

MELISSA TECHNICAL NOTE

Memorandum of Understanding TOS-CT/2002/3161/In/CL



TECHNICAL NOTE: 79.1

PRELIMINARY NUTRITIONAL DATABASE

prepared by/ <i>préparé par</i>	Priou Régis, Creuly Catherine, Pons Agnès, Poughon Laurent
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1 INTRODUCTION

Taking into account the rather extreme live conditions that the members of a crew will undergo during space flight, it seems necessary to provide them a so-called balanced diet. Characteristics of a bioregenerative life support system include a strictly vegetarian source range, a small number of crops compared to the variety available on Earth, and the use of low-waste processing methods. Despite these constraints, a successful diet should have enough variety (in terms of ingredients and recipes obtainable from these ingredients) and sufficiently high acceptability (in terms of acceptance ratings for individual dishes) to remain interesting and palatable over a long period (several months), and an adequate level of nutrients commensurate with the astronauts nutritional requirements.

In addition to the nutritional aspects, other parameters have to be considered for the pertinent selection of the dishes: energy consumption, quantity of generated waste, preparation time...

To facilitate the creation and the management of these menus, a database must be developed. Even for satisfactory diets, it is difficult to satisfy all nutrient requirements within a single day's food; dieticians usually plan to satisfy nutritional requirements over a 3 to 7 days period. We choose to define a series of menus on a ten days period that is the reference period considered in NASA missions, and to calculate the parameters relevant to nutritional, energetic and mass impact aspects.

The definition and the general operation of a database will be first explained before describing the interface itself and then to discuss the possible improvements.

2 CREATION OF DISHES FROM THE MELISSA LOOP

2.1 *Ingredients*

The MELiSSA loop will be able in the long term to provide a limited number of plants. Even if these plants are not completely selected, they should be about ten. Poughon and Dussap (2001) have proposed the following crops: kale, lettuce, onion, potato, rice, soybean, spinach, tomato and wheat. Alone, they will not provide all the ingredients needed to the establishment of a suitable number of dishes. A number of the ingredients used will be of terrestrial origin, so that stored on board and not produced. Some of these plants cannot be used directly as ingredient in a recipe and will need transformations. For these reasons, different categories of ingredients were defined (Hunter *et al*, 1998):

- Fresh plants: they are the plants directly usable as ingredient, without preliminary transformations. The tomato belongs to this category, it can be consumed just after being harvested.
- Stabilized ingredients: they are obtained from fresh plants after a step of transformation. As an example, corn grains can be obtained by threshing.
- Produced ingredients: they are obtained from stabilized ingredients. To take again the example of corn, the corn grains can be ground in flour that is a produced ingredient.

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- Additional components: they are all the ingredients not produced by the MELiSSA loop and are thus of terrestrial origin. The chocolate can belong to this category.
- Unused ingredients: this category was not defined in the preliminary work on this subject (Hunter *et al*, 1998) and was created later to facilitate the structure of the database. It gathers all the ingredients produced by a recipe but not used in the final dish. For example a recipe needs the yellow part of an egg, while keeping the white part for a later use. The white egg is then considered as an unused ingredient.

All these ingredients must produce a great diversity of dishes. The quality of a dish for long duration space missions is judged on many criteria (nutritional value, psychological impact, taste, aspect...) but only some of them are taken into consideration to establish a planning of menus (Vodovotz *et al*, 1997).

2.2 *Nutritional value*

The nutritional contribution of menu as a whole over several days must meet the needs for a crew. A maximum of nutritional information must thus be gathered for each dish in order to precisely determine the possible deficiencies or excess (Jones, 2000). This information takes into account the quantity of proteins, lipids and glucides brought by a dish as well as the quantity of water, of major minerals (sodium, potassium, calcium...), of vitamins and trace elements (iron, manganese, zinc...).

These nutritional values are not sufficient to know the real contribution of a dish to a crew. It is also necessary to take into account the biodisponibility of these elements, i.e. the capacity of an element to be absorbed by the organism. Thus the same element contained in two different dishes will not be absorbed in the same way. For each nutritional value it is necessary to also specify its biodisponibility (Vodovotz *et al*, 1999).

2.3 *Mass*

The development of dishes needs the use of machines automating some steps. Within the framework of a long-term space mission, as in any space flight, the mass is a significant factor (Poughon and Dussap, 2001). The cost in energy increases with the volume and the weight on board. A dish requiring the use of too bulky or heavy machines will not be selected.

2.4 *Energy*

The quantity of energy available on board is not unlimited. It is thus also interesting to take into account the quantity of power consumption for the development of a dish (Hunter and Drysdale, 1996). This parameter can also help to select the list of dishes

2.5 *Time*

The crew will probably have various activities to perform during a long-term mission or a stay on a permanent base. The time to produce the dishes must remain short. For this reason, the automation of some steps of production seems the solution.

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Two different times are considered. The “total time” corresponds to the time spent to the conception of a dish from the beginning until the end, and the “man time” enters in the account only the effective working time (Hunter and Drysdale, 1996). “Man time” thus does not account for the time of cooking and operating time of the machines

2.6 Waste

Waste management has a significant place in the operation of the MELiSSA loop. As MELiSSA recycles all generated waste, a recipe which produces a great quantity of waste will not be regarded as acceptable because it involves a possible overload of the loop (Hunter and Drysdale, 1996).

2.7 Other aspects

These other criteria are not taken into account because they do not have a direct influence on the loop and will certainly be fixed in a preliminary stage. These aspects are related to the psychological impact of a fixed diet and to the “tests of acceptance” (Olabi and Hunter, 1999). Tests showed that a pre-established diet during a long period undoubtedly induces a fall of spirit and performances (Hunter and Drysdale, 1996). The simplest solution would consist in letting the crew decide on his food but the risk of deficiency is then much greater.

The palatability of a dish, i.e. the quality of its taste, its texture and its odor, is also a significant factor. A bad taste, aspect or odor can have negative consequences on the psychological well being (Von Czapiewski, 2000). To minimize the importance of these factors, tests of acceptance should be set up starting from a panel of consumers (Perchonok *et al*, 2002). This step will give knowledge on the degree of acceptance of a dish by any people.

2.8 A database for MELiSSA

All the factors influencing the MELiSSA loop must be taken into account in the establishment of a planning of menus. Their number involves a difficulty in the creation of such a planning. A database can facilitate this work by automating a part of calculations. By this way, the validation of a planning will be facilitated.

3 DESCRIPTION OF A DATABASE

Before detailing the particular structure of the database built for the MELiSSA project, the general conception of a database has to be exposed.

3.1 A database

A database is a program allowing storing information. The storage capacity is often very high. To quickly find information among a whole mass, a database classifies this information in categories called tables. A database generally comprises many tables that can be compared to an Excel sheet. They are made of columns, called “fields”, and of lines, called “tuples”. Each

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field of a table stores a type of information. A tuple will thus be a set of information characterizing an object.

On the figure 1, the table “People” comprises three fields: “Name”, “First name” and “Age”. Two tuples are visible, characterizing two persons: Mr. Dupont and Mr. Durand.

People		
Name	Surname	Age
Dupont	Jacques	35
Durand	Jean-Pierre	42

Figure 1 : Example of a table in a database

3.2 Database management system

A database must be associated with a database management system (DBMS) which allows many operations: creation of new tables, insertion of data in tables, suppression of tuples...

A user asks the DBMS to carry out one of these operations using a language as SQL (Structured Query Language). The instructions are written in SQL and transmitted to the DBMS. The DBMS carries out the required instruction and gives its answer, generally in a table format.

Even if SQL language allows many operations, it is difficult to handle by people not specialized in the databases. Moreover it often requires having a good knowledge of the structure of the database, in order to know where to find information. For rather complex databases, the solution consists in creating and using an interface.

