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# Procedural Decision Support Through The Use of PRODEMO\*

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## ABSTRACT

Procedural decisions, i.e., decisions involving the application of laws, regulations, prescriptions...constitute a tremendous amount of everyday decisions made in any kind of organizations. In this paper, decision tables are put forward as a basic technique enabling the user to structure and to check procedural decisions for completeness and correctness. It is shown that the use of the interactive PRODEMO (PROcedural DEcision MOdeling) system enhances the capabilities of the technique for modeling as well as for making procedural decisions.

## INTRODUCTION

One category of decisions which is mostly neglected by traditional decision support systems (Keen & Scott Morton, 1978) concerns decisions dealing with the application of prescriptions, regulations, laws...However, these "procedural" decisions constitute the great amount of everyday organizational decision making.

In this paper, it is argued that

1. the application of the decision table technique, originating from computer programming, positively influences procedural decision making;
2. the use of the interactive PRODEMO system basically extends the power of this technique.

To this end, we first investigate some fundamental characteristics and inherent problems of procedural decision situations, after which the decision table technique is proposed as a proper decision modeling tool. Some past experiences in using decisions tables and the PRODEMO system are reported in the Practical Experiences section and the latter system itself is fully presented in the PRODEMO System section.

## PROCEDURAL DECISIONS AND DECISION TABLES

### Procedural Decisions

Many decisions made by human beings, including managers, and all decisions made by computer programs, are procedural.

Usually such decisions are of the following nature: if certain conditions are fulfilled, perform certain actions, or draw certain conclusions. Even when decisions are made on an intuitive basis, it can frequently be shown that strict procedures are followed, albeit unconsciously.

If decisions should be made by other persons than the ones who prescribed the underlying procedures, such procedures must be documented. This is usually done by means of a narrative. Typical examples are laws, regulations, administrative rules, policies, and even grammatical rules. We will call this apriori structured (procedural) decision situations.

If decisions are made by the same person who made the rules, then documentation may or may not exist. If it does not exist, the rules (conscious or unconscious) are in the head of the decision maker. This latter case will be called apriori unstructured decision situations.

In the "apriori structured" case, several problems appear:

1. it takes time for the decision maker to study the procedures before being able to make the decision or to draw the conclusion,
2. very often, the text is unclear and can be misunderstood, leading to wrong decisions or conclusions,
3. very often, the text is not exhaustive, i.e., does not treat all possible cases, and is hidden and contradictory in many places, which again entails poor decision making.

Problem (1) is inherent to the fact that natural language is used, problems (2) and (3) can be avoided if the person who made the procedures is an extremely intelligent one, but only few procedures are made by people of that type. It follows that in

actual practice all three problems are frequently experienced, leading to poor decision making. Moreover, they grow very fast as a function of the complexity of the decision situation. They can all be avoided by using decision tables instead of a narrative as a means of documenting the decision.

Decision tables can also be very useful in the apriori structured case. They can become a vehicle for modeling the decision process such that the process gains in objectivity, logical consistency, and efficiency (for an example, see the subsection entitled Credit Granting Procedure in a Bank).

### Decision Tables

For clarifying the power of decision tables in the context of procedural decision situations, let us consider the case of apriori structured decisions, i.e., procedural decisions documented by means of natural language. Standard methods exist (Verhelst, 1980) for translating narrative to decision tables. They will be presented briefly in the subsection entitled The Crucial Problem: How to Construct Effective Decision Tables.

We will now illustrate how decision tables can dispel the above mentioned problems by comparing a typical narrative (Figure 1) with the decision table derived from it in a standard way (Figure 2).

Let us now review the contribution of decision tables for solving the three problems mentioned above.

Problem 1. If decisions are made using the decision table, a maximum of three questions must be answered, sometimes only two questions (in case R1 or R5 applies), and sometimes only one question (in case R6 applies). If all rules occur equally frequently, this makes an average of 2.33

## Order Handling

### 1. Discount

Only wholesalers are granted discount, provided that they order a quantity of at least 10 units. The discount rates are 10%, 5% and 2%: 10% for wholesalers ordering at least 15 units, or living at a distance of less than 50 km and ordering at least 10 units; 5% for wholesalers ordering at least 10, but less than 15 units, and living at a distance of at least 50 km, but less than 100 km; 2% for wholesalers ordering at least 10, but less than 15 units, and living at a distance of at least 100 km.

