DEVELOPING AN INTERACTIVE INTERFACE FOR MICRO-MAGICS

Elisa Nishimura
Andre Battaiola
Gilberto Camara

CENTRE FOR WEATHER FORECASTS AND CLIMATE STUDIES
INSTITUTE FOR SPACE RESEARCH
BRAZIL

Jens Daabeck

EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

ABSTRACT

The MICRO-MAGICS product is a graphical system for meteorological applications on microcomputers. It is adapted from the MAGICS/GKS software system from ECMWF and includes a user-friendly interface and an animation module. This paper describes the main issues and concepts encountered when developing the interactive interface for MICRO-MAGICS.

1. INTRODUCTION

The development of graphical applications on microcomputers is a growing area in Computer Graphics. One such system is MICRO-MAGICS, a meteorological applications software package which is adapted from MAGICS (Meteorological Application Graphics Integrated Colour System). MAGICS is responsible for a major portion of the general meteorological graphics applications at the European Centre for Medium-Range Weather Forecasts (ECMWF).

MICRO-MAGICS is being developed by CPTEC (Centre for Weather Prediction and Climate Studies), a unit of Brazil's Institute for Space Research (INPE), under guidance from ECMWF.

The MAGICS software is an integrated collection of FORTRAN-callable subroutines, which operates in batch mode. When adapting MAGICS for the microcomputer environment, it was decided that an interactive layer would be built on top of the MAGICS software, making it user-friendly.
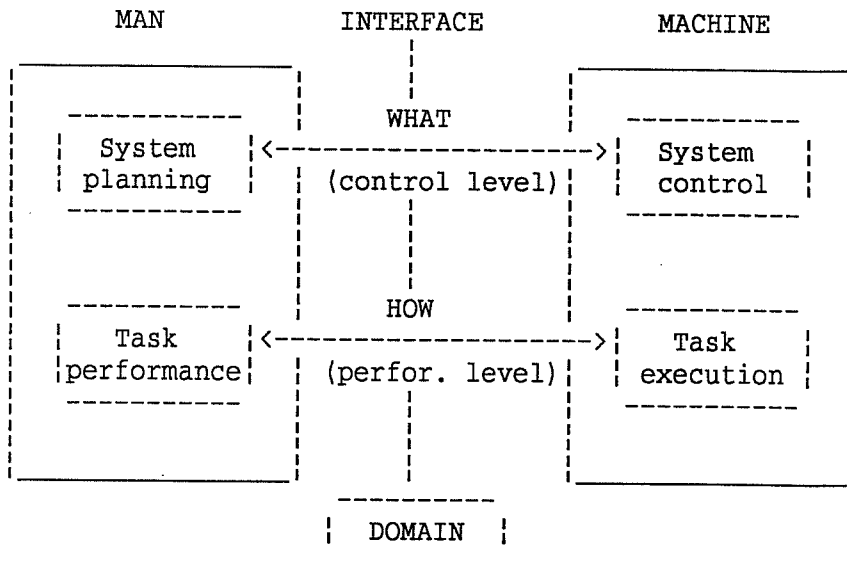
This paper discusses the development of the Micro-MAGICS interactive interface. In what follows, the general concepts used for the interface are described, followed by a its description.

2. GENERAL CONCEPTS

2.1 CONCEPTUAL MODEL

The interactive interface of MICRO-MAGICS is based on a conceptual model of a man machine-interface. The basis for the model is the separation between planning and doing, and the basic model involves a user who has a conceptual knowledge of how the computer system can be used by him to perform his specific task. The system designer has some idea of the user's behaviour, which he takes into account.