3.3 Interface of a database

An interface allows to graphically represent information of a database and to send easily requests to the DBMS. It is created with a programming language. The language used for the interface of the MELiSSA database is the PHP language (Preprocessor Hypertext). This language is particularly well adapted to the databases and is designed for building Internet Web based interface. Thus it can only work with a Web server to decode the PHP instructions. The operation of the interface is rather simple. The user loads an Internet page with various links and buttons. For example, when he clicks on a link, information is sent to the server to open the requested page. Before displaying the content of the page, the server checks if the page has a PHP format. In this case, it activates a program to read PHP instructions and to carry them out. Among all the instructions, some of them send SQL requests to the DBMS. The DBMS carries out the required research and sends SQL result to PHP, which translates information in a language comprehensible by the Web server. The server recovers all the information before sending it to the user. On the screen, a new Internet page is displayed. The

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interactive network created between the user and the database by such a system is represented on the figure 2.

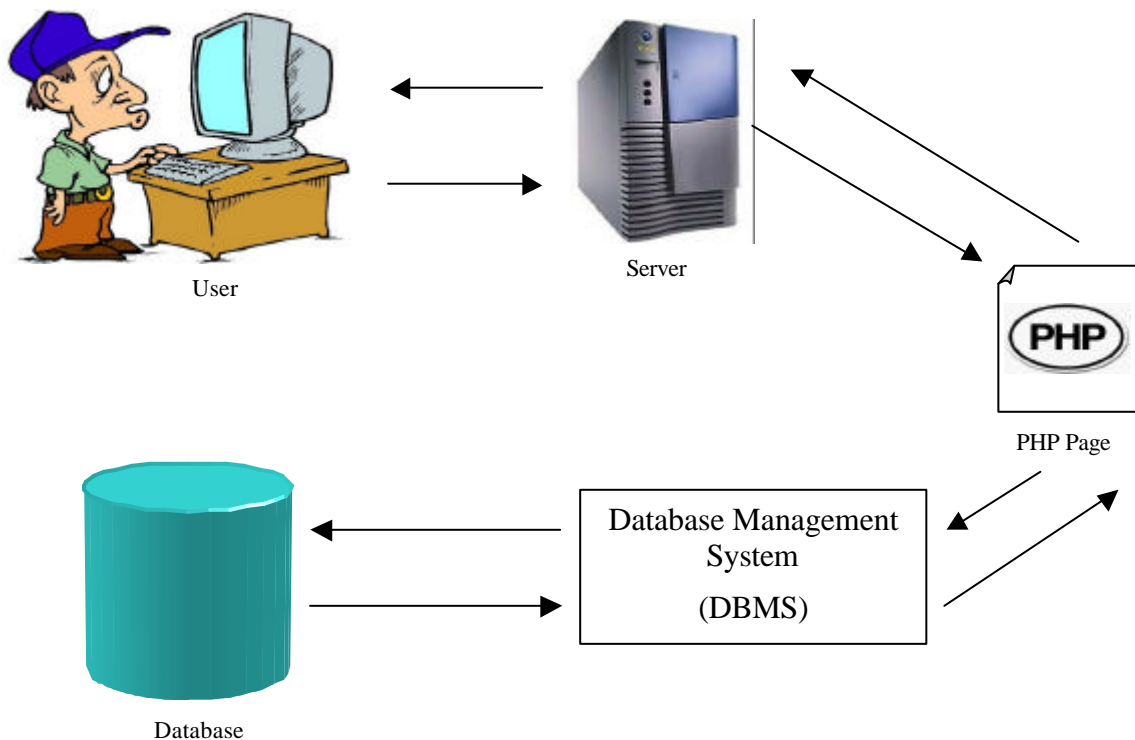


Figure 2 : Operation of a PHP interface on a database

4 STRUCTURE OF THE MELISSA DATABASE

The building of the database's structure is a determining step because it greatly influences the interface. One of the methods consists in creating a structure that describes reality.

The structure of the MELiSSA database was thought to remain evolutionary. Some information stored in the database for the moment is not yet used in the calculations. However they were included in the structure because they will be required if a stock management of ingredients is added to the database. A complete diagram of the structure of the database is detailed in the figure 3.

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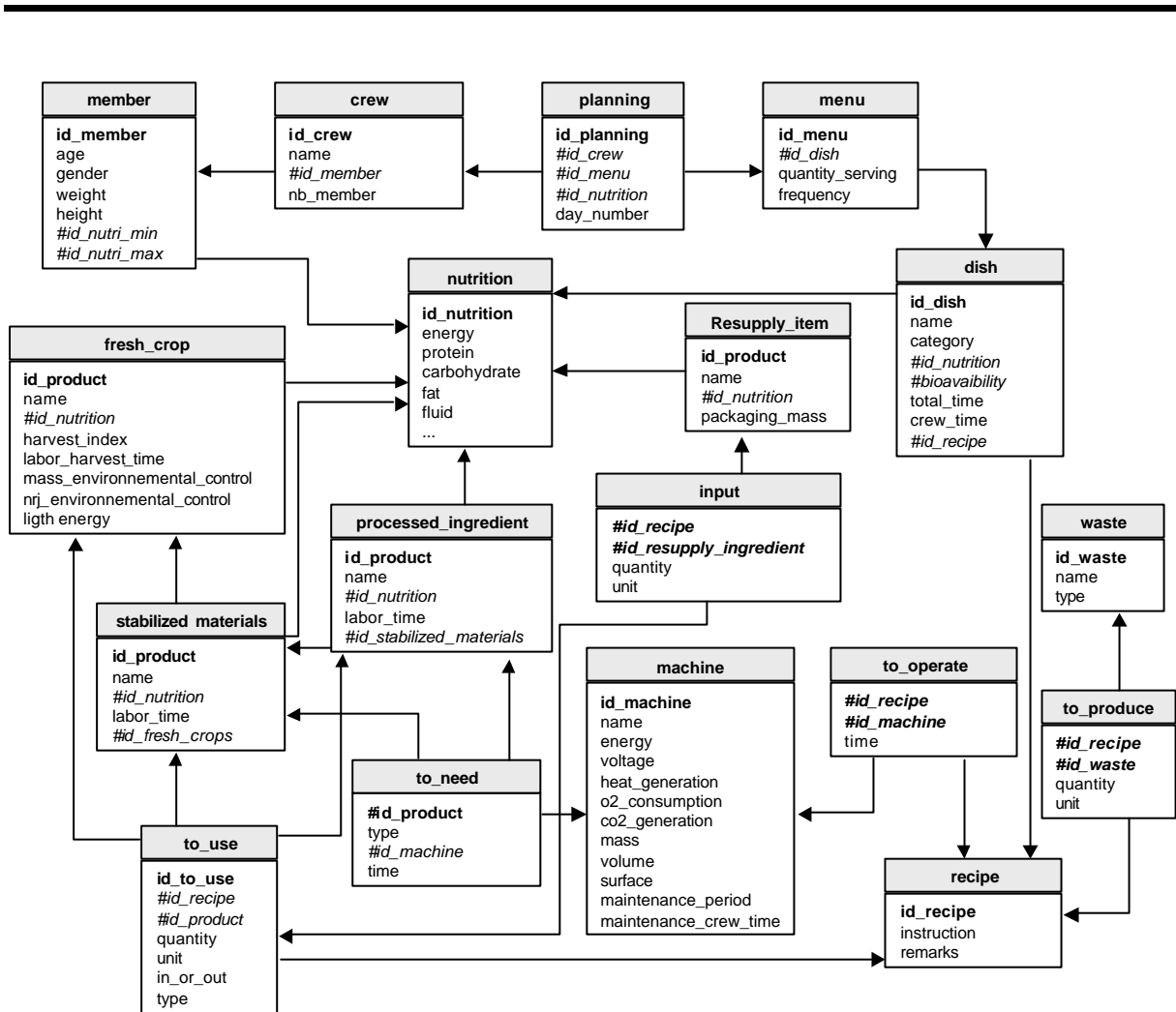


