Labor Manpower Requirement System In Hierarchical Tables

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Abstract

The Labor Manpower Requirement System (LMRS) is a tabulated display of descriptive statistics in hierarchical tables. This system utilizes the "PROC TABULATE" procedure, Full Screen Product (interactive menu-driven facilities), and statistical analysis to achieve its end results. The system was developed to provide engineering functional managers and project managers with budget visibility and replanning control. The anticipated benefits of this system are improved planning capability and better management of engineering budgets.

The output of LMRS includes a tabulated hierarchical format which compares budgeted manpower with actual expended manpower. The output shows the budgeted labor, the actual labor expended to date, the variance between budget and actuals, and a replan line that can be modified monthly. Labor is expressed as equivalent people (headcount).

The LMRS offers the following features:

- Provides actual manpower expended from the direct labor files at month end
- Provides the capability for a monthly update of the replan/estimate-to-complete (ETC) line
- Calculates the projected indicated-final-cost (IFC) on a monthly basis, which is based on actuals to date plus the replan/estimate-to-complete (ETC) line
- Provides reports for each Engineering organization functional discipline in a project cross-reference table.

Statement of the Problem

At the Northrop Corporation, Ventura Division, the previous method of tracking labor expended versus budget came from two different systems. One system stored the actual direct labor hours expended, while another system stored the budgeted manpower, expressed in equivalent people (headcount). The goal of this project was to eliminate the amount of paper work and manual calculations which the two separate systems created. The required manual calculations were the following:

- Convert actual manhours to manpower headcount by dividing total actual manhours by 166 (one man-month is equal to 166 hours per month)
- Variance = (actuals - plan)
- IFC = (actuals to date + future replan)
- Yearly Budget = total plan
- Project Variance = (IFC - yearly budget)

The present Labor Manpower Requirement System (LMRS) provides the user with one interactive system, where actual direct labor expended and budgeted labor are constructed in one hierarchical table which automatically performs the required calculations.

System Description

The Labor Manpower Requirement System (LMRS) is a tabulated display of descriptive statistics in hierarchical tables. This system is designed to track actual manpower expended to date, compare it with the budgeted manpower, and define the variance between budget and actuals where manpower is expressed in equivalent people (headcount). LMRS allows the user to manipulate data so that a report containing only the
information needed is produced. With LMRS, the user can access the following:

- Total engineering manpower summary by discipline number
- Total engineering manpower summary by project
- Total engineering manpower summary by project type
- Total engineering manpower summary by project showing discipline
- Total engineering manpower summary by discipline showing project
- Total engineering manpower summary by managers
- Total engineering manpower summary by project type showing project, discipline and managers.

The information for the LMRS is extracted from two sources: (1) existing on-line files which are the cumulative actual direct labor hours expended updated weekly by engineering time card data, and (2) user created files of the monthly engineering budgeted manpower expressed as headcount.

The output of LMRS includes a tabulated hierarchical format designed for tracking labor expended, showing budgeted headcount, actual labor expended (headcount), the variance between budget and actuals, and a replan line that can be modified monthly.

The LMRS offers the following features:

- Provides actual manpower expended from the direct labor files at month end
- Provides the capability for a monthly update of the replan/ETC line
- Calculates the projected IFC on a monthly basis, which is based on actuals to date plus the replan/ETC line
- Produces management summary reports, with actuals, budget, variance and replan
- Provides reports for each engineering organization functional discipline in a project cross-reference table.

System Procedure

The "PROC TABULATE" procedure constructs tables of descriptive statistics from compositions of classification variables, analysis variables, and statistical names. Tables may have up to three dimensions: row, column, and page. The "PROC TABULATE" procedure offers the following advantages:

- A concise, powerful control language
- A greater degree of complexity in classification hierarchies compared to procedures as "MEANS", "FREQ" and "SUMMARY".
- Flexible mechanisms for titling and formatting.