### 2. Way of transportation

We transport by railway if the order is not from a wholesaler, or if a wholesaler orders at least 15 units. In all other cases transportation is by road.

### 3. Type of invoice

The normal type is A. Exceptionally, an invoice type B should be made, vis a vis for a wholesaler who orders at least 15 units.

Figure 1.

Order Handling	R1	R2	R3	R4	R5	R6
C1. Customer = wholesaler	Yes	Yes	Yes	Yes	Yes	No
C2. Quantity ordered (Q)	Q 10	10 Q 15	10 Q 15	10 Q 15	Q 15	-
C3. Distance between warehouse and place of delivery (D)	-	D 50	50 D 100	D 100	-	-
A1. Discount in %	0	10	5	2	10	0
A2. Transportation by railroad	-	-	-	-	X	X
A3. Road transportation	X	X	X	X	-	-
A4. Type of invoice	A	A	A	A	B	A

Figure 2.

questions. With the text of Figure 1, an average of 7.66 questions is needed. Therefore with the decision table, decision speed is increased by a factor of 3.3. The underlying reason is that, by their nature, texts are action-oriented and decision tables are condition-oriented.

Problem 2. Making use of the decision table, fewer mistakes will be made because 1) fewer questions must be answered and therefore the probability of wrong answers is lower, and 2) the table does not contain words or expressions which are easily and unconsciously misunderstood. Examples of such words appearing in the text are "only," "provided that," "or," "in all other cases," "the normal type," "exceptionally," "vis a vis," and "but."

Problem 3. The text of Figure 1 is complete and does not contain any contradictions. We will now show how decision tables can be used for finding omissions and contradictions. Suppose that the first paragraph of the text of Figure 1 were:

#### Discount

Only wholesalers are granted discount. The discount rates are 10%, 5% and 2%: 10% for wholesalers ordering at least 15 units, or living at a distance of less than 50km and ordering at least 10 units; 5% for wholesalers ordering at least 10 but less than 15 units, and living at a distance of at least 50km; 2% for wholesalers ordering at least 10 but less than 15 units, and living at a distance of at least 100 km.

Applying a standard method for translating the new text into a decision table with the purpose of finding omissions and contradictions, we get the table of Figure 3.

By inspecting the action part of the table, we see that for R1 no discount appears (not even 0%) which is an omission. Furthermore, R4 shows a contradiction: discount = 2% and discount = 5%. The advantage of

the decision table here is that such omissions and contradictions are made visible, whereas in the text they remain hidden.

### Audience

A very often heard remark concerning procedural decisions is that this category of repetitive decisions is located at the lowest level of the organizational hierarchy. One of the basic themes of this paper, however, is that by properly applying the decision table technique (e.g., by using the PRODEMO system), one should be able also to "structure" a whole range of decisions traditionally dealt with by tactical management. In this respect, the decision table can be considered as a real structuring tool. Some striking examples will be given later.

In addition, anyone who is confronted with prescriptions, laws, procedures...can, irrespective of any organizational context, benefit from the technique proposed in this paper. The following schematic classification of the audience we were working with in the past may be clarifying in this respect:

- Managers who want to design new procedures, or to analyze and correct existing ones used in their organizations, or even by themselves.
- Lawyers who are confronted with logically chaotic and even incomplete and/or contradictory laws.
- Legislators who have to design new laws adapted to complex modern life.
- Anyone involved in the design of new regulations and prescriptions in general.
- Systems engineers who have to grasp complex organizational and infological problems.