Figure 3 : Diagram of the database structure

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Nutrient	Units	Requirement
Energy	kilojoules (kilocalories)	WHO equation
Protein	% total energy consumed	12 – 15
Carbohydrate	% total energy consumed	50 – 55
Fat	% total energy consumed	30 – 35
Fluid	ml per MJ consumed or ml/kcal	238-357 or 1.0-1.5 or at least 2l/d
Vitamin A	µg retinol equivalent	1000
Vitamin D	µg	10
Vitamin E	mg α-tocopherol equivalent	20
Vitamin K	µg	80
Vitamin C	mg	100
Vitamin B ₁₂	µg	2
Vitamin B ₆	mg	2
Thiamin	mg	1.5
Riboflavin	mg	2
Folate	µg	400
Niacin	mg niacin equivalent	20
Biotin	µg	100
Panthenic acid	mg	5
Calcium	mg	1000 – 1200
Phosphorus	mg	1000-1200 < 1.5 times Ca intake
Magnesium	mg	350
Sodium	mg	1500 – 3500
Potassium	mg	3500
Iron	mg	10
Copper	mg	1.5 – 3
Manganese	mg	2 – 5
Fluoride	mg	4
Zinc	mg	15
Selenium	µg	70
Iodine	µg	150
Chromium	µg	100 – 200
Amino acids (*)		
Histidine	mg/kg body wt	8.0 - 12.0
Isoleucine	mg/kg body wt	10
Leucine	mg/kg body wt	14
Lysine	mg/kg body wt	12
Methionine and Cystine	mg/kg body wt	13
Phenylalanine and Tyrosine	mg/kg body wt	14
Threonine	mg/kg body wt	7
Tryptophan	mg/kg body wt	3.5
Valine	mg/kg body wt	10

(*) Essential Amino Acids (Cenci - McGrody and Stiller, 1997).

Figure 4 : Nutritional day advice for missions on ISS for a maximum of 360 days

(Lane and Schoeller, 1999).

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4.1 The crew

The number of people composing the crew is not determined and will be certainly variable. It is the role of the user to create his crew with the right number of members. A table gathering this information exists in the database.

Information on each member of the crew enables to calculate his nutritional needs using the equation established by the World Health Organization (WHO) in 1985 and nutritional recommendations (Heuclin *et al*, 2002). The equation of WHO calculates the energy needs for a person from his age, his weight W (in kg) and his sex:

<u>Man</u>	18 - 30 years	kcal/day = 1.7(15.3W + 679)
	> 30 years	kcal/day = 1.7(11.6W + 879)
<u>Woman</u>	18 - 30 years	kcal/day = 1.6(14.7W + 496)
	> 30 years	kcal/day = 1.7(8.7W + 829)

The nutritional recommendations were established to provide for people needs during a maximum mission length of 360 days in the International Space Station (ISS). They are visible on the figure 4.

In the database, information concerning the members of the crew is dissociated from information on the nutritional recommendations. The members are stored in a table “member” whereas the recommendations are in the table “nutrition”.

The table “nutrition” is an “hybrid” table because it allows storing different information. Here the nutritional recommendations are stored. Further, the nutritional contributions will be also stored, as well as the biodisponibility of the food nutriments. This concept of “multi-direction” table is not very correct. In theory, it would have been necessary to dissociate all these aspects to obtain a clearer and more readable basic structure of data. However, this table “nutrition” has more than 40 fields and is thus very bulky. The creation of three different versions of the same table would not have been an optimal solution in term of space.

4.2 Ingredients

As defined earlier, there are several categories of ingredients. This classification is also found within the structure of the database where a table was created for each category of ingredient.

4.2.1 FRESH PLANTS

They are produced from the IV-b compartment of the MELiSSA loop. Only nutritional information is significant for this type of ingredient. However in forecast of a further management of ingredients stock, supplementary information was added:

- the harvesting index is the percentage of the plant which is stored after harvest.
- the time of harvest corresponds to the total time of culture.
- the mass and energy refer to the mass and power consumption of the instrument controlling the conditions of plant culture.
- the light energy is the quantity of light necessary for the development of the plant.

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All these data are stored in the table “fresh_crop”.

4.2.2 STABILIZED INGREDIENTS

These ingredients are produced from fresh plants.

Two parameters are stored in the table “stabilized materials”: the working time necessary to transform a fresh plant into a stabilized ingredient and the name of the fresh plant used in this transformation. The table “nutrition” gives nutritional information. Additional information is stored in other tables such as the name and the operating time of the machines used for the transformation.

4.2.3 PRODUCED INGREDIENTS

The information stored for this type of ingredient is the same as that stored for the stabilized ingredients excepting that a produced ingredient is obtained from a stabilized ingredient and not from a fresh plant. The name of the table is “processed_ingredient”.

4.2.4 ADDITIONAL COMPONENTS

A few information such as its composition and the mass of packing is stored for this category of ingredient in the table “resupply_item”.

4.2.5 UNUSED INGREDIENTS

These ingredients are produced in excess during the manufacture of a dish and can be used for another dish. Except its composition, the mass of packing once the ingredient is produced is the only information to be managed. As the information required for an unused ingredient is the same as for the additional components, the same table “resupply_item” was used. Hence, for data processing, the unused ingredients are considered as additional components.

Another table named “input” was created to reference the unused ingredient and the recipe that produces it. This is useful when an unused ingredient is necessary in a dish, to take account of all the production steps of this unused ingredient in the calculations of the new recipe.

4.3 *Machines*

A great number of information is stored for each machine in the table “machine”. Even if everything is not yet used for calculations, new calculations can thus be added. The stored data are:

- power and voltage necessary to the operation
- heat produced, oxygen uptake, production of carbon dioxide
- mass, volume and surface of the machine
- period of maintenance: the number of days between two revisions of the machine
- maintenance time: time spent for the revision of the machine.

The operating time of a machine is stored in other tables: the table “to_need” for the machines that transform fresh plants into stabilized ingredient and stabilized ingredient into produced ingredient, and the table “to_operate” for the machines used in the production of a dish.

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4.4 Dishes

Information on the dishes is the most significant. Several calculations can be carried out from this data: working time, nutritional contribution... Different tables are necessary to suitably store this information.

A dish is elaborated from a recipe. Each recipe uses ingredients that are transformed with machines. Waste and sometimes unused ingredients can be produced. In addition to all this information, it is also necessary to store the working time, to choose a category, to define its composition and to give the values of bioavailability for the nutrients.

The quantity of information is rather significant. The instructions of recipe and the information on the dish are respectively stored in the tables "recipe" and "dish". The different kinds of ingredients and the machines have their own tables. Links have to be created between the recipe and these objects. For the ingredients, the link is the table "to_use" which references all the ingredients used in a recipe with the required quantity. As there are several kinds of ingredients (fresh plant, stabilized ingredient...), this table must also specify the type of ingredient used in the recipe. The link with the machines used in the recipe is made by the table "to_operate" where the operating times are stored.

All the produced wastes are recorded in the table "to_produce" with their quantity.

4.5 The planning of menu

One of the aims of the database is to simply conceive a planning of menu over several days. The scientific literature on the subject estimates that a planning over ten days is correct to ensure a good cover of the needs and a sufficient variety for dishes (Cenci-McGrody and Stiller, 1997). The database must thus store a whole of dishes in order to establish menus over a ten days period. This information is present in the table "planning".

Each day comprises a maximum of four menus: a breakfast, a lunch, a dinner and a break. Each menu can contain a non-limited number of dishes, each dish being proposed only once. The quantity for each dish is also stored. This information is found in the table "menu".

5 CALCULATIONS CARRIED OUT

All the information of the database is the basis to carry out many calculations. The detail of these calculations allows understanding how the information of the database is used

5.1 Nutritional needs

It is the most significant calculation as it allows knowing if the defined planning suitably covers the needs for the selected crew. The cover of the needs is calculated for each element of the list of the nutritional needs (figure 4), which represents more than one forty operations on the whole.

The first step consists in calculating the needs for the crew, by summing the needs for each member of the crew. The equation of WHO is applied to each member in order to estimate the energy needs. The nutritional values for the other elements correspond exactly to the values defined by the nutritional recommendations for a space flight of long duration (figure 4).

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The second step is to calculate the nutritional value brought by all the menus proposed for each day. Each menu comprises a series of dishes. Each dish is defined by its proper composition with the biodisponibility of the nutriments, and is proposed in a definite quantity. The nutritional value brought by each nutriment is obtained by multiplying the mass fraction of the nutriment by its percentage of biodisponibility and by the specified quantity. When the biodisponibility is not known (vitamin C for example), the default value is 100%.