The model consists of two equal partners (a man and a machine), and a domain of application, and is divided into two levels. In the upper level, both parties are concerned with making a plan; at the lower level, they are concerned with automatically performing the plan. The upper level may be called system planning on the man's side and system control on the computer side. The lower level may be called task performance (on the man's side) and task execution (on the computer's side). The following diagram illustrates the model:

26

```
         MAN              INTERFACE           MACHINE
                              |
   _____            |           _____
  |              |           |          |              |
  |  _____  |         WHAT         |  _____  |
  | | System   |<----------------------->| System   | |
  | | planning | |    (control level)  | | control  | |
  | |_____| |           |          | |_____| |
  |              |           |          |              |
  |              |           |          |              |
  |  _____  |         HOW          |  _____  |
  | |  Task    |<----------------------->|  Task    | |
  | |performance| |   (perfor. level)   | | execution| |
  | |_____| |           |          | |_____| |
  |              |           |          |              |
  |_____|           |          |_____|
                          _____
                         |  DOMAIN  |
                         |_____|
```

2.2 APPLICATION TO MICRO-MAGICS

It should be noted that the existing MAGICS/GKS package
already uses the conceptual model presented above. In MAGICS/GKS,
the parameter selection is done independently of the actions,
therefore enabling the separation of the performance level from
the control level. The Micro-MAGICS user interface applies these
concepts in a more complete form.

3. CONCEPTS FOR MICRO-MAGICS INTERACTION

3.1 INTRODUCTION

The user's model of MICRO-MAGICS can be described in the following fashion:

> "A scientist has an _experiment_ or an _event_ he wants to visualize. The experiment consists of GRIB data, containing a time-_sequence_ of meteorological _variables_. The event consists of meteorological observational data in BUFR format. He may choose which variables he wants to _view_, and the computer will generate the desired charts.
>
> The scientist needs no special expertise. The system will enable a predefined set of parameters to be used for generating the plots. The scientist may _inspect_ and _modify_ the parameters, if so desired. He may also _retrieve_ another specification group.
>
> After the graphical plots are generated on his screen, he may _zoom_ and/or _animate_ the plots and change _display_ parameters.
>
> MICRO-MAGICS also supposes that the typical user is interested in a sequence of plots, on some previously defined set of conditions (parameters)."

3.2 METEOROLOGICAL CHARTS

In MICRO-MAGICS, each view of one (or more) meteorological variables is seen as a _meteorological chart_. A meteorological chart may consist of one or more _plots_ (enabling variables to be super-imposed).

MICRO-MAGICS enables the following types of charts to be generated:

- _Simple Charts_ when one or more meteorological variables are used: for example, a single 500 hPa pressure field or a joint U-V-Temperature colour wind plot;

- _Complex Charts_, which combine more than one graphical action; for example, a chart in which 500 hPa pressure is contoured and temperature is shaded.

28

MICRO-MAGICS enables one or more charts to be plotted on the output device.

3.3 SPECIFICATION GROUPS

An important concept in MICRO-MAGICS is the specification group, which contains all of the relevant information for the plotting of meteorological charts. Most of the commands on the interface layer are concerned with accessing and manipulating specification groups.

Two specification groups are associated to each plot:

- Action specification group: choice of the parameters for the graphical functions to be applied to the data. The graphical functions are:

  CONTOUR, SHADE, WIND, OBS, ISOTACHS, STREAMLINES, AXIS.

- Plot specification group: controls the output generation and associated information (including page lay-out, geographical area and map projection, text and legend).

3.4 KNOWLEDGE BASE

The domain of application is modelled with a knowledge base.   I n establishing the knowledge base, the user may build a number of different specification groups, which may be retrieved later.

The knowledge base also serves as an aid to the user, so that the effort for parameter selection is minimized. In practice, the knowledge base contains the set of all specification groups.

3.5 ANIMATION

MICRO-MAGICS enable the animation of a chart sequence. Due to the micro-computer limitations and to the planned extension of MICRO-MAGICS to handle images, animation will always operate with bit-mapped data (raster). Note that, until the IKS (Image Kernel System) standard becomes available, the implementation of slides and carousels will be device-dependent.

The animation is based on the <u>slide/carousel</u> idea:

- A slide is a bit-mapped representation of a chart, or of a combination of an image and a chart;

- A carousel is a sequence of slides.

The animation commands will control the order and the time difference between two slides. The user may also manipulate the carousel, to change the sequence and to disable the viewing of some slides.