Order Handling	R1	R2	R3	R4	R5	R6
C1. Customer = wholesaler	Y	Y	Y	Y	Y	N
C2. quantity ordered (Q)	Q 10	10 Q 15	10 Q 15	10 Q 15	Q 15	-
C3. Distance between warehouse and place of Delivery (D)	-	D 50	50 D 100	D 100	-	-
A.1.1. Discount = 0%	-	-	-	-	-	X
A.1.2. Discount = 2%	-	-	-	X	-	-
A.1.3. Discount = 5%	-	-	X	X	-	-
A.1.4. Discount = 10%	-	X	-	-	X	-
A.2.1. Transportation by railway	-	-	-	-	X	X
A.2.2. Road transportation	X	X	X	X	-	-
A.3.1. Type of invoice = A	X	X	X	X	-	X
A.3.2. Type of invoice = B	-	-	-	-	X	-

Figure 3.

- Teachers looking for a clear and unambiguous tool for representing complex material.

### The Crucial Problem: How To Construct Effective Decision Tables?

The crucial problem, commonly neglected in the traditional literature on decision tables, is how to construct decision tables given a more or less explicit narrative or written decision description. In our opinion this common lack of knowledge is also the main reason why decision tables failed to get accepted as a practical technique.

As far as the systematic construction of decision tables is concerned, experience has shown that different methods are needed for the "apriori structured" case and for the "apriori unstructured" case:

- The conversion of an apriori structured decision into decision tables, in order to examine the correctness of the existing representation, involves the application of so-called "direct" construction methods:
  - if the starting description is rather simple, one can immediately enter the appropriate entries (including don't care's) in the decision table, using any variant of the progressive rule development method (London, 1972).
  - in any other case, a two step method can be applied:
    1. the original text is translated into equivalent logical expressions (originally proposed in (7));
    2. these expressions are used to fill in the action entries

of the completely expanded decision table.

- When dealing with apriori unstructured situations, decision tables can very well be used as structuring tools. In this case, so-called search methods for constructing decision tables have to be applied (Verhelst, 1980).

All these methods will be illustrated in the PRODEMO System section, when dealing with the interactive PRODEMO system for constructing and manipulating decision tables. It will be demonstrated that this system enables us to use the different methods in any arbitrary combination. This feature has proven to be very useful in real-life cases.

### PRACTICAL EXPERIENCES

Decision tables in general, and the PRODEMO system in particular, were profitably used by several organizations to analyze quite different problem areas. The personal experience of the authors goes back to the categories of users mentioned in the Audience section. In what follows, however, we confine ourselves to the short presentation of three typical case studies:

- the Belgian Houserent Law,
- the Transfer Arrangements of the Belgian Football Association, and
- the Credit Granting procedure in a bank.

The third case study typically deals with an "apriori unstructured" decision situation, whereas the other two studies start from written documents, and hence are examples of "apriori structured" decisions. It should be noted that the size of the problems dealt with in the past included systems of some fifty interrelated tables.



In cases of that order of complexity, manual methods are too cumbersome and use of the PRODEMO system is the answer.

### The Belgian Houserent Law of April 15, 1975

One of the purposes of this law was to freeze the rent of certain categories of houses in an effort to curb inflation. All landlords and tenants (a sizeable part of the Belgian population) needed to know the law, because rents had to be recalculated with retroaction until December 1974. Had the tenant paid too much between December 1974 and April 1975, then the landlord had to reimburse him. On April 15, 1975, about one million families had to know whether their rent was frozen and if so, what the new amount was and on which dates in the future that amount could be raised by how much.

The law itself, as published, was a text of three pages of logically complex articles; it therefore was utopian to hope that the ordinary citizen would easily and correctly find his case by consulting that text. Therefore, the Ministry of Economic affairs published a brochure of fifteen pages in an effort to clarify the law.

Currently starting from the original text of the law and using the methods mentioned in this paper, we made a decision table containing all relevant procedural information for tenants and landlords. During this process several flaws of the law (omissions and contradictions) were detected and corrected. The final correct result was one simple table (see Figure 4). Using the table, each tenant and landlord can straightforwardly discover his particular case in a minute.

### Transfer Arrangements of the Belgian Football Association

The legislation of the Football Association typically illustrates the problems entailed by any text subjected to periodical revisions; the latter both introduce anomalies between different clauses of the legislation and obscure its original structure. Out of the complete legislation, the chapter on "Transfer and Related Arrangements" was taken. This choice was not arbitrary, since these articles are heavily used and cause a lot of discussions (implying important financial consequences!).

