

EUROPEAN DSS CONFERENCE

DEVELOPING KNOWLEDGE FROM INFORMATION

AMSTERDAM, 29 - 31 OCTOBER 1990

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CONFERENCE PROGRAM

Monday 29/10

- 11.00 - 12.30 Arrival/Registration
12.30 - 14.00 Buffet Lunch
14.00 - 14.30 Opening of the Conference (Mr. Theo Zwart, Oasis, The Netherlands)
14.30 - 15.00 Execucom Update (Mr. Gary Boese, Execucom, USA) *Execucom*
15.00 - 15.30 Guidelines for Documentation of DSS Applications (Mr. Ross Gwinner, Application Research, Belgium)
15.30 - 16.00 Break
16.00 - 17.00 Strategic Planning and Budget Allocation (Mr. Weekenstoo, Ministry of Defense, The Netherlands)
17.00 - 17.30 Demonstration of Paradigm, the workstation DSS (Ms. Cheryl Namovice, Execucom International, USA)
17.30 - 18.00 Information Technologies and Management Processes (Mr. Paul Welter, Welter Impemba Co., Italy)
18.00 - 19.00 Cocktail hour

Tuesday 30/10

- 09.00 - 10.00 Executive Information Systems used for Sales Management (Mr. H. Matzer, Hewlett Packard, Germany)
10.00 - 10.30 Break
10.30 - 11.30 Short term product development plans (Mr. Mark Wood, Execucom International, USA)
11.30 - 12.30 Keynote adress, "Developing knowledge from Information" (Mr. H. Valian, Schrack Electronic A.G., Austria)
12.30 - 14.00 Buffet Lunch
14.00 - 14.30 The integration of Decision Support Systems and Financial Management Systems in Great Belt A/S. (Mr. L. Kirkegaard, Great Belt A/S, Denmark)
14.30 - 15.30 Intelligent Decision Support Systems; an example in IFPS (Mr. J. Wesseling, University of Amsterdam, The Netherlands)
15.30 - 16.00 Break
16.00 - 16.45 A Decision Support Model for optimal pricing in multiple markets. (Mr. A. Dag Sti, Norwegian School of Management, Norway)
16.45 - 17.30 Information delivery for knowledge workers through workstation technology (Mr. Kirk Jones, Execucom, USA).
19.00 - 23.30 Dinner and Entertainment

Wednesday 31/10

- 09.00 - 09.45 A Corporate plan in IFPS/Personal
(Mrs. I. Roelvink, PTT, The Netherlands)
- 09.45 - 10.30 IFPS for advertising management (Dr. Arnaldo Massari, RCS, Italy)
- 10.30 - 11.00 Break
- 11.00 - 11.45 Cash Management in bank offices (Mr. M. van Nieuwburg, VSB, The Netherlands)
- 11.45 - 12.30 Strategic Planning Models in a multi-disciplined organisation.
(Mr. M. Steenknuksen, Novo Nordisk, Denmark)
- 12.30 - 14.00 Buffet Lunch
- 14.00 - 15.00 Open Forum: invited questions and discussion (Mr. Gary Boese, Execucom International, United Kingdom)
Opportunity to founding of European User Association (Mr. Ross Gwinner, Application Research, Belgium)
Closing the Conference (Mr. Theo Zwart, Oasis, The Netherlands)
- 15.00 onwards Optional activities:
- 'Clinic' (Execucom Staff will be available to discuss technical problems)
 - Demonstration of Paradigm
 - Demonstration of Executive Edge
 - Individual input sessions with Execucom Management (opportunity to provide input into Execucom future plans)

LIST OF PARTICIPANTS EUROPEAN DSS CONFERENCE 1990

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XI

Intelligent Decision Support Systems; an example in IFPS

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INTELLIGENT DECISION SUPPORT SYSTEMS: AN EXAMPLE IN IFPS

By Jan Wesseling, Barend Bergh and Dong Huailin

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LITERATURE

ACKNOWLEDGEMENTS

SUMMARY

This article offers some basic guidelines about when an Intelligent Decision Support System (IDSS) is most suitable for automating a task. An example of such a task will be given. This task, a credit advice system, has been implemented with the (I)DSS generator IFPS/PLUS. Finally a comparison will be drawn between the implementation and use of the credit advice expert system in the expert system shell Acquaint, and IFPS/PLUS.