The last step allows to compare the needs for the crew with the nutritional contributions of a one day menus (Hsiang *et al*, 2000). A histogram plotting the brought quantities versus time is created for each nutritive element. The minimal and maximum values relevant to this element are also placed on the graph. More than forty graphs are thus generated only for the calculation step of nutritional needs.

5.2 Calculation of mass

As already stated, the mass of the machines used to prepare the dishes is also a parameter to be considered. A space flight can carry on its board a limited mass of equipment.

This calculation primarily consists in indexing all the machines used for the design of the dishes in a ten days planning and for a given crew. The only value necessary to calculation is the name of the selected crew. In the database, this name is associated to a planning of menus by the table “planning”, then to the whole of menus in the planning by the table “menu” that is connected to the dishes included in the menus by the table “dish” and finally to the machines associated with these dishes by the table “to_operate”. The fields “mass” of the table “machine” are summed to calculate the mass relevant to a particular planning.

If the same machine is used more than once throughout a planning, its mass is entered once only.

5.3 Energy consumption

The user defined an operating time for all the machines used during a planning. Knowing the power characteristics of each machine, it is easy to calculate the quantity of energy consumed by a machine during operation. The search for all the machines used per day for a crew is exactly the same as for the mass calculation. The results are presented in a histogram.

5.4 Time

The “man time” spent to the preparation of the dishes is drastically limited and greatly influences the creation of a planning. The calculated time is the sum of the different periods necessary to the preparation of the dishes. This information is stored in the field “total_time” of the table “dish”. The sum of the make-ready times for each day is presented in a histogram.

5.5 Quantity of waste

The waste produced by the development of the various dishes must be recycled by the MELISSA system. It is thus necessary to take into account this parameter in laying up a planning of menus.

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In the database, the quantity of waste generated by the preparation of a dish is stored in the field “quantity” of the table “to_produce”. Calculation consists in seeking all the dishes used in a planning of menu and to sum the quantities of waste relevant to. The whole of the results is also presented in a histogram.

6 SOFTWARE TOOLS USED

6.1 Database

A database is always delivered with its system of management. For this reason the term “database” often gathers the database and the system of management (DBMS).

There are many databases in the data-processing world, each one with particular characteristics. The two great free databases available on Internet are named: MySQL and PostgreSQL. Considering the performances, PostgreSQL is more powerful, nevertheless for reasons developed further, MySQL system was retained.

6.2 EasyPHP package

The development of an interface was justified in chapter 2.3 and the PHP language was selected to carry it out. The operation of PHP language needs a server, as explained in chapter 2.3. Currently several free servers exist on the Web and one of them was chosen: Apache.

To build the database and its interface, we thus need MySQL, PHP and Apache. These three tools are free distributed in a “package” entitled EasyPHP. This software deals with all the operations of installation and configuration of the three tools and offers other interesting additional tools to manage databases more easily. Hence, our choice of the database was also guided by the fact that MySQL is the only system provided in the form of a “package” with PHP and Apache. The use of PostgreSQL would have required an independent installation of PHP and Apache, which is not free of problem.

6.3 Other tools

PHP language allows developing an interface that looks like an Internet site. Its only disadvantage is to function in the dimension of the server, that is the display of new information to the screen inevitably depends on a reload of the new Internet page. These operations of update can be numerous in certain cases, and consequently the interface quickly becomes “heavy” to use. For example, let us take a page containing two lists of words, one being full and the other one empty. Between these two lists, a button allows to transfer the words from one list to the other. If the page must be brought up to date with each action of transfer, the handling of data will be drastically slowed down.

To mitigate this problem, we use the Javascript language, a customer language. The navigator of the user interprets this customer language and carries out the operations asked to the server. This leads to a saving of time and the interface is more pleasant to use.

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7 “MELISSA DATABASE”

It is the name chosen for the interface of the database.

The aim of this interface is to allow a fast insertion or suppression of the data. Calculations are carried out automatically and the interface is designed to obtain a chart of the data stored in the base.

It has a structure in “cascade” or “layer”. The majority of the pages allow to handle elements; if a desired element is not present, a link opens the page allowing to create it from a whole of elements; if an object misses in this new unit, another link gives access to a new page...

7.1 *Management of the crews*

The first page loaded when starting the interface is the page used to manage the crews present in the base (figure 5). As for all the pages of the interface, a tool bar is present. The tools are designed to create a new crew with a new name and to remove or modify the contents of an existing crew.

The page references all the crews defined in the base with an interactive list of names. Each name can be selected in order to carry out an operation (suppression, modification on this crew...)

When a crew is selected, it is also possible using two other tools, to access to the page of calculation (“calcul”) or to the page of planning creation (“menu”).

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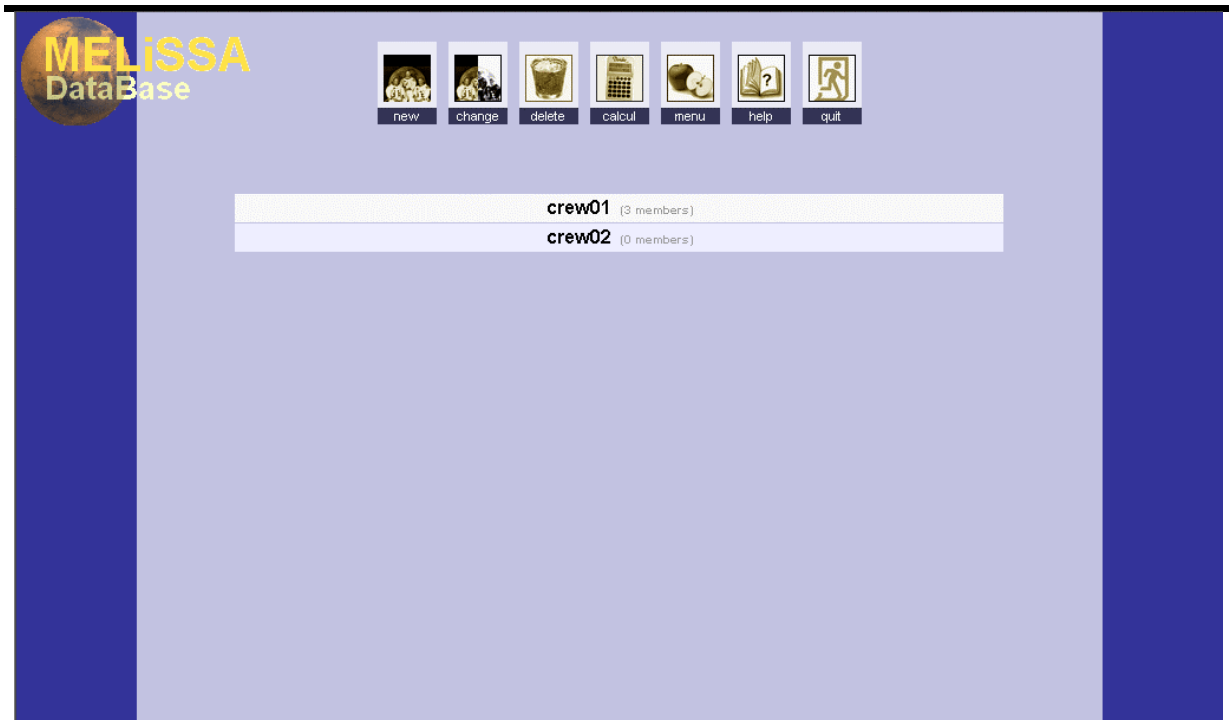


Figure 5 : Outline of the page of management of the crews

Once a new crew is created, the interface automatically directs the user towards the page of management of the members of the crew.

7.2 *Management of the crew's members*

This page lists all the members of the selected crew (figure 6). For each member a “record card” specifying information of the table “member”, such as the sex, the weight, the size and the age, is available. These cards can also be selected.

This page is used like the page of management of the crews. The tools of the bar allow creating new members. When a member is selected, it is possible to modify information relating to it or to remove it.

An additional tool allows displaying a new window with the list of the needs for the selected member. The values are calculated from the equation of WHO and from the nutritional recommendations (figure 4).

Once the creation of the members is finished, it is necessary to return to the page of crew's management (figure 5) to access to the creation of a planning of menus.