The results of this comprehensive study were evident:

1. The "apriori analysis," necessary to start the decision table modeling, revealed some obvious yet previously undetected anomalies (e.g., wrong inter-article references).
2. Lots of "gaps" (unforeseen cases) were detected. Although similar gaps caused many endless discussions and poor jurisdiction, no such complete list of gaps could ever be made without the application of decision tables.
3. Equally revealing was the list of internal contradictions, crept in as a result of the many revisions.

### Credit Granting Procedure in a Bank

Because of its highly risky nature, approval of cash credit requests has traditionally been dealt with by complex, implicit, and casual decision procedures. The main concern of the study therefore was

- a. to standarize the procedure as far as possible, and

LEASE EFFECTIVE JAN. 1, 1973	YES							NO								
PERIODIC FLUCTUATIONS CONTRACTED (INDEX-COUPLED OR NOT)	NO	YES					NO	YES								
CADASTRAL INCOME (C)	-	≤ 10000	10000 < C ≤ 12000	12000 < C ≤ 20000	> 20000	-	≤ 10000	10000 < C ≤ 12000	12000 < C ≤ 20000	> 20000	-	≤ 10000	10000 < C ≤ 12000	12000 < C ≤ 20000	> 20000	
POPULATION OF COMMUNITY	-	-	< 5000	≥ 5000	< 30000	≥ 30000	-	-	-	< 5000	≥ 5000	< 30000	≥ 30000	-		
LEASE CONTRACTED SINCE AT LEAST 12 MONTHS	-	-	-	-	-	-	-	NO	YES	-	NO	YES	-	NO	YES	-
ADAPT HOUSERENT ONLY ON DEC. 1, 1974 AND ON DEC. 1 OF EACH SUCCEEDING YEAR AS FOLLOWS	-	x	-	x	-	x	-	-	x	-	-	x	-	-	x	-
NEW RENT = (BASIC RENT x [INDEX FIGURE DEC. 72] / START INDEX FIGURE) x GOVERNMENT COEFFICIENT	-	x	-	x	-	x	-	-	-	-	-	-	-	-	-	-
NEW RENT = BASIC RENT x GOVERNMENT COEFFICIENT	-	-	-	-	-	-	-	-	x	-	-	x	-	-	x	-
AT EACH DUE DATE, RENT SHOULD NOT BE HIGHER THAN BASIC RENT x NEW INDEX FIGURE/START INDEX FIGURE	-	-	x	-	x	-	x	-	-	x	-	-	x	-	-	x
NEW RENT = BASIC RENT	x	-	-	-	-	-	-	x	x	-	-	x	-	-	x	-

- b. to create more objective decision criteria, which could also lead to a (partial) computer support.

This analysis is based upon an apriori unstructured problem situation, i.e., the procedure did not confine itself to strict and written operating rules. Therefore it was necessary to take the following steps, when performing the analysis:

- a. Interviews combined with document analysis, enabled the detection of various judgment criteria. In some cases, this led to a mathematical formulation, in others to a decision table explicitation of each criterion. Here, the "search method" for constructing decision tables was intensively used (Verhelst, 1980).
- b. Due to the absence of written operating rules, the resulting decision tables had to be discussed in detail with the responsible management representative.
- c. Only at this stage the modified decision tables were combined into a hierarchical structure of tables. The cooperation of the related department and the growing insight concerning the structure of the problem have proven very helpful in this respect. This so called "bottom up" approach also enlarges the user's trust in the capabilities of the decision table technique.
- d. Approval by higher management.
- e. The global and rough value distinctions of the qualitative criteria were translated into operational terms, which together with the measurable criteria resulted in a list of nineteen distinct elements to be filled in by the bank's credit

agent(s) when handling a customer's request.

The contribution of the decision table technique to this study can be summarized as follows:

1. The syntactical scheme of the decision table proved to be an extraordinary tool for detecting all relevant criteria (conditions) of the credit granting procedure.
2. Structuring and relating the various criteria has shown to be very confusing without the aid of decision tables; these latter were advantageously used for structuring the processes of thought.
3. The resulting decision tables need not be considered as the final step. A more elaborate scoring and weighting could emanate from the obtained decision table structure.

