MANAGEMENT OF THE PRACTICE OF AN OLFACTORY PANEL

E. Dicrescenzo*, Ph. Bernadet**
*CRES -Centre de recherche Elf Solaize - BP 22 - 69390 Solaize
Phone: (33) 78 02 63 14 - Fax: (33) 78 02 60 90
email: edith.dicrescenzo@eaf.elf1.fr
**GRL - Groupe de Recherches de Lacq (Groupe Elf) - BP 34 - Lacq 64170 ARTIX
Phone: (33) 59 92 67 56 - Fax: (33) 59 92 69 47
email: philippe.bernadet@calcrd.elf-atochem.fr

ABSTRACT : The Elf Group produces many chemical compounds used in the manufacture of products. In recent years, in addition to the usual applicative specifications of each product, sensory specifications can make the difference with competiter's products. That is why, at the GRL Lab, a panel (jury) of fifteen qualified persons regularly practises recognizing 44 descriptors so as to be able to describe in standard vocabulary any odor. In this paper, we give a training method based on the notion of priority of the descriptors in function of performance criteria of the panel. The basic tool is a multi-criteria aggregation using fuzzy decision tables taking into account the non linearity of the function *f* relying the priority to the criteria. The originality of our approach is that it precedes other studies such as " the preference mapping " generally used in sensory studies with consumers; Another advantage comes from the simplicity of the software developped at the CRES, and used at the GRL for 6 months. The user has not to specify the technical choices resulting from the fuzzy logic .

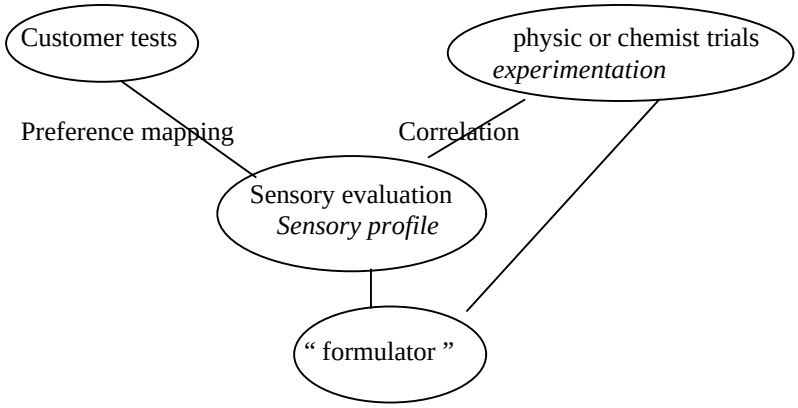
KEYWORDS : panel, expert, sensory evaluation, training, descriptors, fuzzy logic, aggregation, criteria, priority.

1. CONTEXT/STAKE OF THE STUDY

Chemical compounds of the Elf Group are present in many products available to the public. These polymers, are present in food packagings, dashboard, cosmetics, odorisings for gas or gasoil, solvents for painting. In recent years, in addition to the usual applicative specifications of each product, sensory specifications can make the difference with the competiter's products. The GRL sensory evaluation Lab, created in 1992, is highly equipped (Gas Chromatography GC, Mass Spectrometry, electronic noses) and has set up an odor sensory panel of 15 volonteers from different departments. The expert panel is intermediate between the customer expressing himself in hedonic terms (such as « I like », « i Don't like »), and the formulator who is a chemist. These experts must have a precise vocabulary. This vocabulary is represented by 44 molecules (the descriptors) grouped in families or " poles " which enables, according to JN. Jaubert the description of any odor (" Field of Odor " – Jaubert (1995)).
The GRL Lab controls the olfactory qualities of the products at different levels :

- During the developping period (R&D), the olfactory research, determine the commercial success of the final product.
- During the manufacturing process, production can be stopped in time if all the olfactory controls are not satisfied which avoid significant losses.
- When on the market, if a customer discovers an unusual smell, the quick identification of the odor will permit the identification of the chemical component and then the manufacturer of this component. This can avoid new batches that are not up to standard being launch.

The olfactory panel is able to describe the olfactory profile of any product through the vocabulary of the 44 molecules. Each molecule is associated by each expert to a precise evocation. For example : ethymol is often associated to a smell of caramel, burnt sugar – diallyl di sulfide to garlic - thymol to smell of thyme or laurel.
The source of odor is then given by GC/MS/sniffing with a sample selected by the panel.



