DECISION TABLES - AN EFFECTIVE PROGRAMMING TOOL

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Manufacturing businesses have many information processing problems such as the rules for ordering materials, the rules for granting credit, the logic of what to build to meet a customers requirements, the rules for union dues, deductions for savings and pension plans, tax requirements, etc.

Decision Tables have been used to express the logic in a manner which people can understand and also can be used as a computer program. Both General Electric and B. F. Goodrich Chemical have reported a three-to-one increase in programming productivity when using Decision Tables. Here are some examples of applications which illustrate the power and simplicity of Decision Tables.

Turbine blades are up to five feet long and must be machined to airfoil shapes. A FORTRAN program produced the magnetic tape necessary to control the Excello contour milling machines. Unfortunately, some bug caused the milling cutter to gouge a blade once in a while.

The decision was made to do the program over using Decision Tables along with calculations. The analysis and tables were completed in five weeks. The subroutines were completed in two more weeks. The program was independently checked and debugged in three weeks and has been running successfully for ten years. The people involved say that this success in solving a difficult logical problem is due to the use of Decision Tables.

We started using Decision Tables when we were challenged to automate an entire business.

The business chosen for this work built electric indicating instruments for industrial panels. These included D.C. voltmeters and ammeters and AC voltmeters, ammeters, wattmeters, frequency meters and power factor meters. To get a bill of materials for each instrument we decided to use Decision Tables to generate the bills. One of the Decision Tables is like TABLE 1000 - ARMATURE ASSEMBLY, Figure 1, next page.

```
1000 TABLE - ARMATURE ASSEMBLY
1010C FREQ-  APPLICA-  RATING  NO. OF   SCALE   TYPE OF   QUAN.   ARM
1020C UENCY  TION      UNITS   PHASES   DIST.   ARM       COILS   DWG
1030C
1040   FRQ  & APPL  &   RU   & NP   &  SD  # TA=    & QAC= & AD=    & GOTO #
1050 EQ  0  &EQ DC  &EQ --   &EQ -- &EQ -- # DCMC   &   1  & 17614  & 1210 #
1060 NE  0  &  RECT &   --   &   -- &   -- #DCMC    &   1  & 17614  & 1210 #
1070    --  &  DCMR &  AMPS  &    1 &   -- #  IV    &   0  & 17617  & 1310 #
1080 EQ 60  &    AC &  AMPS  &    1 &   -- #  IV    &   0  & 27617  & 1310 #
1090    60  &    AC &  VOLTS &    1 &  REG #  IV    &   0  & 17617  & 1310 #
1100 GE 25  &    AC &  VOLTS &    1 &  EXP #  ED    &   1  & 17615  & 1310 #
1110    25  &    W  &  WATTS &    1 &   -- #  ED    &   1  & 17615  & 1220 #
1120    25  &    V  &  VARS  &    1 &   -- #  ED    &   1  & 17615  & 1220 #
1130    25  &    W  &  WATTS &LE  3 &   -- #  ED    &   2  & 17616  & 1220 #
1140    25  &    V  &  VARS  &    3 &   -- #  ED    &   2  & 17616  & 1220 #
1150    25  & FREQ &  HZ    &EQ  1 &   -- #  ED    &   1  & 17615  & 1220 #
1160 EQ 60  &    PF &  PA    &LE  3 &   -- #  PV    &   0  & 17618  & 1310 #
1170 ENDT
```

FIGURE 1.

The Decision Tables expressed very complex product logic. As a result we were able to generate the bill of materials for any one of several million instruments. The cost of storing and processing bills of material was reduced by 10 to 1. We proceeded to try using Decision Tables on many other product lines and found considerable success if:

1. The product was made up of a variety of parts and assemblies used in different combinations.

2. There was a large variety of final products.

The work of capturing the logic would not be justified for a simple product line or for a single one-of-a-kind product.

After this success in the order entry - bill of materials application, we looked at the manufacturing instructions for making parts and inspection.

A business making industrial controls made extensive use of Decision Tables to convert a panel layout into the factory instructions for shearing, punching, and bending sheet metal. The enclosure design was captured in TABLE 2100 - BACK DIMENSION and TABLE 3010 - HOLE SPACING - VS on next page, Figure 2.