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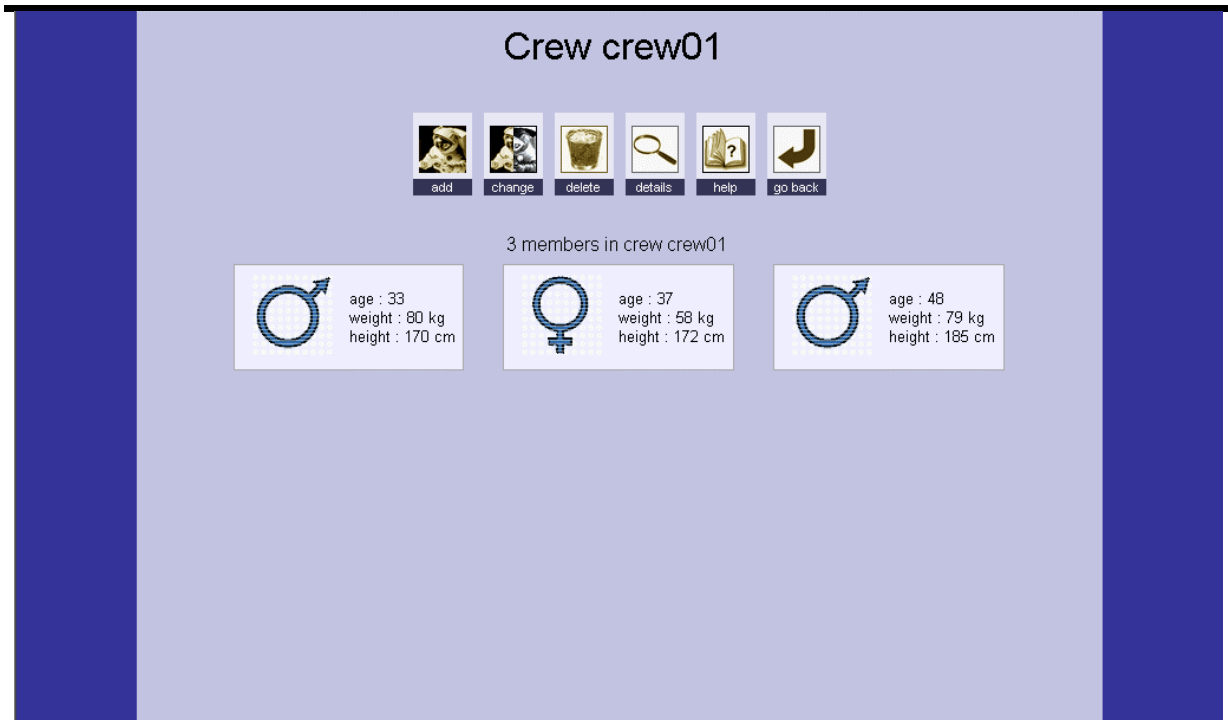


Figure 6 : Outline of the page of management of the members of the crew

7.3 Management of a planning of menus

In this page the user can simply define a planning of menus over 10 days, with four menus by day. The quantity of information to enter in the database for this step requires a flexible and fast interface. The developed interface allows storing all these data on the same page. An outline of this page is given in figure 7.

In top of the page a row of fields is numbered from 1 to 10. Each field represents one of the ten days planning. When a day is selected, the content of each menu is displayed in four lists (breakfast, lunch, pause and dinner). Another list on the left indexes all the dishes stored in the base. By this way, the user can very simply create a planning. He selects one day, a menu and a whole of dishes, which is transferred in the selected menu using a button.

Various tools were added to facilitate the operations of increase or reduction in the quantity of selected dishes.

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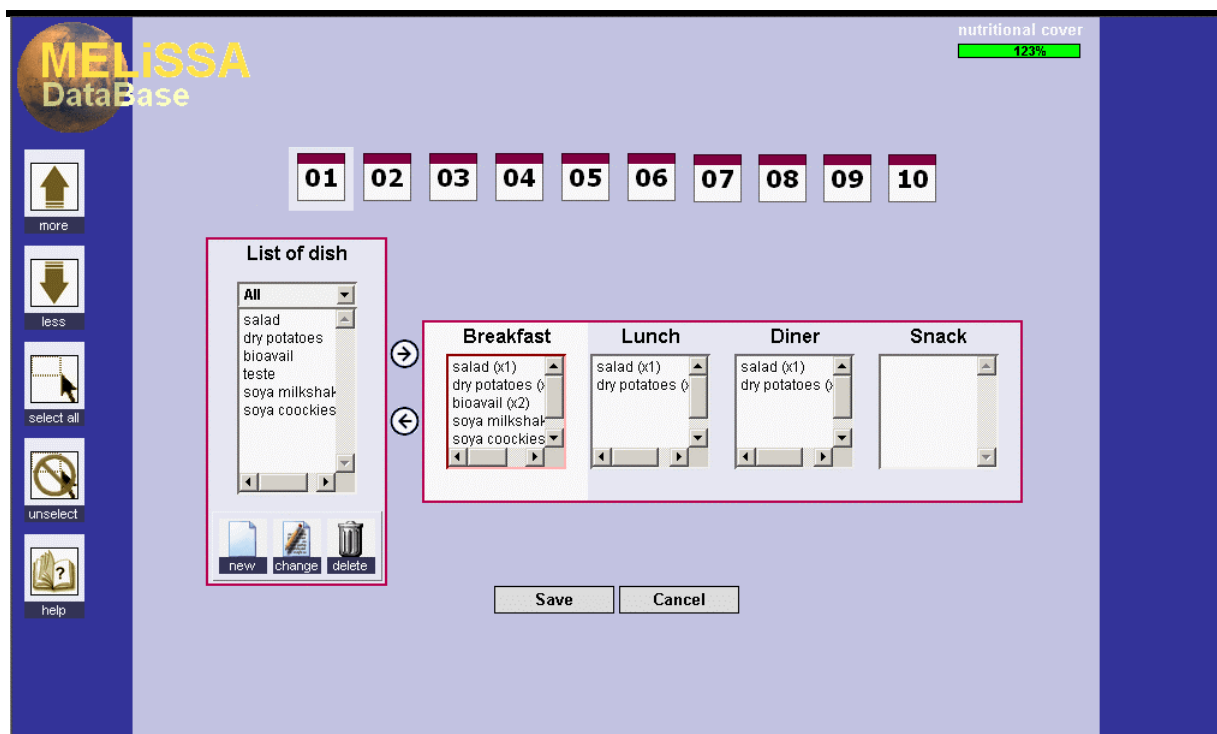


Figure 7 : Outline of the page of management of the planning of menu

Though the manipulation of data on this page appears simple, its realization required a thorough training of the Javascript language. The use of Javascript allows to create a page and to define a planning without any reload of this page. When the user creates his planning, Javascript stores all the information. Once finished, the action of the button “Save” indicates to Javascript to send this information to the server, where PHP stores it in the database.

Another element of the page is also entirely managed by Javascript : the bar “nutritional cover” located in top on the right (figure 7). It indicates the cover rate of the needs for the selected day. For example a value of 50% signifies that the planning for the selected day covers half of the needs for the crew. With each modification of the planning, Javascript automatically recomputes this value in real time. This tool helps to more precisely define a planning according to the cover of the needs.

To define a planning of menu, it is necessary that several menus are pre-existent in the base. From this interface, it is always possible to add or modify dishes in the database.

7.4 Management of the dishes

The use of the interface in the creation of dishes requires training. An outline of this page is visible on figure 8. In reality, a dish is prepared from a recipe. A series of ingredients is transformed according to precise steps and using various instruments. In the database, only

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useful information relates to the unused ingredients, machines, waste and ingredients. The order of use of the ingredients and the precision of the steps are not to be stored.