INTELLIGENT DECISION SUPPORT SYSTEMS: AN EXAMPLE IN IFPS

INTRODUCTION

In this article we want to show the implementation of an Intelligent Decision Support System (IDSS). This system for credit advice has been built before with the expert system shell Acquaint. Afterwards we compare the two implementations to show the (dis)advantages of the use of a ruletable within the DSS modeling language IFPS compared with an independent rule-based expert system shell. Some conclusions will be drawn.

1 WHEN TO USE A DECISION SUPPORT SYSTEM OR/AND AN EXPERT SYSTEM

Some years ago the development of Decision Support Systems (DSS) and Expert Systems (ES) was parallel but separate. Lately there has been a tendency to integrate both systems. Technical progress has made it possible that more and more problems can be solved or functions can be supported by a computer based information system using different technologies. For some problems DSS or ES do have their advantages but integration can generate a synergetic effect. The total effect is much greater than the sum of the individual effects of the systems. What are the differences between and similarities of both systems? In literature on the subject an Expert System is defined as a computer based system that has built-in knowledge of one or more expert(s) in a certain field, and has the capability to use this knowledge to solve problems in this field. This is the first difference between an ES and a DSS. The domain of a DSS can be more complex and general. Main purpose of a DSS is to support the human factor, whereas an ES in general will replace the human factor.

A working definition of a DSS is: a DSS is an interactive, flexible and adaptable computer based system that utilizes decision rules, models, databases and decision makers' own insight. With a DSS the user asks the system, this in contrast to an ES where the system questions and the user has to answer.

Information systems can be distinguished from a functional and from a technical point of view. The functionality of an information system can be described by these characteristics of the task that influence the choice of a representation formalism (programming language). Technically information systems can be distinguished by the key features of the formalism used to represent algorithms and data. Examples of these formalisms are assembler, COBOL, ALGOL, procedural languages, DSS-generators and expert system shells. It makes sense to distinguish information systems from a technical point of view because every representation formalism possesses its own syntactic en semantic rules. These key features determine which characteristics of tasks are essential for the selection of a representation formalism.

An important function of decision support systems (DSS) and expert systems (ES) is to "support" decision making. Most of the data on which decisions are based often reside in existing databases [King89] that is why integration of DSS and DBMS (database management system) and integration of ES and DBMS has already proven rather successful in the past. But the characteristics of the decision making process itself will in general lead to the use of the DSS and ES technology.

Some characteristics of the tasks in the decision making process are summed up below, as far as it concerns the difference between DSS and ES.

Differences between characteristics of decision making tasks best executed with DSS or ES are:

	<u>DSS</u>	<u>ES</u>
1) frequency of data	unique	repetitive
2) type of data	quantitative	qualitative
3) method	algorithm	heuristic
4) sensitivity analysis	easy	difficult

With frequency we refer to the number of times the same data are used as input. What we mean by different types of data can be illustrated by a quotation from [King89]: "What's missing in the DSS is not so much "symbolic reasoning" but the ability to handle qualitative data (i.e. string or text values)."

Inside the black box of the systems there are different methods used to solve the problems. In case of heuristic methods for problem solving and the use of variables, which are strongly related, a combinatorial explosion of possibilities leading to the final conclusion, will occur. Only an inference engine is capable of reaching a final conclusion in an efficient way.

With sensitivity analysis we refer to the possibility of examining how sensitive the conclusion to (solution of) the problem is in relation to some change in the input data.

In certain problem domains we want to use the synergetic results of the integration of DSS and ES. There are several scenarios to effect the integration, for instance in attaching ES to the different components of the DSS, or in adding an ES module as a new DSS component.

In our example we used the last possibility. For this integrated DSS and ES we used the qualification Intelligent Decision Support System (IDSS). In figure 1 we show the main components of an IDSS.