2. THE METHOD OF THE OLFACTORY PANEL

The panel is constitued by 15 volonteers. A practice session is organized every two weeks (in self service) with at least, half of the experts. They have to identify ten molecules per session. These molecules are in liquid sample forms, and each expert in his cubicle, can smell them according to a fixed order. These sessions are computerized, and each expert ticks, on his computer screen, the molecule he has chosen, and its pole. Then the answers are marked :

- molecule recognized -> mark = 10/10
- molecule not recognized , but pole correct -> mark = 4/10
- molecule not recognized -> mark = 0/10

Before this study, the molecules were evaluated at random. The aim of our study is to improve the performances of the panel with a more targetted training. That means, to define a notion of priority enabling the automatic selection of the 10 molecules to be evaluated during the next session. Our target is for the panel to reach marks of nearly 10 for all the 44 descriptors.

3. DEFINITION OF THE NOTION OF PRIORITY OF THE DESCRIPTORS

How to choose these 10 molecules, taking into acount the constraint that the sessions can’t be individualised, in order to improve the global performances of the panel. This choice depends on the following:

- The actual level of recognition of the panel.
- The evolution of this level with time, to give priority to the molecules with a decreasing recognition level, even if this level remains relatively correct.
- If a molecule hasn’t been tested for a long time, there is a tendancy to forget it, even if it used to be well recognized. This notion of duration is an important constraint.
- The panel has to be globaly efficient, and must have homogeneous recognition rates. As the decisions are taken by consensus, it’s better to have a panel with an average recognition level, but homogeneous, as this enables us to deal with the resulting limits, and uncertainties.

3.1 DEFINITION OF THE CRITERIA ASSOCIATED TO THE NOTION OF PRIORITY

Several mathematical criteria are deduced from these concepts. For each molecule, we have:

1. The global recognition level of the panel during the last session noted TX subsequently (the last session can be a different time for each expert and each molecule) $\Rightarrow$ real between [0, 100].
2. The evolution of the recognition rate of the panel during the 3 last sessions which is an average of the evolutions of each individual. The possible marks are 0, 4, 10. Therefore, we have $3^3 = 27$ characteristic profiles of evolution. These profiles are given a subjective mark by Ph. Bernadet, the Head of the panel and of the Lab.

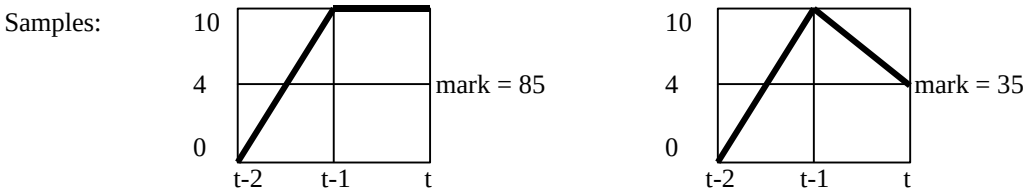


***fig.1**: Example of marking of characteristic profiles*

Each expert has therefore, for each molecule, a mark representing his evolution between 0 and 100. The global panel tendancy is given by the average of these marks ⟹ integer in [0,100], noted TEND subsequently.

3. Standard deviation of the panel for each molecule ⟹ real in [0,1], noted ETR subsequently.

4. The period during which a molecule has not been tested. For a given molecule P, it is the average of P1,…P15, where Pi is the period during which this molecule has not been tested by the i^{th} expert of the panel ⟹ real in [0, 180] (the results of the sessions are saved for six months), noted DURATION subsequently.

3.2 REPRESENTATION OF THESE CRITERIA

We have developped at the CRES a tool named REFLEXE to describe the fuzzy variables and aggregation method by decision tables. The variables are described by α-cuts, which permits the definition of rather complex classes. The graphic of the classes is automatically drawn. It's a generic tool which has already been used in different applications by the Elf Group.