## THE PRODEMO SYSTEM

The PRODEMO (PROcedural DEcision MOdeling) system is a computer program for constructing and subsequently using decision tables. A more complete description can be found in (Maes, Vanthienen, 1981). In the following, we successively deal with:

- the reasons for computer introduction into the decision table manipulation process,
- the philosophy behind the PRODEMO system,
- the PRODEMO modeling methodology,
- PRODEMO and decision making, and

- PRODEMO and the application of decision table structures.

Finally, some considerations are given on the actual implementation.

### A Rationale For Computer Introduction

In the section on Procedural Decisions and Decision Tables, straightforward manual procedures for constructing decision tables were mentioned. However, in a high number of cases, the complexity becomes overwhelming; then, introducing the computer into the construction process is the obvious means to enlarge the applicability of the decision table technique. The following reasons can be put forward:

1. Combining different construction methods is hardly possible without the assistance of the computer. Besides, an interactive computer program like the one presented in this paper can give valuable indications about the desirable method.
2. The automatic generation of condition entries guarantees the completeness by enumerating all possible combinations of condition ranges.
3. A lot of administrative and clerical work that inherently accompanies the use of the decision table technique can be taken over by the computer.
4. Some manipulations of the resulting decision table can very easily be automated, e.g.
  - the contraction of the decision table using various criteria,

- reordering the conditions and actions.

5. Some other manipulations lend themselves very well to the use of interactive problem solving techniques.
6. The resulting decision tables, in a further stage, can form the basis of computer based decision making (see below).

### The PRODEMO Philosophy

As was outlined, the main purpose of the PRODEMO program is to guide and support the user during decision modeling as well as during decision making by giving suggestions and feedback, by checking for incompleteness and inconsistencies, and by executing all of the administrative routine tasks and the cumbersome drawings. No special knowledge is required in order to use the PRODEMO system. The interactive environment, in which it has been conceived, guarantees an extended and effective user support when this is required and is able to create a highly flexible and well controlled use of the system.

The PRODEMO system is able to operate in one of two modes:

1. Command mode: the user takes control of the program and determines the path through the modeling process. This is achieved by grouping all important functions on a central index page: the PRODEMO menu (see Figure 5). From this page the user can choose which option he wants to take, execute it, and then return to the menu to choose another option. One of the options is to load previously constructed decision tables in memory and to use these tables.

16.08.22.

**prodemo - menu**



Choose one of the following options :

(→ : recommended option, + : also possible)

- + a. to start/restart decision modeling
- + b. to change PRODEMO default options
- 
- + c. to add/change/delete conditions (or states)
- + d. to reorder conditions or states
- 
- + e. to add/change/delete actions
- + f. to reorder actions
- 
- + g. to add decision rules
- + h. to inspect/change/delete decision rules
- 
- i. to construct decision table
- 
- + j. to make decisions with this table
- + k. to generate program code
- 
- + x. to access the working storage
- + y. to access your own table library
- + z. to access public table library

-stop- to end or restart PRODEMO

-lab- for response mode

-shift help- for general information

-help- available

Figure 5.

2. Response mode: the computer controls the program and leads the user through the modeling process. The construction of the decision table is accomplished through suggestions of the PRODEMO software, after deducing underlying rules and constraints.

The possible alternation of command mode and response mode guarantees a flexible, computer-supported yet user-directed modeling approach.

### PRODEMO Modeling Methodology

Since any procedural decision is translated into its equivalent decision table, in order to start the modeling process, PRODEMO needs at least:

- a table name,
- some prevailing conditions and their states,
- some actions, and
- some relations between conditions and actions, in the form of logical expressions.

The supply of all these elements is grouped around the MENU-page (Figure 5). From this page the decision description is gradually built up, while fully exploiting the advantages of the decision table scheme.

The general methodology to be followed by the PRODEMO user is very straightforward. At any given moment the information the user has about the decision is entered. The most obvious way to do that is by entering all conditions with their states, and all actions the user has in mind (Verhelst, 1975). Then the user can enter the decision logic. Using PRODEMO, this can be done from the Decision Input page (see Figure 6).