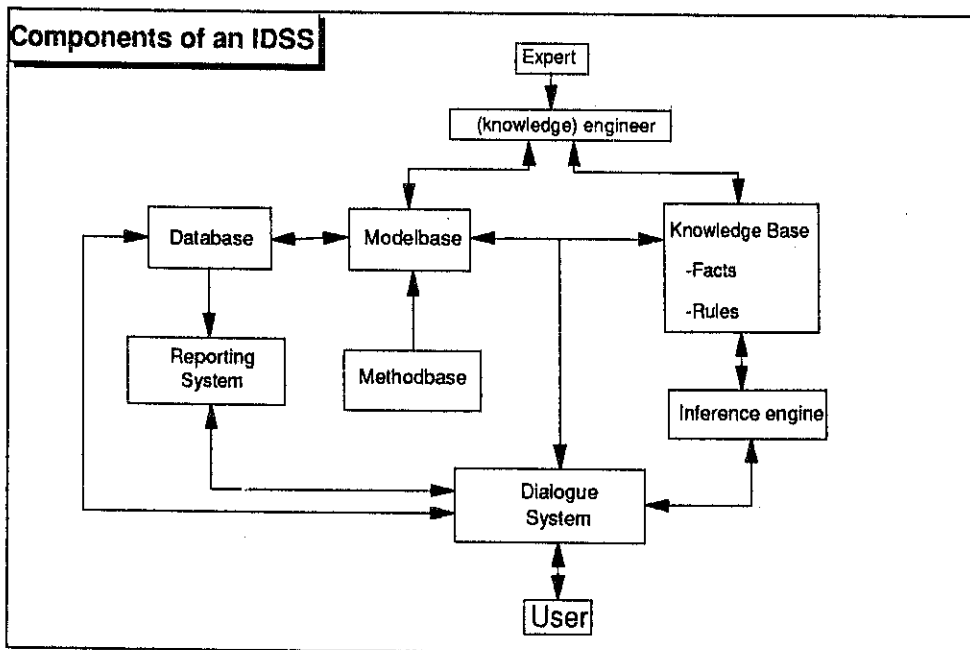


Figure 1 The main components of an Intelligent Decision Support System

Problems which are to be solved and which have some DSS characteristics and some ES characteristics are best automated by an Intelligent Decision Support System (IDSS). An example of such a task will be described in the next chapter.

2 A CREDIT ADVICE EXPERT SYSTEM

2.1 Introduction

In this section we will describe one application in which the credit worthiness of companies is judged. The system has to support a credit officer in making a decision about commercial credit application. The system asks the user to input data about operational strength, competitive situation, marketing situation. After calculating and reasoning, the system gives some advise as to whether or not to accept credit requestor, whether the request should be rejected completely or to approve the credit with conditions. The application has been built on an IBM 3090 Mainframe with IFPS/Plus as an IDSS named CAES (Credit Advice Expert System).

Starting point for the system built was an already existing expert system (named KES), built with the expert system shell Acquaint. The task can be split up in two parts. The first part can be solved with a DSS, the second part with an ES.

In part 1 seven variables are taken into consideration to calculate a credit ratio, ranging from 1 to 10. From 5.5 up credit can be given and the maximum credit limit can be given to the debtor.

These variables are:

- 1) age of the enterprise
- 2) number of employees
- 3) payment history of the debtor
- 4) analysis of the annual report
- 5) credit ratio of the mother company
- 6) financial calamities
- 7) other calamities

For instance about the variable age of the enterprise it is known that 20% of the bankruptcies occur in companies less then two years in existence, 45% in companies less then five years in existence and 75% is ten years or younger, the conclusion will be: the younger the enterprise the lower the valuation should be.

A statistical relation can be shown between the value of each variable and the solvency of the enterprise.

From the annual report a lot of ratios are calculated, which give information about the liquidity, solvability, rentability and activity. After comparison of the ratios with some standards these ratios give an overall image of the financial situation of the company.

The most dominating factors in this decision making process are the calamities.

Examples of calamities are:

- discharge of a big number of employees;
- director in prison because of fraud;
- destruction of the headquarters by fire; etc.