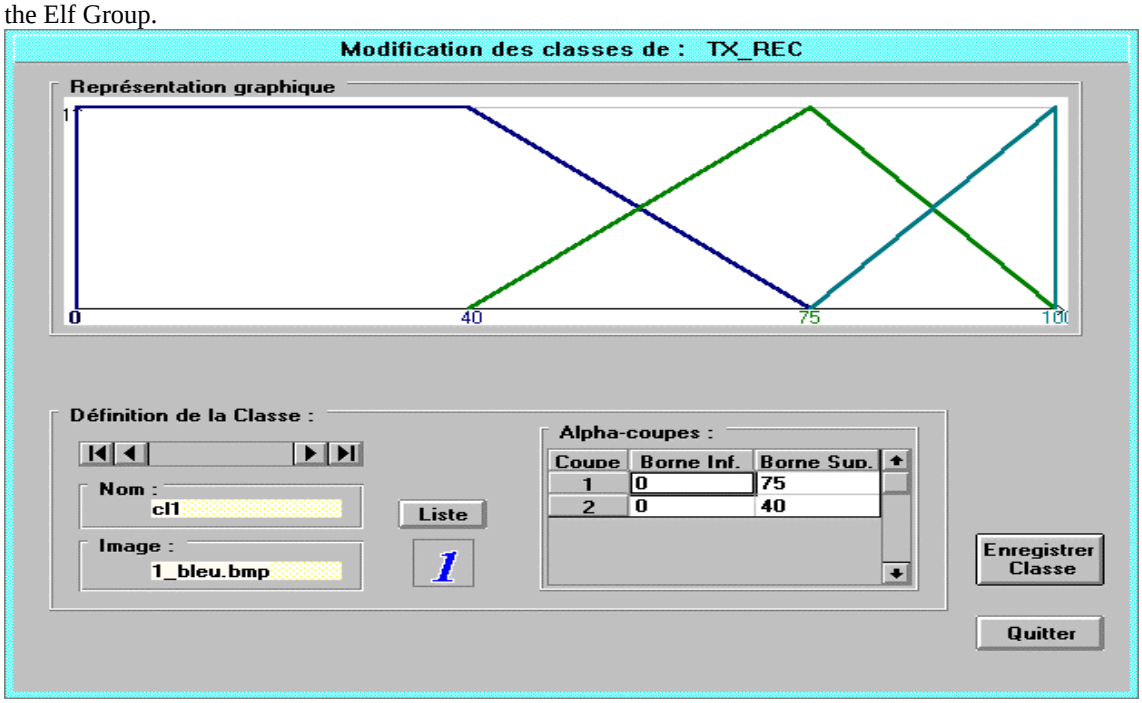


***fig. 2**: fuzzy representation of TX variable with the details of the membership function **1**(REFLEXE interface)*

Class 1 represents a recognition level which is " Low ", surely less than TX=40%, because recognizing the pole is rather easy, and it'snt our target. For Tx>40%, TX improves, and becomes acceptable, i.e. " Average " (classs 2). Class 3 corresponds to a " Hight" recognition level. Its graph is not shoulder shaped, because the objective is for the whole panel to reach a level of recognition of about 100%.
The criteria TEND and ETR are also represented by 3 fuzzy triangular classes, shoulder shaped on one side. Their modal values have been given in the same way as TX by Ph.Bernadet according to the targets.
The output variable PRIORITY is represented by 5 triangular equidistributed classes in [0,100], ranging from class 1 representing the lowest priority to class 5 the highest.

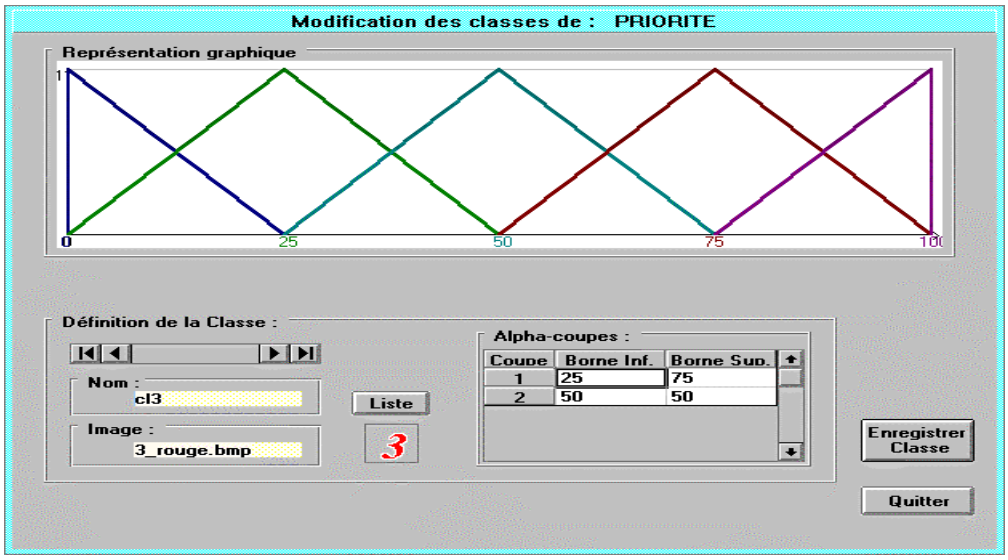


fig. 3*: representation of the variable PRIORITY, with detail of the membership function* ***3 (REFLEXE interface)***

The criterion DURATION is considered as a variable which activates a set of fuzzy propositions grouped together in decision tables according to its value comparedto a threshold.