The system required a very large amount of logic for bend allowances, tool designation, etc. The logic was done in Decision Tables and then programmed. This system has been up and running successfully for over ten years.

```
2100 TABLE - BACK DIMENSIONS
2110C                          MATERIAL  BACK     BACK     FLANGE  MTG     ASSM
2120C ENCLOSURE HEIGHT          THICK    WIDTH    HEIGHT   WIDTH   HOLE    HOLE
2130      PH    &   PH     #   MT=  &   BW=   &   BH=   &  BA= &  BB= &  BG= & GOTO #
2140 GE 10.00 &LT 28.00 # 0.090 & PW-0.16 & PH-0.16 & 1.36 & 1.11 & 3.42 & 3010 #
2150    28.00 &LE 56.00 # 0.120 & PW-0.25 & PH-0.25 & 1.42 & 1.07 & 3.38 & 3010 #
2160       -- &      -- #    -- &      -- &      -- &  -- &  -- &  -- & 2120 #
2110 ENDT
2120 PRINT: ERROR IN ENCLOSURE HEIGHT

3010 TABLE - HOLE SPACING - VS
3020C                          NUMBER
3030C ENCLOSURE HEIGHT         OF HOLES
3040      PH    &   PH     #  BD=  #
3050 GE 10.00 &LT 15.00 #  2    #
3060    15.00 &   31.00 #  3    #
3070    31.00 &   45.00 #  4    #
3080    45.00 &LE 56.00 #  5    #
3100 ENDT
```

FIGURE 2.

In a computer business, the quality control people had set up a punched card system for recording the type of defect on a circuit board, but found that manual analysis of the data required extensive time and had many errors. They used Decision Tables like TABLE 4100 - OPERATOR ERROR, Figure 3, next page.

Their comments were that the program runs and is easily expandable, if necessary.

Thus, we have a number of cases where complex logic was expressed in Decision Tables and used to control a computer.

In several businesses as diverse as an insurance company, a construction company and a builder of nuclear power plants, payroll and labor cost analysis logic has been done in Decision Tables. One such table selects the correct tax table depending on marital status (M=married; S=Single), and pay requency.

WK = weekly

BW = bi-weekly

SM = semi monthly

MN = monthly

TABLE 2880 - MARITAL STATUS, PAY FREQUENCY, Figure 4, shows the Decision Table.

The single monthly federal tax table would be like TABLE 4380 - SINGLE MONTHLY FEDERAL TAX, Figure 5., where:

FED is the federal withholding tax

TXGR is the taxable gross income

FE is the number of exemptions

```
4100 TABLE - OPERATOR ERROR
4110C DEFECT
4120C CODE    TYPE OF OPERATOR ERROR
4130  DEFC #  ND  &  NE= &  NF= & NG= & NX=  & GOTO #
4140 EQ 28 # ND+1 &   -- &  --  &  -- & NX+1 & 4200 #
4150    29 #   -- & NE+1 &  --  &  -- & NX+1 & 4200 #
4160    30 #   -- &   -- & NF+1 &  -- & NX+1 & 4220 #
4170    40 #   -- &   -- &  --  & NG+1& NX+1 & 4200 #
4180 ENDT
```

FIGURE 3.

```
2880 TABLE - MARITAL STATUS, PAY FREQUENCY
2890C MARITAL  PAY
2900C STATUS   FREQ
2910   MST   &  PF   # GOTO #
2920 EQ M    &  WK   # 3010 #
2930    M    &  BW   # 3180 #
2940    M    &  SM   # 3320 #
2950    M    &  MN   # 3510 #
2960    S    &  WK   # 3770 #
2970    S    &  BW   # 4020 #
2980    S    &  SM   # 4200 #
2990    S    &  MN   # 4370 #
3000 ENDT
```

FIGURE 4.

```
4370 FINC=TXGR-62.50*FE
4380 TABLE - SINGLE MONTHLY FEDERAL TAX
4390C FEDERAL          BASE       DEDUCT        PERCENT-
4400C TAXABLE          TAX        AMOUNT        AGE
4410C INCOME
4420          FINC  #    BT=   &   DAMT=   &  PRCT=  #
4430 LE    142.00  #     0.00 &    0.00   &   0.00  #
4440       329.00  #     0.00 &  142.00   &   0.16  #
4450       621.00  #    29.92 &  329.00   &   0.18  #
4460       788.00  #    82.48 &  621.00   &   0.22  #
4470       954.00  #   119.22 &  788.00   &   0.24  #
4480      1288.00  #   159.06 &  954.00   &   0.28  #
4490      1538.00  #   252.58 & 1288.00   &   0.32  #
4500         --    #   332.58 & 1538.00   $   0.36  #
4510 ENDT
4520 FED=(FINC-DAMT)*PRCT+BT
```

FIGURE 5.

Another problem is the different union deductions. A table can be written giving each deduction depending on the union involved. These tables show the logical relationship so clearly that changes are easy to make.

The conclusion, from the twenty years of experience with Decision Tables, is that they are very useful in writing complex logical relationships. They are, in effect, a powerful programming language which is useful in many functions of a business. Several users have reported a doubling or tripling in the productivity of their programmers.

Based on this experience, MUSCL - a Decision Table language was developed. The best ideas from five other languages were used, READ and WRITE commands for file processing and a REPORT writer to format reports, were included.

MUSCL has been implemented on a Hewlett-Packard 3000 to do payroll, order entry, and executive compensation system.