3.6 SATELLITE IMAGERY

MAGICS/GKS does not yet handle images. However, it is only fair to suppose that within a foreseable future, MICRO-MAGICS could manipulate graphical and image data together. MICRO-MAGICS will be organized to aim at a future extension to handle images. For animation purposes, the graphical charts could be plotted superinposed on images, and saved to build a slide.

The following diagram illustrates the interaction concepts for MICRO-MAGICS.

MICRO-MAGICS enables one or more charts to be plotted on the output device.

3.3 SPECIFICATION GROUPS

An important concept in MICRO-MAGICS is the specification group, which contains all of the relevant information for the plotting of meteorological charts. Most of the commands on the interface layer are concerned with accessing and manipulating specification groups.

Two specification groups are associated to each plot:

- <u>Action</u> specification group: choice of the parameters for the graphical functions to be applied to the data. The graphical functions are:

  CONTOUR, SHADE, WIND, OBS, ISOTACHS, STREAMLINES, AXIS.

- <u>Plot</u> specification group: controls the output generation and associated information (including page lay-out, geographical area and map projection, text and legend).

3.4 KNOWLEDGE BASE

The domain of application is modelled with a <u>knowledge base</u>.   I n establishing the knowledge base, the user may build a number of different specification groups, which may be retrieved later.

The knowledge base also serves as an aid to the user, so that the effort for parameter selection is minimized. In practice, the knowledge base contains the set of all specification groups.

3.5 ANIMATION

MICRO-MAGICS enable the animation of a chart sequence. Due to the micro-computer limitations and to the planned extension of MICRO-MAGICS to handle images, animation will always operate with bit-mapped data (raster). Note that, until the IKS (Image Kernel System) standard becomes available, the implementation of slides and carousels will be device-dependent.

The animation is based on the slide/carousel idea:

- A slide is a bit-mapped representation of a chart, or of a combination of an image and a chart;
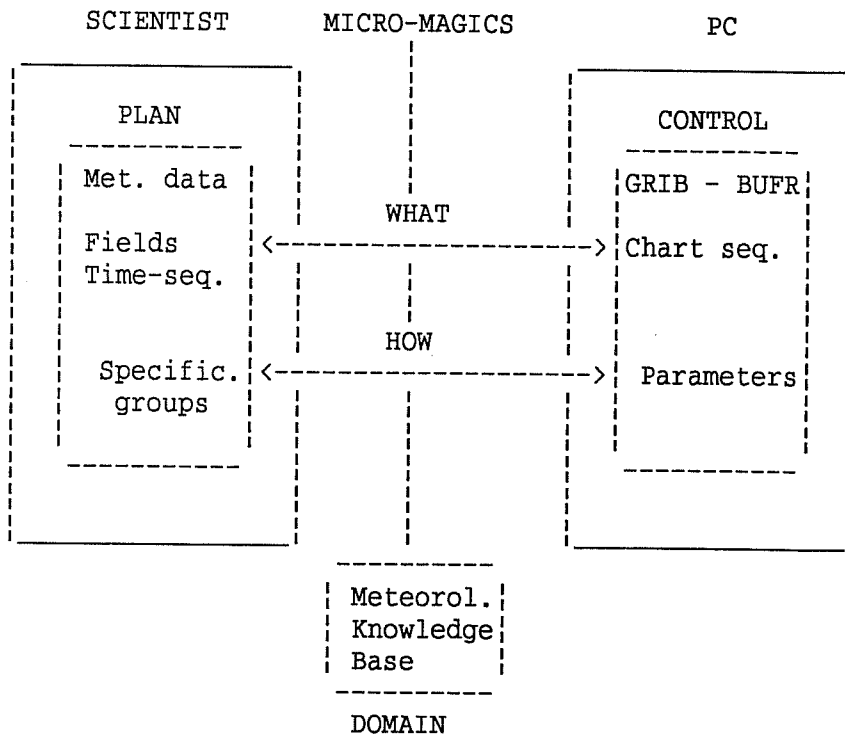
- A carousel is a sequence of slides.