3.3 AGGREGATION OF THESE CRITERIA

The 3 criteria TX, TEND, ETR, are aggregated by decision rule tables in 3D, described by the interface REFLEXE. According to the value of the criterion DURATION, one of the two tables is activated. The criterion DURATION is a parameter, fixed actually at 100 days.

If DURATION $\leq$ 100, the table 1 is activated, causing the intervention of the classes 1 to 4 of the variable PRIORITY.
If DURATION > 100, the table 2 is activated, causing the intervention of the classes 2 to 5 of the variable PRIORITY, expressing a more severe attribution of the priorities. The table 2 is obtained from the table 1 by increasing by 1 the classes of the variable PRIORITY. Therefore, class 1 becomes class 2, ...,class 4 becomes class 5.
Each of the two tables is in fact represented by sections**,** to enable a 2D representation. The membership to a class of the variable TX is fixed, and the two other variables are represented (fig. 4: TX $\in$ class 3).

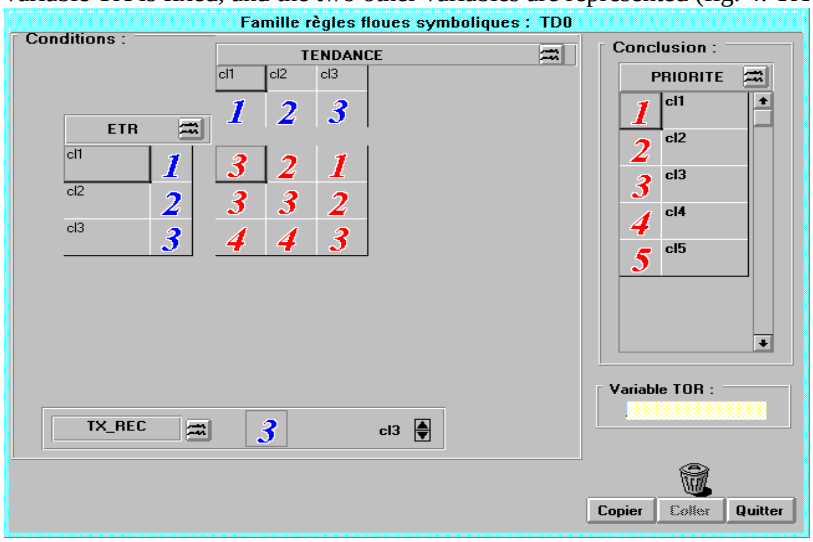


fig. 4: *Table 1: definition of the classes of the variable PRIORITY for TX* $\in$ class 3 *(REFLEXE interface)*

Example of rules from the fig. 4 (explanation of the column 3, line 1):

IF the recognition level of the panel is " High " (TX $\hat{I}$ *class 3)*

AND IF the global tendancy of the panel is " Good " (TEND Î class 3)
AND IF the panel is " Homogeneous " (ETR Î class 1)
THEN the priority of this molecule is " Very Low " (PRIORITY Î class 1)

REFLEXE also permits the technical choices of the MPG (Modus Ponens Generalisé) Generalized Modus Ponens to be specified: see fig. 5, the screen of the different operators.

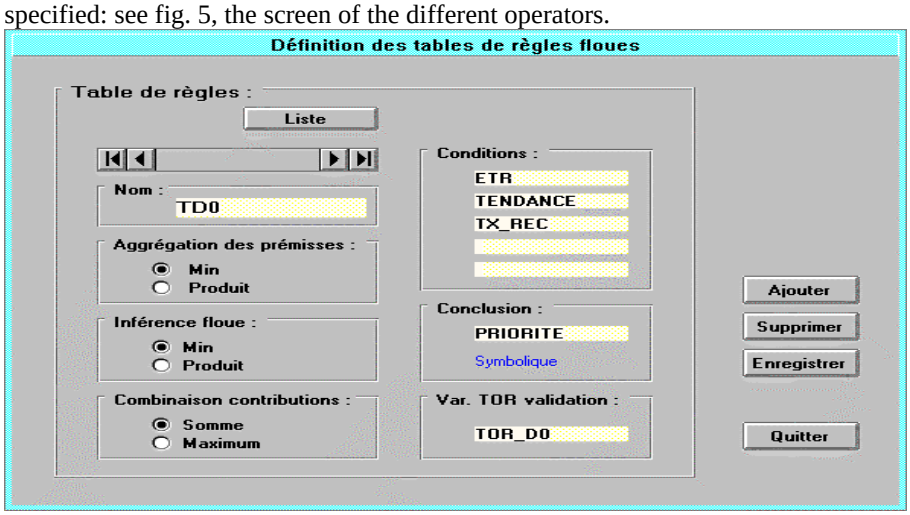


fig. 5: Choices of the operators of the MPG (REFLEXE interface)

With these descriptions, the REFLEXE interface module generates an ASCII file representing the knowledge base (description of the variables and rules). An independant running module, applying the MPG computes the output variable according to the descriptions in this ASCII file. This principle is a generic method: for each specific application, based on fuzzy decision tables, you just have to install the ASCII file corresponding to the knowledge base of the application and the running module.