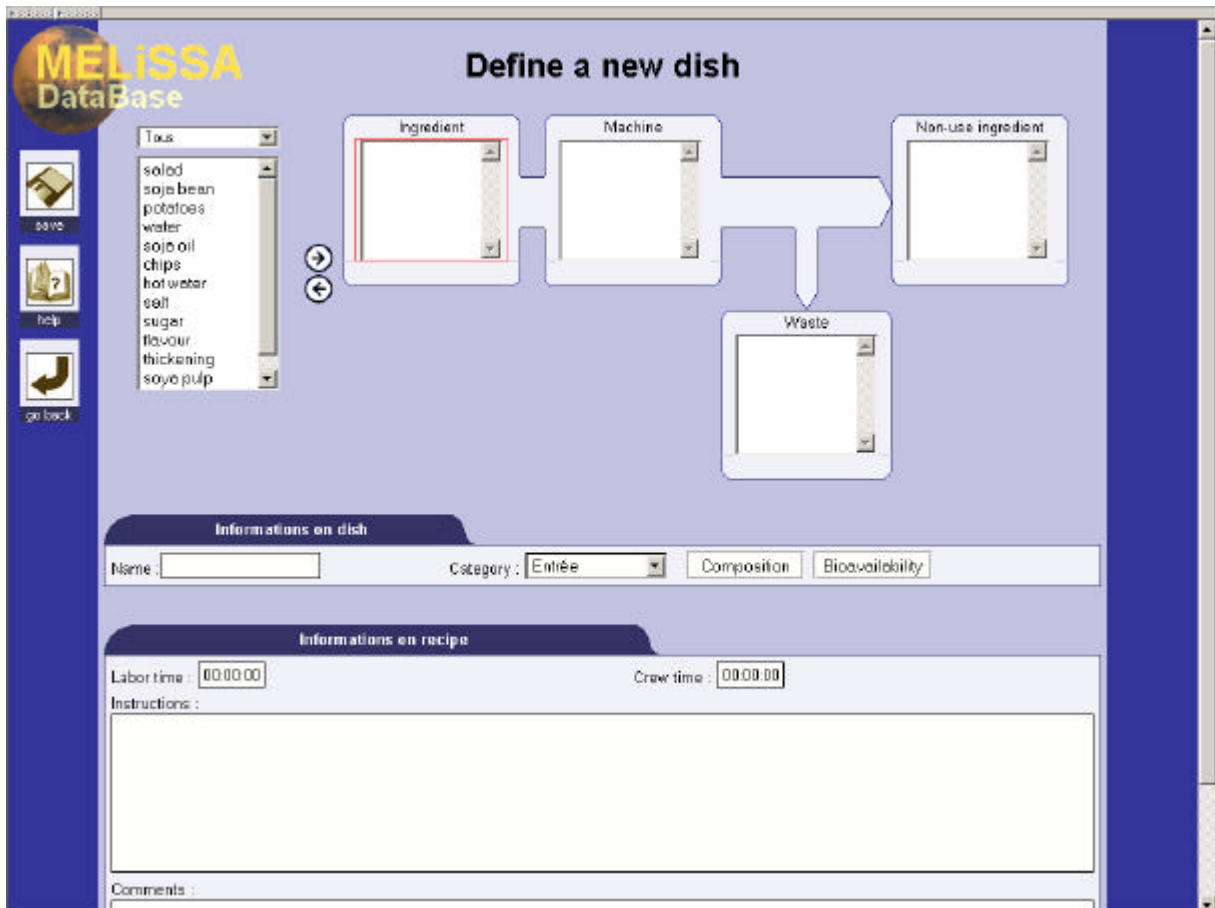


Figure 8 : Outline of the page of creation of a dish.

In order to more precisely illustrate the function of this part of the interface, we will develop an example: the manufacture of Soya milk shake.

The manufacturing process detailed in figure 9 results from a series of rather complex processes transforming Soya beans into several dishes (cookies, milk...).

The milk shake production is based on hot water and Soya beans. The whole is ground and filtered. The pulp of Soya obtained from these operations will be used in another process. The remainder (filtrate) is added to a series of ingredients (Soya milk, sugar, thickener, flavor) and is mixed before being bottled and sterilized.

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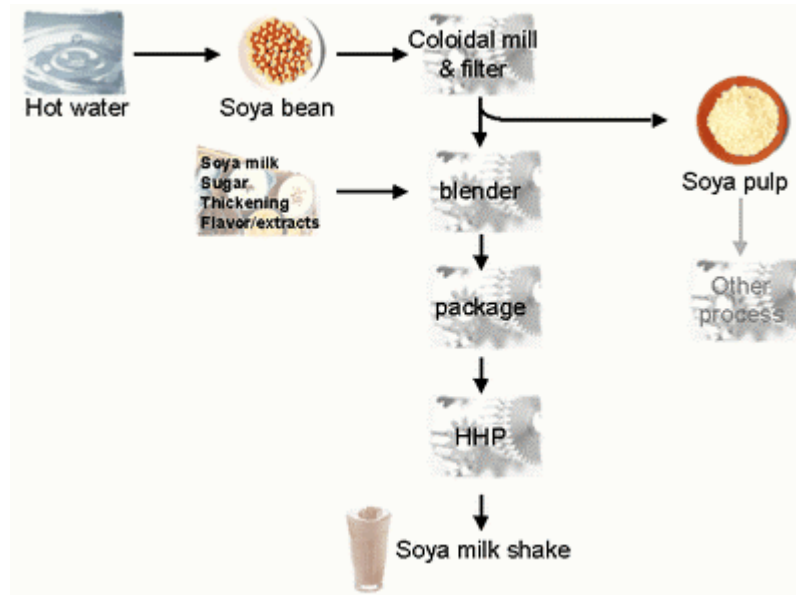


Figure 9 : Production process of Soya milk shake

All the information of this recipe is not stored in the base. The first step consists in gathering this information by category. Among the ingredients, we will place Soya beans, hot water, Soya milk, sugar, thickener and flavors. Four machines will be used: the crusher, the filter, the mixer and the sterilizer. No waste is produced and only the pulp of Soya is regarded as an unused ingredient. The step of setting out in bottle is not taken into account because no machine is necessary; nevertheless the time spent for this operation will be counted in the crew time and in the total time.

When ingredients and machines are defined, the process is reproduced using the categories of the interface (figure 8). Four lists relevant to four categories are opened: ingredient, machine, waste and non-used ingredient. The whole schematically represents a recipe: ingredients are transformed with machines to produce unused ingredients, waste, to obtain a dish. The operation consists in selecting one of the lists, finding the elements in the general list on the left, and transferring these elements in the selected list. The last step consists in filling the end of the form to give a name to the dish, to add instructions and comments. In this way it is possible to create a dish very quickly, the most difficult step being to determine the adequate category for each element.

On this page the composition and the biodisponibility of the dish can be specified. A button is used to open a new window to give a value for each nutriment defined by the nutritional recommendations. An outline of this new window is given on figure 10. Different tables contain the values of composition and biodisponibility used for the further step of calculations.

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The screenshot shows a Netscape browser window with the following content:

Energy

Energy		kCal
Protein		kCal
Carbohydrate		kCal
Fat		kCal

Fluid

Fluid		mL per MJ
-------	--	-----------

Fat-soluble vitamins

Vitamin A		µg retinol equivalents
Vitamin D		µg
Vitamin E		mg a-tocopherol equivalents
Vitamin K		µg

Water-soluble vitamins

Vitamin C		mg
Vitamin B12		µg
Vitamin B6		mg
Thiamin		mg
Riboflavin		mg
Folate		µg
Niacin		mg niacin equivalents
Biotin		µg
Panthenic acid		mg

Figure 10 : Outline of the window : definition of the dish composition

7.5 Management of new ingredients and machines

To cook of a new dish, new ingredients and machines must be necessary. The following describes how to create these new elements. All the forms relevant to can be loaded from the page “define a new dish”.

7.5.1 SIMPLE FORMS

Simple forms are used for the definition of new fresh plants, additional components, unused ingredients, machines and waste. An example is given in the figure 11.

A list of all the elements of the chosen category (for example machines) is displayed and can be selected. The characteristics are displayed in a table and can be modified by the user. The “new” button allows the user to create a new element in this category with its proper characteristics. The modifications and creations are saved in the database using the “save” button in the tool bar.