On this page, sequence numbers are used for referring to conditions and actions, and letters are used for referring to condition states. The decision logic is expressed by relating condition states and actions by means of a straightforward syntax. Suppose, e.g., that the following sentence is part of the order processing example treated in Figure 6: "An order should be put on a waiting list if stock is not sufficient, and if either the credit limit is not exceeded or if the credit limit is exceeded and the customer is important." This sentence results in the following logical expression (see Figure 6):

3 + 2b and (1b or (1a and 3a))

This means that action number 3 ("Put order on waiting list") should be executed each time that condition 2 ("Sufficient stock?") has its second value ("No"), and either condition 1 ("Credit limit exceeded?") is "No" (1b) or condition 1 is "Yes" (1a), and condition 3 is "Yes" (3a). Notice also that the number of mutually exclusive states a condition can have is not limited to two. If more than two states exist, they are indicated by a,b,c,d, etc....At any chosen time, the user can ask the PRODEMO system to construct and display the decision table (option i in Figure 5).

Constructing a table implies matching the logical expressions to an expanded table, contracting the table, checking for errors, and displaying the table on the screen. When contracting a table, the user can choose between:

- a contraction with the given condition order,
- a contraction with optimal condition order.

The latter option minimizes the table length (number of columns) by reaching an optimal condition order, which improves

decision input	
ACTIONS	CONDITIONS
1° Execute order 2° Refuse order 3° Put order on waiting list	1° Credit limit exceeded ? <input type="checkbox"/> Yes <input type="checkbox"/> No 2° Sufficient stock ? <input type="checkbox"/> Yes <input type="checkbox"/> No 3° Important customer ? <input type="checkbox"/> Yes <input type="checkbox"/> No 4° Amount involved ? <input type="checkbox"/> ≤ 100 <input type="checkbox"/> > 100
Enter first decision logic (max. 98 characters) : > 3 * 2b and (1b or (1a and 3a))	

-help- available

-shift data- for menu

Figure 6.

ORDER TREATMENT

	Yes				No	
	Yes	No	Yes	No	Yes	No
Credit limit exceeded ?						
Sufficient stock ?						
Important customer ?						
Amount involved ?	-	≤ 100	> 100	-	≤ 100	> 100
Execute order	x	x	x	-	-	-
Refuse order	-	-	x	-	-	x
Put order on waiting list	-	-	-	x	-	-

Figure 7.

both the efficiency of automatic decision making and the clarity and ease of use by a human decision maker. The condition order can also be subjected to precedence constraints.

Suppose now that, at a certain moment, the developing decision table looks as in Figure 7. A simple table diagnosis provided by PRODEMO reveals that column 3 contains contradictory actions ("Execute order" and "Refuse order"), and that column 5 has no executable action. Now the user can either

- switch to touch submode and adapt the table, or
- switch to response mode and ask PRODEMO what to do next.

(This latter option is more convenient for elaborate tables involving lots of conditions).

Suppose the user wants to add that in the case of column 5 the order should be put on a waiting list. The user enters the search submode by pressing a function key and adds the new action entry by simply touching the screen. By inspecting the table, the user detects that, in the case of the credit limit being exceeded, the order should be refused when the amount involved exceeds 100 and the customer is not important (columns 3 and 6). Column 3 can then be corrected either by changing the appropriate logical expressions (cf. supra) or the decision table can immediately adjust via the touch submode. The end result of this very simple modeling exercise is shown in Figure 8 (screen output).

The rest of the PRODEMO menu-page (Figure 5) is rather self-explanatory. However, the following conventions and/or comments should be kept in mind:

ORDER TREATMENT

Credit limit exceeded ?	Yes				No	
	Yes		No		Yes	No
Sufficient stock ?						
Important customer ?	Yes	No	Yes	No	-	-
Amount involved ?	-	≤ 100	> 100	-	-	-
Execute order	x	x	-	-	-	x
Refuse order	-	-	x	-	x	-
Put order on waiting list	-	-	-	x	-	-

Figure 8.