In case of a financial (6) or other calamity (7) the credit ratio will be 1.0 (less than 5.5) so no credit will be given.

The data used for calculating the credit ratio and maximum credit are quantitative and

unique, while the interdependence between variables is weak. All characteristics mentioned determine that the task can best be executed with a DSS. Finally one should take into account that most of the data used in part one are probably residing in existing databases.

When the credit ratio is less than 5.5, credit is denied and CAES part two will not be used. In other cases the credit limit (output of part one) is input for part two. Next section is about the second part of CAES.

2.2 The CAES System

We only show part two of the system built with the DSS generator IFPS, because only that part can be characterized as an expert system. In KES users answer questions asked by the computer, and the system combines and evaluates these data (using certainty factors) during the reasoning process. Finally, advice is given, whether to approve the credit as requested, to reject the credit completely or to approve the credit with conditions. Given a particular set of data CAES will reach the same conclusions as KES.

The following variables are used to determine whether and under which conditions credit can be given. The variables are represented in a dependency diagram.

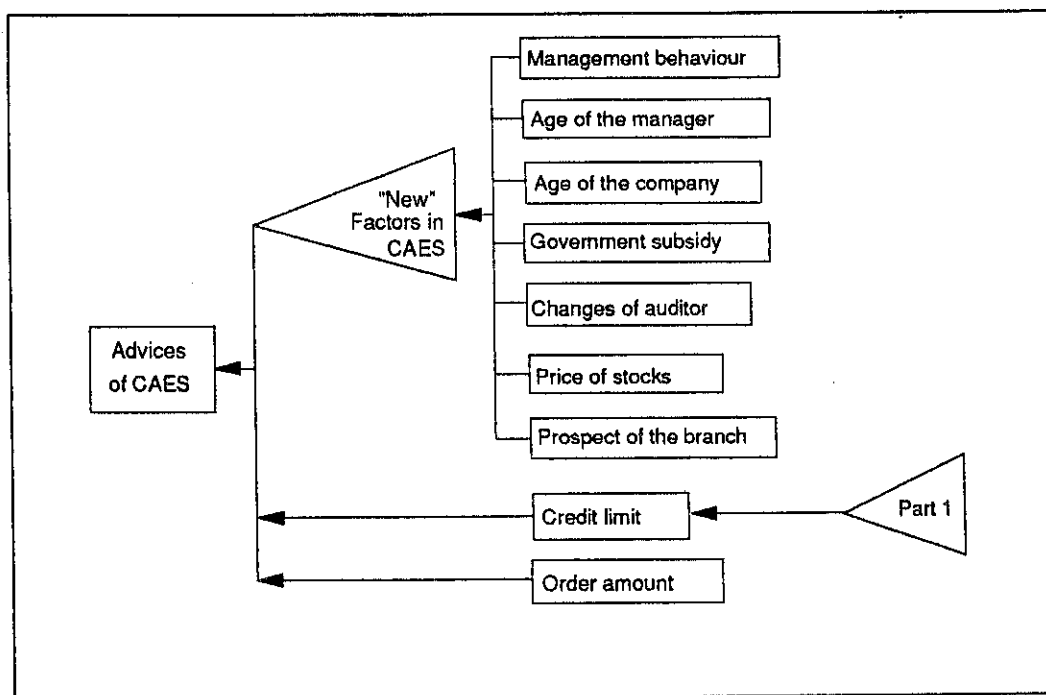


Figure 2 The dependency diagram of CAES

The data concerning the "new" variables of CAES are qualitative, not unique and interdependent. All these characteristics determine that the task can best be executed with an expert system.


```

*   How do you image the management behaviour ?   *
*   1 ----- Very good           2 ----- Some questions *
*   3 ----- No good             4 ----- Unknown       *
=====
IMAGE = 1
=====
*   How old is the management ?                   *
*   1 ----- Below sixty         2 ----- Above sixty  *
*   3 ----- Unknown              *
=====
AGE = 1
=====
*   How long is the management working ?         *
*   1 -- More than 10 years       2 -- Between 5 & 10 years *
*   3 -- Between 1 & 5 years     4 -- Less than 1 year   *
*   5 -- Unknown                  *
=====
SERVICE YEARS = 3
=====
*   Is there government subsidy ?                 *
*   1 ----- No                 2 ----- Some          *
*   3 ----- Sure               4 ----- Unknown       *
=====
SUBSIDY = 3
=====
*   How often change of auditor during the last 5 years ? *
*   1 --- No change              2 --- Some changes     *
*   3 --- More than 5 times     4 --- Unknown          *
=====
AUDITOR = 2
=====
*   How is the price of stocks ?                 *
*   1 --- Increasing tendency    2 --- No fluctuation   *
*   3 --- Slight decline        4 --- Large decline    *
*   5 --- Unknown               *
=====
PRICE OF STOCKS = 2
=====
*   Is the development in this branch good ?     *
*   1 ---- Good prospects       2 ---- Bad prospects    *
*   3 ---- Unknown              *
=====
BRANCH = 1
=====
CREDIT LIMIT = 6896476.00
ORDER AMOUNT = 6000000.00
=====