The LMRS uses the "PROC TABULATE" procedure to produce manpower headcount expended summaries in several dimensions, in addition to formatting the tables. This application does not use all of the statistics supported by "PROC TABULATE;" its major role is formatting. The statistics are derived from previous data steps and other procedures. The "PROC TABULATE" procedure is always accompanied by one or more "TABLE" statements specifying the tables to be produced. Listed below is the Statistical Analysis System (SAS) coding used to develop the hierarchical tables:

SAS CODE
1. PROC TABULATE MISSING FORMAT = 6.1;
2. TITLE1 ENGINEERING DIRECT LABOR MANPOWER REQUIREMENT LEVEL 1;
3. BY YEAR;
4. CLASS DISC DISCNM MYR;
5. VAR SHEAOCNT SDHRS VARAN SBLANK PV;
6. LABEL DISC = 'DISCIPLINE NUMBER'
   a. DISCNM = 'DISCIPLINE TITLE'
   b. YEAR = 'CONTROLLING YEAR'
   c. SHEAOCNT = 'PLAN'
   d. VARAN = 'VARIANCE'
   e. SBLANK = 'REPLAN/ETC'
   f. SDHRS = 'ACTUALS'
   g. MYR = 'MONTHS'
   h. PV = 'PROJECT VARIANCE'
   i. EAC = 'EAC/IFC LINE';
7. TABLES (DISC*DISCNM) ALL,
   a. (SHEAOCNT SDHRS VARAN SBLANK PV),
   b. (MYR ALL = '12 MONTHS OF DATA');
8. KEYLABEL SUM = 'HEADCNT'
   a. ALL = 'TOTAL SUMMARY BY ALL DISCIPLINE';
   b. N = 'FREQUENCY';
Step 1. PROC TABULATE PROCEDURE: The options are MISSING and FORMAT = 6.1. MISSING requests that MISSING values be considered as valid levels for the classification variables. Special MISSING values are considered as different level values. Unless MISSING is specified, TABULATE does not include observations with a MISSING value for one or more classification variables in the analysis. FORMAT=(W.D) specifies a default format for the formatting of each table cell where "W" is the field width and "D" is the number of digits to the right of the decimal (D may be omitted). If no value is specified, the default value is 12.2. The default format is always overridden by any formats specified in a TABLE command. This option is especially useful for decreasing the number of print positions required to print a TABLE. LMRS uses 6.1 as its width and decimal. Width of 6 means 6 places to the left of the decimal, the decimal of 2 means 2 places to the right of the decimal.

Step 2. TITLE: The TITLE statement is used to specify up to ten TITLE lines to be printed on the SAS output.

Step 3. BY VARIABLES: The BY statement may be used with "PROC TABULATE" to obtain separate analyses on observations in groups defined by the BY variables. When a BY statement appears, the procedure expects the input data set to be sorted in the order of the BY variables.

Step 4. CLASS VARIABLES: The CLASS statement is used to identify variables in the input data set as CLASSIFICATION variables. Any CLASSIFICATION variable used in a TABLE statement must be included in this list. The variables may have either numeric or character values. Normally each CLASS VARIABLE has a small number of discrete values or unique levels.

Step 5. VAR VARIABLES: The VAR statement is used to identify numeric VARIABLES in the input data set as analysis variables. All analysis VARIABLES used in TABLE statements must be included in this list.

Step 6. LABEL VARIABLES=TEXT: The LABEL statements are especially useful with "PROC TABULATE." Any LABEL text specified in a LABEL statement for a CLASSIFICATION or ANALYSIS VARIABLES is used in any page, row, or column titles where that VARIABLE appears.

Step 7. TABLES {EXPRESSION,} {EXPRESSION,} EXPRESSION {OPTIONS}: The TABLE statement consists of one to three dimension EXPRESSIONS separated by commas and followed by an option list. If all three are specified, the leftmost EXPRESSION defines pages, the middle EXPRESSION defines rows, and the rightmost EXPRESSION defines columns. DISC*DISCNM ALL, = CLASS NESTING - being the leftmost EXPRESSION defining page. ALL = TOTAL SUMMARY BY DISCIPLINE summary total. SHEADCNT SDHRS VARAN SBLANK PV), = CLASS CONCATENATION - middle EXPRESSION defining row. (MYR ALL = '12 MONTHS OF DATA'); = CLASS VARIABLE - rightmost EXPRESSION defining column. ALL = TOTAL SUMMARY BY MONTHS row totals.

