.&OLDWT;
```

Note that the 'DUM' name used when no copy is requested is a dummy dataset which, of course, is empty. Upon completion, the Main Menu is again displayed.

Menu Option 5

When the user first accesses the system, he is asked which project name (dataset) he wants to use. If at any point the user should want to use another (existing) project name, he does so with this option. This option displays the Figure 3 PROC PSEDIT screen, the NAMENEWS one-observation dataset, which was discussed previously under Menu Option 1. Upon exit from this screen, the user is given a message that the new file name was accepted, and the user is then returned to the Main Menu.

Menu Option 6

At any point during the session, the user may need to view the listing of all existing project (dataset) names. This option displays a PROC DATASETS listing of the T1S library, and upon exit then displays a PROC DATASETS listing of the WTS library. When the user is finished viewing these listings, the Main Menu is again displayed.

CONCLUSION

This automated material estimating system provides a level of estimating accuracy which was previously unattainable due to manpower and temporal constraints. It was developed with several considerations in mind: critical time constraints for development; the flexibility vs. applicability and ease-of-use dilemma; data presentation/reporting requirements; and user expertise levels. Utilization of PROC PSEDIT for a "fill-in-the-blanks" approach provides the necessary flexibility for report requests and creation of new datasets, while not losing sight of the user's level of computer literacy. Additionally, using PROC TABULATE for report production provides the desired reporting flexibility, yet maintains objective applicability. While maintaining an uncomplicated appearance, this SAS system has fulfilled all stated requirements and has proven to be an effective and sophisticated tool.

Any requests or comments should be directed to:

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