```

Figure 5 Datafile screen for answers

After the datafile has been saved, the system starts the evaluating and reasoning process. User will be given an advice report on the credit application, that indicates whether to approve the credit as requested, to approve it with conditions or to reject the credit. The

report is shown in Figure 6.

CREDIT ADVICE REPORT	

DATE: 06/08/90	XXXX Company

CREDIT LIMIT	6896476.00
ORDER AMOUNT	6000000.00

Image	Very good
Age of the manager	Below 60
Service years	Between 1 and 5 years
Government subsidy	Sure
Changes of auditor	Some changes
Price of stocks	No fluctuation
Prospect of the branch	Good prospects

EXPERT ADVICE :	Advice 1-1
	Advice 2-1

COMMENT :	
Advice 1-1 ----	The order of F 6,000,000 is within the estimated solvency. The calculated limit is F 6,896,476.
Advice 2-1 ----	Management performance is good.

Figure 6 A sample of an advice report

In this example, an enterprise asked for a credit of F 6,000,000 and the credit advice is positive. For demonstration purposes we will change some variables.

If the company asked for the same credit but the "variables" were not equally positive, the resulting advice would be more careful. Before the delivery of goods the company would have to pay a small percentage deposit of the value of the order.

In Figure 8 we give very negative values to the variables.

Some Examples :

CREDIT LIMIT	6896476.00
ORDER AMOUNT	6000000.00
Image	Very good
Age of the manager	Below 60
Service years	Between 5 and 10 years
Government subsidy	Some
Changes of auditor	Unknown
Price of stocks	Slight decline
Prospect of the branch	Good prospects
EXPERT ADVICE :	Advice 1-1 Advice 2-2
COMMENT :	*****
Advice 1-1 ----	The order of F 6,000,000 is within the estimated solvency. The calculated limit is F 6,896,476.
Advice 2-2 ----	Management performance forces to ask a little prepayment. This prepayment is minimal F 300,000.

Figure 7 A less positive situation

CREDIT LIMIT	6896476.00
ORDER AMOUNT	7000000.00
Image	Some questions
Age of the manager	Below 60
Service years	Between 5 and 10 years
Government subsidy	Some
Changes of auditor	Some changes
Price of stocks	Slight decline
Prospect of the branch	Unknown
EXPERT ADVICE :	Advice 1-2 Advice 2-3
COMMENT :	*****
Advice 1-2 ----	We cannot accept the order of F 7,000,000, because the credit exceed the credit limit. If management performance allows, an order of F 6,896,476 is acceptable.
Advice 2-3 ----	Management performance forces to ask a partial prepayment. This prepayment is minimal F 3,448,238.

Figure 8 A negative situation

As shown in figure 8, the credit limit is below the order amount and for safety reasons a high percentage should be paid as a deposit.

In the next chapter, we discuss the more technical aspects of this expert system module in DSS environment.

3 THE SYSTEM BUILT WITH THE DSS-GENERATOR IFPS

The Components Of CAES

CAES consists of datafiles, models, ruletables, commandfiles and reports etc. The following are all of the components of CAES, which shows how we constructed CAES with the modeling language IFPS/Plus.