Step 8. KEYLABEL KEYWORD=TEXT: KEYLABEL statement is one of the valid statistical names discussed above or the UNIVERSAL CLASS VARIABLE ALL, (TEXT) is up to 40 characters of labeling information. If TEXT includes blanks or special characters, TEXT must be enclosed in quotes. The replacement TEXT will be used in any LABEL where the specified KEYLABEL is used, unless another LABEL is specified in the TABLE statement. See the figure for an example of a LMRS report.

Future enhancement to the system will show a sixth level on the report which will calculate the labor efficiency percentage, labor efficiency = (actual manpower /budgeted manpower). Labor efficiency gives a direct relationship for meeting labor budgeted objectives, a scale will have to be developed to determine at what percentage is not acceptable. Other enhancement include adding more departments to the system, the current users are the entire Engineering organization. It is also possible that the entire Northrop Ventura Division might be added to the system in a "NETWORK," which will greatly increase the storage required.

Conclusion

The "PROC TABULATE" procedure can be used for a number of applications. Although this paper highlights how labor manpower can use the "PROC TABULATE" procedure in hierarchical tables, it is by no means the only application for PROC TABULATE. LMRS also may be used to calculate manhours or man-dollars expended versus
budget. As a result of LMRS, another system -- the Labor Manhour Task & Budget System -- was subsequently developed. This latter system uses SAS/GRAPH, which plots actual time-card hours data versus budgeted manhours. Other applications for the "PROC TABULATE" procedure include the following:

- School Function System

This system could include a breakdown of class subject, number of students in class, number of instructors for a given subject, and a calculation of the student/teacher ratio for a given subject.

- Organizational Employment Breakdown System

This system could include job classifications, vacancies, number of men/women in each classification, salary grade, number of minorities in each classification, and a calculation of the government-required minority quota.

- Travel Agency System

This system could include various air lines, alternative routes, their respective cost, and a calculation of the best route at the lowest cost.

- Tax Table System

This system could include tax tables for single, married filing jointly, married filing separately and head of household for any given taxable income.

- Financial System

This system could include monthly business expenses and income, showing income received minus expenses incurred for net income.

References

- * SAS, SAS/FSP, and SAS/GRAPH are registered trademarks of SAS Institute Inc., Cary, NC, USA.
### Disciplines and Titles

1. **Discipline Number 511**
   - **Title:** Project Office
   - **Table:***
     - **Plan**
     - **Actual**
     - **Variance**
     - **Replan/ETC**
     - **Position**

2. **Discipline Number 537**
   - **Title:** Elect Test (Tech)
   - **Table:***
     - **Plan**
     - **Actual**
     - **Variance**
     - **Replan/ETC**
     - **Position**

3. **Discipline Number 501**
   - **Title:** Project Office
   - **Table:***
     - **Plan**
     - **Actual**
     - **Variance**
     - **Replan/ETC**
     - **Position**

### Yearly Budget

- **Engineering Direct Labor Manpower Requirements Level 1 Test***
- **Total Engineering Summary by Disc (Plan, Actual, Variance, Replan & P.V.)**
- 1 man-month is based on 166 hrs.
- **Yearly Budget = Total Plan + Variance = Actual + Plan**
- **IFC = Actual to Date + Future Replan**
- **Project Variance = IFC - Yearly Budget**
- **Negative (-) Project Variance is an Under Run, Positive (+) Project Variance is an Over Run, Controlling Year 1985**

### Notes
- 1 man-month is based on 188 hrs.
- 1 man-month is based on 166 hrs.
- Project variance is an over run.
- Negative (-) Project Variance is an under run.
- Positive (+) Project Variance is an over run.
- IFC = Actual to Date + Future Replan.
- Project Variance = IFC - Yearly Budget.
- Yearly Budget = Total Plan + Variance = Actual + Plan.
- Yearly Budget = Total Plan + Variance = Actual + Plan.