4. LIST OF PRIORITY MOLECULES - THE SOFTWARE " PANODEUR "

By the preceding section, all we need for the management of the olfactory panel, is the description of the fuzzy variables and tables with REFLEXE interface module, and the developpement of a specific interface PANODEUR in Visual Basic. PANODEUR calls the independant running module, and displays the list of the molecules by priority order, as well as the values of each criterion, and the performances of the panel.

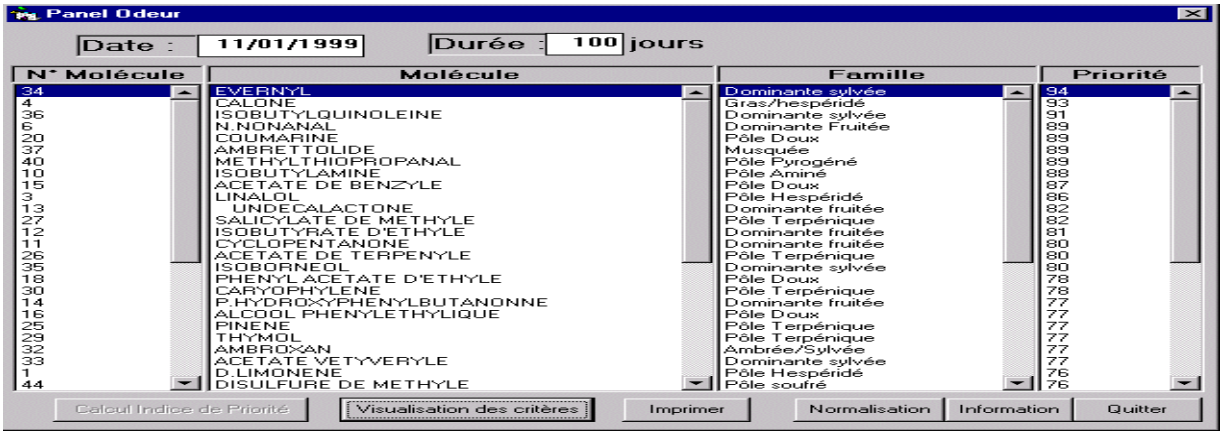


fig. 6: *List of the molecules by a decreasing order of priority (PANODEUR interface)*

5. CONCLUSIONS

The software PANODEUR has been functionning for 6 months at the GRL lab, giving satisfaction to Ph.Bernadet, the director of the Lab: the performances of the panel are globally improving, even if certain molecules are more difficult than others to recognize, and have a recognition level which can still be improved

It is interesting to note that, as soon as we identify the criteria to be taken into account in the notion of priority, the fuzzy logic enabled us to describe the decision rules of Ph. Bernadet which were rather intuitive, into a structured table very easly. The implementation, was extremely efficient owing to our generic tool REFLEXE.

Besides the management of the olfactory panel, we are working with Bouchon-Meunier's team (LIP6 Paris-Jussieu) on the estimation of the uncertainties in the description of an olfactory profile of a product. It is the description of the odors present in the product, using the 44 molecules vocabulary. It can be required during the manufacture period to control the olfactory qualities of a product, or during the marketing period, if there is a complaint from a customer concerning a product. It is important to obtain profiles as reliable as possible, hence the importance of the practice for the panel. It is also very important to manage the uncertainties associated to these profiles. These uncertainties can be linked to the specific difficulties of some experts to recognize certain molecules (limit of perception thersholds, confusion between molecules, or between poles of molecules), and to the heterogeneity of the panel. Therefore actually we are working on the determinationof a degree of reliability to be attributed to a sensory profile described by a panel of experts.

REFERENCES

Beauchêne, Chèbre, Di crescenzo, Hartmann, 1995, " REFLEXE " a tool for combining fuzzy logic and expert systems " - Eufit 95 Aachen

Jaubert, 1995, " The field of odors : toward a universal langage for odor relationships " - Vol 20, May/June 1995