The facts from the knowledge base of the normal ES are in the database or datafiles of the DSS. The rules are in the model equations and the ruletables.

The reasoning process from the inference engine is done by solving the models.

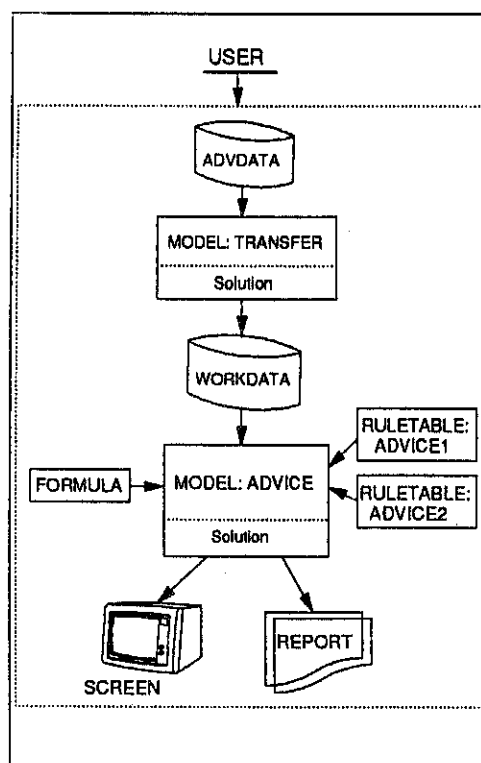


Figure 9 Structure of CAES

It was possible to translate every ES component into a DSS component. The IFPS ingredients of CAES are:

<u>Datafiles:</u>	ADVDATA	a datafile for entering the necessary data in an easy way. It is used by model TRANSFER to translate the entering data to the form of text strings, saved as datafile WORKDATA.
	WORKDATA	a datafile comprises the user entered data and their text form. Works with model ADVICE to get the advises.
<u>Models:</u>	TRANSFER	translates the user entered data to the form of text strings. The result are saved on datafile WORKDATA.
	ADVICE	works with datafile WORKDATA to evaluate the certainty variables and gives advises.
<u>Ruletables:</u>	ADVICE1	judges whether the order amount is within the credit limit.
	ADVICE2	judges whether to approve the credit as requested, to reject the credit or to approve the credit under conditions.
<u>Formula:</u>	CFCOMB	calculates the combination of certainty factors.
<u>Report:</u>	CREDITRT	a formatted report including advises (can be printed).
<u>Command file:</u>	CAES	activates the system; control throughout the package.

In the next chapter we shall compare this IFPS implementation with the original expert system in Acquaint.

4 COMPARISON OF THE IMPLEMENTATIONS IN IFPS AND THE EXPERT SYSTEM SHELL ACQUAINT

In this chapter we want to compare the two implementations. The Acquaint application has a knowledge base consisting of a set of rules and a set of facts describing the problem of interest. Rules generate an output response derived from the values (text or numeric) of a series of input variables. This capability of shells like Acquaint and IFPS/Plus enables us to implement a rule-based, expert system for decision making or analysis.

By showing two of 161 rules we get an impression of the lay out of the rules in Acquaint.

```
(DefRule R001      IF      :$CF*Image
                    Age
                    Service years
                    Subsidy
                    Auditor
                    Price of stocks
                    Branch
                    THEN :100 Conclusion_performance)

(DefRule R007      IF      :Conclusion>=75
                    THEN :MSG_INFO(the expert advises: Management performance
                                can be considered good))
```

Alternatively, in the modeling language IFPS, a model can be thought of as a set of non-procedural, algebraic rules. With the support of "IF-THEN-ELSE" expressions in the modeling system, the concepts and rules can be established. It works in much the same way as an ES shell combines forward and backward chaining.

The feature called Ruletable in IFPS/Plus can be used as a substitute for the nested set of "IF-THEN-ELSE" statements that are often found in an ES representation. With the using of text strings in IFPS, we can represent qualitative data and symbolic reasoning with modeling syntax.