- The user can impose and change the order in which the conditions, condition states, and actions should appear in the table (option d and f in Figure 5).
- Once a table has been constructed, it is possible to make decisions on an interactive basis (option j in Figure 5). This option is further treated in the following section.
- Although the PRODEMO system was designed as a modeling tool for the interactive construction of decision tables, it can also be used to translate the resulting decision table(s) in executable source code (option k in Figure 5). The resulting code is a non-optimized, straightforward translation of the decision table.
- In order to save or reload a decision table or a system of decision tables, one can use a working storage, with rather limited protecting mechanisms (option x), or have access to the general public library (option 2). The latter option is more complex and should only be used for almost finished decision descriptions. Any user can also create a fully protected private library (option y).

### Making Decisions With the Use of PRODEMO

Making decisions is nothing but an option to be taken at the PRODEMO menu page (see Figure 5). Actually, this can be accomplished in one of the following two ways:

1. One can display the "active" decision table and simply use it as a versatile and very compact directory for procedural decision making, or

2. one can ask PRODEMO to "interpret" the decision table(s) (option j in Figure 5). In this case, PRODEMO goes through the contracted decision table(s), while confronting the decision maker with the successive relevant condition tests. Practical experience has shown that this "interpretive" mode leads to very fast decision making because all redundant information is disregarded and all irrelevant condition tests are avoided.

Moreover, the PRODEMO system automatically links interrelated decision tables when making decisions (see below).

### Decision Table Structures

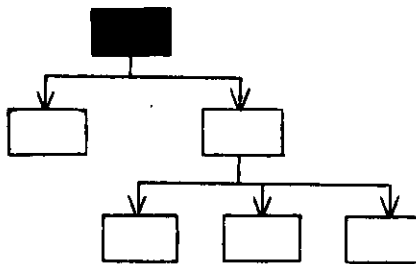
PRODEMO is able to deal with structures of decision tables. A table structure is a collection of interrelated decision tables, concerning the same decision situation. The relations are formed because some tables are a further elaboration of a condition or of an action of another table. In most cases, all tables within a system can be combined into one single table with the same logic. Such a table, however, would be so large that it would be completely useless. Moreover, the construction of small and related tables, containing coherent decision information, offers some important advantages. It enables the designer to focus on only the relevant aspects of the decision situation part by part, and to keep the decision structure in mind. It therefore adds to the modularity and the top-down approach of the problem description.

The relation between tables in a system can take two forms, because of the distinction between action and condition subtables. An action subtable is a table which refines an action of another table. A condition subtable refines a condition of

another table, by indicating which condition states are satisfied in the various decision situations.

Only tree structures are allowed. Tree structures consist of one head table with underlying levels of subtables, so that each subtable has one and only one higher parent table. A table can refer to various (lower level) subtables, but it can only be referred itself by one higher level table.

The structure of a system might, e.g., look like this:



PRODEMO deals with these system relations. During the decision making process, e.g., the successive condition tests of all relevant tables are automatically presented to the decision maker in their correct order and, depending upon the decision maker's answers, the actions to be executed are displayed.

#### Some Notes on the Actual Implementation

PRODEMO was first implemented on the CDC Plato system. This rather unusual environment was chosen because:

- PRODEMO was created in cooperation with the Management and Development Training Department of a Belgian bank. There, the Plato system was extensively used as a training tool.

- Plato had wide facilities for creating visually attractive displays and a touch-sensitive screen which is useful for manipulating decision tables.
- Processing speed and response time had proven very satisfactory even for performing lengthy and complex decision table manipulations.

## CONCLUSION

Procedural decision making, as defined in this paper, is a highly neglected yet important part of everyday decision making. The problems that go with this category of decisions were examined and the decision table technique was set forward as a practically valuable tool for tackling most if not all of the prevailing problems. Empirical evidence of this claim was delivered by means of a sample of real-life studies.

Furthermore, the PRODEMO system was presented. This system was and is actively used in quite divergent case studies. Systematic use of PRODEMO also influences its further development. Amongst others, research continues in the following directions:

1. A more powerful decision specification language, a first proposal of which was made in (Maes, 1981), should replace the current very elementary logical expressions.
2. The incorporation of further intelligence should, for example, lead to the automatic splitting of too complex decision tables into a structure of interrelated smaller subtables.

Feedback from the PRODEMO users is at the basis of each of these potential improvements.

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