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MELISSA DataBase

List of machine

- washer
- boiler
- chopper
- blender
- drier
- extracter
- coloidal mill & filter
- HHP

Machine

Name	blender	
Energy	2	kW
Voltage	380	V
Heat generation		kJ
O2 Consumption		L/h
CO2 generation		L/h
Mass	60	kg
Volume	0.1	m3
Surface	0.81	m2
Maintenance period	30	days
Maintenance crew time	00:30:00	
Informations : This machine is used in 3 dish.		

Figure 11 : Outline of a simple form to create a new machine

7.5.2 JAVASCRIPT FORMS

These forms have been developed to create or modify information concerning stabilized materials and produced ingredients. The stabilized materials result from fresh plants and the produced ingredients from stabilized materials. Obtained from another ingredient, these two types of products are more complex to manage than the basic ingredients. An example of the form developed in this case is given in the figure 12.

The page presents a drop-down list to select the ingredient of origin, another list to select the machines used, and a text box for the name of the new ingredient. The buttons “Add” and “Remove” provide help to select or to remove the machines used during the process. For each machine inserted in the list, an operating time must be given: a double-click on a machine displays a text box to register this data. Additional information such as the composition and the working time can also be recorded.

Javascript manages all of these rather complex operations.

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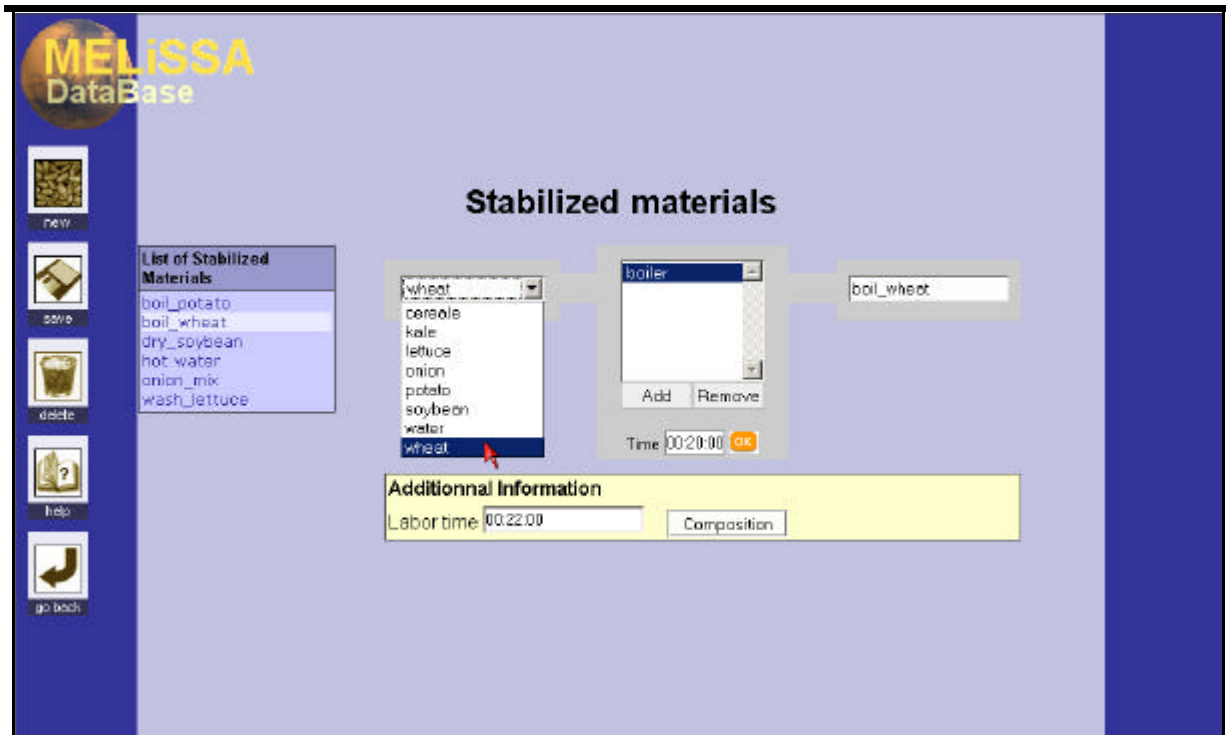


Figure 12 : Outline of a Javascript form for the creation of stabilized ingredients.

7.6 Step of calculation

Once the planning of menu is defined for a given crew, the step of calculation is executed. Depending on the composition of the crew, a series of calculation is specific of the selected crew. On the page listing all the crews (figure 5), the button “calcul” gives access to the required page. This page is given in the figure 13.

On this page more than one forty graphs are gathered. The required graph is selected using a button or a key word. The use of Javascript allows displaying a single graph, the others being invisible. The other advantage to work with Javascript is the gain in processing speed. The total time of calculation and display for such a number of data is about ten seconds on a recent computer. Without the help of Javascript, a graph would have been calculated at each new request. With Javascript all the graphs are calculated and stored in memory before the display of the page. The time of access is thus about ten seconds but after, the display of each graph is instantaneous. The interface is then much more reactive for the user.

Each histogram present on this page is a HTML element, that is text inserted in colored tables. The generation of images would have offered the possibility to save them, but the computing time would not have been acceptable. The creation of HTML histogram instead of image does not change the precision of the graphic and the quality of the result.

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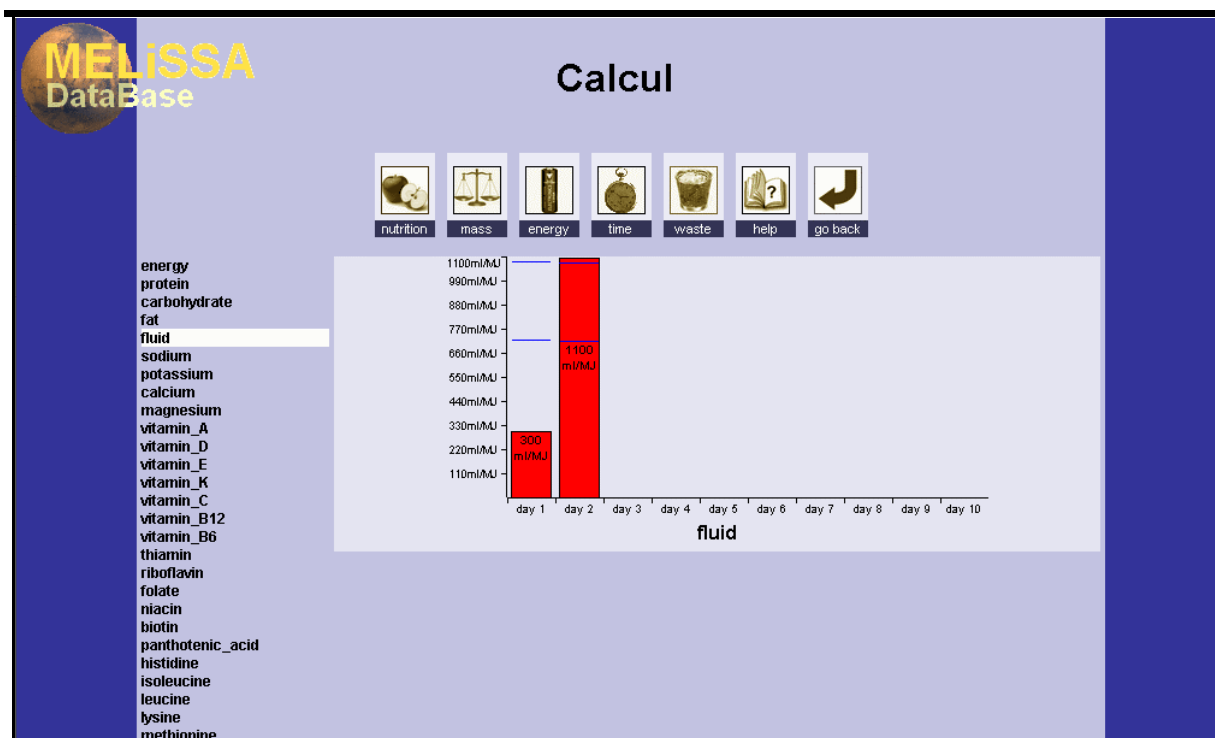


Figure 13 : Outline of the page of calculation

7.7 Help section

Help files were created to give assistance to the user during the use of the interface. The help can be asked from each page of the interface; it concerns the operation of each page, each button and each possible operation. Some examples are also given.