Most of the rules in the ES will be combined in our system as ruletables like ADVICE2. For instance rule 007 from the Acquaint rulebase has the same meaning as the first rule in the IFPS ruletable described below. If the variable "conclusion" has a value equal or greater then 75 the conclusion in both systems will be: Management performance can be considered good. In figure 6 the output of this conclusion is shown.

```
FILE RULETABLE ADVICE2 07/04/90
* Conclusion.CF, Conclusion.CF, Advice
*
    >=75,          - ,          ADVICE 2-1
    >=65,          <75,         ADVICE 2-2
    >=40,          <65,         ADVICE 2-3
    >=30,          <40,         ADVICE 2-4
    >=20,          <30,         ADVICE 2-5
    - ,           <20,         ADVICE 2-6
```

Another example is a concept in Acquaint.

The concept has two functions:

- 1) It generates an input screen
- 2) Depending on the answer of the user a value is assigned to the variable.

```

(DefConcept Age
  PROMPT: How old is the manager ?
  COMMENT: We want to know if changes in management are to
            be expected which can result in significant
            changes in the companies performance
  EXPECT: CONVCF (age unknown 5 >)
              (below sixty 20 >)
              (above sixty -5 >)
  PROP: ASKFIRST)

```

The first function of the concept Age will result in the following input screen.

```

=====
Context      :      Credit advice
Hypothesis   :      0 R001 Conclusion_performance

How old is the manager ?
--age-----
We want to know if changes in management are to be expected which can
result in significant changes in the companies performance
-----
Below sixty
Above sixty
Unknown
=====

```

If we compare some aspects of the two generators:

	ACQUAINT	IFPS
Software:	ACQUAINT	IFPS
User interface:	User friendly, easy	Normal
Input control:	Very good	Difficult
Incomplete input:	possible	Not
Manual input:	Question after quest.	Multiple questions together
Max. amount data:	High if from dbase	High
Input efficiency:	Low	Fast if fixed portion big and variable small
Input overview:	No	Good
Help function:	Easy and good	Bad but possible
Sequence of quest:	Logical	Sequential order
Calc. possibilities:	Less	Very good
Sensitivity analysis:	Difficult	Very easy
Why question:	Yes	No
How conclusion:	Yes	Limited explanation
Output messages:	Easy	Long texts difficult
Computer:	Personal computer	Mainframe
Reasoning process:	Inference engine	Model solving
Responds time:	Normal	Fast
Cost:	Low	High
Integr. with MIS:	Normal possibilities	Very good

One of the important distinctions between an expert system shell like Acquaint and IFPS is that IFPS needs complete input. Consider an application with one hundred variables to which a value can only be assigned to by manual input. Suppose in Acquaint only ten questions have to be answered to reach a specific conclusion, while on the other hand in IFPS, all the hundred questions will have to be answered. Under such conditions IFPS is probably not suitable because a lot of data which are not necessary for drawing the conclusion, have to be put in.

Another distinction is the facility of expert system shells to explain the behaviour of the system. During the consultation and after a conclusion has been reached, the user may interrogate the system by means of WHY or HOW questions. Which means: WHY are you asking this question and HOW did you reach this conclusion. This is no standard for a DSS generator. Even with the advanced EXPLAIN RESULTS option of IFPS/PLUS it is not easy to trace the steps to the conclusion.

5 CONCLUSIONS

The border between DSS and ES is disappearing. For some types of problems it is now possible to use an IDSS, an Intelligent Decision Support System. This is an integration of a DSS generator and an ES shell. This integrated system is very effective in supporting the decision making process.

Our advice for tasks carrying both characteristics of DSS and ES is to solve these problems with IDSS tools.

We succeeded in translating an original ES system for credit advice in an IDSS. As IDSS tool we used the DSS generator IFPS/PLUS. Some advantages remain for the Acquaint system, for instance: the explain facility provides more useful information and incomplete input of data is acceptable.

When to use an IDSS instead of an ES:

- if a great number of data to be put into the system is already available in a database,
- if the number of calculations is great and the complexity of mathematics is high,
- if the user needs an intelligent interpretation of the (DSS) output.

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