The help is stored in an hundred of files, each one devoted to a particular point. To facilitate the navigation among all these files, three modes of use are available. Each mode displays the same type of screen: the left part is reserved to the research mode and the right part loads the expected help file (figure 14).

7.7.1 NAVIGATION BY PLAN

It is the default mode of navigation. It shows a general plan made up of various chapters. Each chapter contains sub-chapters or help files. The search for a file is thus carried out by progression: a general topic is initially selected before consulting the detail.

7.7.2 NAVIGATION BY KEY WORD

This mode presents a zone of text with a drop-down list of specific terms. Typing a word in the text zone automatically selects the nearest word in the list. A double-click on a word of the list displays the associated help file. This method of research is often the faster as it avoids knowing the hierarchy of the help files.

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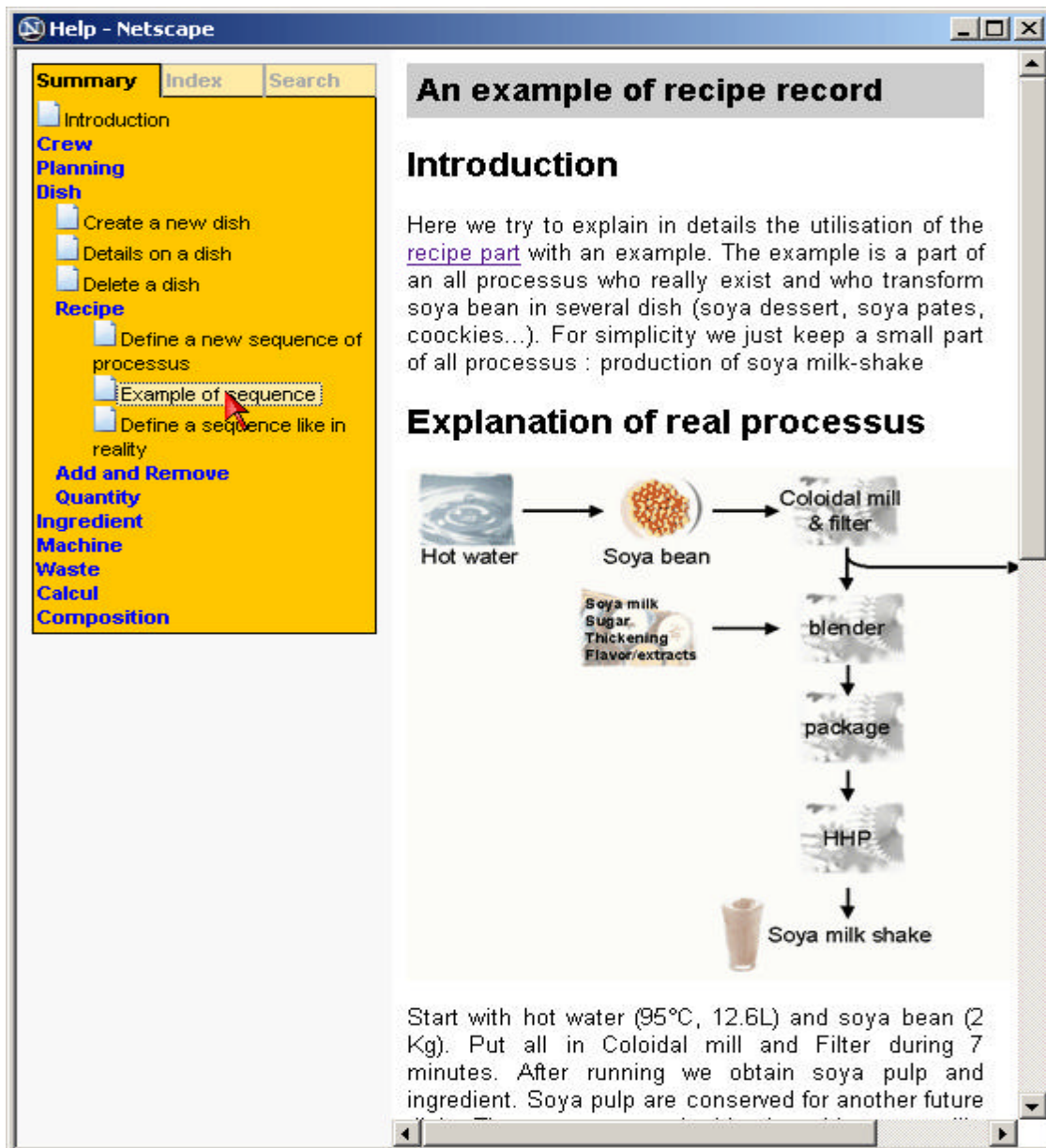


Figure 14 : Window of assistance in the navigation mode by plan

7.7.3 NAVIGATION BY RESEARCH

It is similar to the mode of navigation by key words except that the list is initially empty. Typing a word in the text zone automatically launches a research in all the help files. Finally, the list contains all the files comprising this word. The files are sorted by decreasing occurrence of the required word. This mode allows finding information rather quickly if the required word is not too widespread.

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7.8 Closing of the database

The interface is closed using the button “quit” located on the page of management of the crews (figure 5). At this time, all the tables of the database are updated. When many operations of insertion and suppression of data are carried out on a table, a loss of disk space can be displayed. To mitigate this problem, the database management system of MySQL executes a special function to remove this loss of space. This operation is thus carried out on all the tables of the database in order to optimize the size of the base.

8 CONCLUSION

In this preliminary study, we try to build the structure for a nutritional database according to the constraints brought by the MELiSSA loop. The interface is now functional and rather easy to use. The next step is to collect data to fill all the fields: nutritional characteristics of fresh plant, nutritional and biodisponibility data of dishes, recipes, menus...

Actually, the base allows the creation of ten days planning for a crew, and computes the nutritional value resulting from this planning. Besides this basic functionality, a number of improvements can be considered.

To save time and to optimize the development of a planning, the system would be modified to build a planning of menu automatically. On the basis of criteria not still defined, the computer would select the well-adapted planning among the whole possible solutions. The pre-requisite consists in defining the criteria to decide which planning is better than another one for a given crew.

Another parameter not yet taken into account is the number of dishes per meal. To let the computer solve this value should considerably increase the complexity of the problem. First, we will begin in fixing 4 dishes for each meal: an entry, a principal dish, a dessert and a drink or other. With 4 meals per day, we thus have 16 dishes per day, that is to say 160 dishes to be determined for each planning.

The creation of a planning gives the cover of the needs for a crew. Actually, these needs are regarded as constant. In a future development, it would be interesting to include the physical activities performed by the crew to balance the nutritional needs. According to the efforts carried out by the crew, the choice of the planning of menus would be much more adapted to the real needs of the crew.

The last improvement would consist in creating a stock management of the fresh plants, the unused ingredients, the additional components and the waste. This would highlight the feasibility of a planning with the real possibilities of operation of the MELiSSA loop.

The structure of the database was built according to all these possible improvements.

9 TECHNICAL OUTLOOKS

Before taking into account all these modifications, each step of the interface has to be tested with many data to detect and correct the possible bugs due to computer links. This step could

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be carried out by MELiSSA partners from the original CD given to ESA. This CD allowed to set up on PC computer, the free tools: EasyPHP, MySQL and Apache and the MELiSSA database (version 0).

After this step of analysis on the product, the MELiSSA database must be filled with pertinent nutrient data. The best way should be that only one official version exists in UBP with an internet access to MELiSSA partners with different levels of access authorization. This last point was necessary to keep a scientific guarantee to the main data (the nutrient composition of fresh plant, stabilized ingredients and produced ingredients) which have to be limited to the administrator.

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Aurora and MELiSSA : http://www.esa.int/export/esaMI/Aurora/ESA9CV0VMOC_0.html

MELiSSA : <http://www.estec.esa.nl/ecls/melissa/aboutmelissa.html>

Help on HTML, CSS, Javascript : <http://selfhtml.selfhtml.com/fr/index.htm>

Help on PHP : <http://www.php.net>

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