The animation commands will control the order and the time difference between two slides. The user may also manipulate the carousel, to change the sequence and to disable the viewing of some slides.

3.6   SATELLITE IMAGERY

MAGICS/GKS does not yet handle images. However, it is only fair to suppose that within a foreseable future, MICRO-MAGICS could manipulate graphical and image data together. MICRO-MAGICS will be organized to aim at a future extension to handle images. For animation purposes, the graphical charts could be plotted superinposed on images, and saved to build a slide.

The following diagram illustrates the interaction concepts for MICRO-MAGICS.

```
          SCIENTIST        MICRO-MAGICS              PC
                                  |
   _____      |      |      _____
  |  _____  |    |      |     |   _____   |
  | |    PLAN       | |    |      |     |    CONTROL        |
  | |  ----------   | |    |      |     |   ----------      |
  | | Met. data   | |    |      |     | GRIB - BUFR |    |
  | |             | |    |  WHAT      |             |    |
  | | Fields      |<|----+-----------+>|Chart seq.  |    |
  | | Time-seq.   | |    |      |     |             |    |
  | |             | |    |      |     |             |    |
  | |             | |    |  HOW       |             |    |
  | | Specific.   |<|----+-----------+>| Parameters |    |
  | |   groups    | |    |      |     |             |    |
  | |  ----------   | |    |      |     |   ----------      |
  | |_____| |    |      |     |_____|
  |_____|    |      |
                            ----------
                           | Meteorol.|
                           | Knowledge|
                           | Base     |
                            ----------
                            DOMAIN
```

4. DESCRIPTION OF MICRO-MAGICS INTERACTION

4.1 GENERAL

The user interface in MICRO-MAGICS is composed of a set of menus. At each stage, a number of commands are presented on the top of the screen, and messages and questions use the two lowermost lines of the screen.

A MICRO-MAGICS command processor is responsible for handling the screen management facilities and for activating action processes as a result of user commands.

The interactive layer is composed of 4 command menus:

- The DATASEL menu, where the input data are chosen.

- The VIEW menu, where the graphical output is controlled.

- The PARAM menu, where the user may inspect or modify the parameter values of the specification groups currently in use.

- The UTILITIES screen, where general book-keeping and maintenance functions will be executed.

4.2 MICRO-MAGICS SCREEN LAYOUT

4.2.1 THE DATA SEL MENU

The DATASEL option enables the user to select the variables and for the animation sequence for visualization. In the DATASEL menu, four commands are available, corresponding to the 4 types of input data accepted by the system:

- GRIB: enables the selection of meteorological GRIB variables;

    For each meteorological variable (found in the GRIB files available) the number of time-steps, the initial time-step, the rate between time-steps, and the associated specification groups are listed.

- BUFR: enables the selection of meteorological BUFR variables;

    The variables are presented in relation to the synoptic time of assimilation.

- CHART: enables the selection of stored CHARTS, which are pre-generated plots.

- CAROUSEL: enables the selection of carousels.

The user may browse through the list and select which variables he wants to view. He may also select the desired time steps and change the specification groups. A listing of the specification groups is available on-line, at the user's request.

For each choice of a meteorological variable, the system will indicate:

- Which Action Specification Group is currently selected;

- Which Plot Specification Group is currently selected;

If the user selects more than one time-step for a given meteorological variable, MICRO-MAGICS will automatically assume he wants an animated sequence. A conflict may occur when the user selects more than one variable, at different time-steps. In this case, MICRO-MAGICS will consider only the latest choice as a valid one.

Some special cases may occur:

- Wind variables (U and V) are always shown to the user as a
  single variable;

- If the user wants to see wind arrows in colour, where the
  colour is given by the temperature, he must do so by
  choosing a specific specification group which indicates
  this choice. In this case, the temperature variable will
  have to be indicated by the user, by selecting it and
  choosing the same specification group.

4.2.3   THE VIEW MENU

Four options are available in the VIEW menu:

- CREATE CHART: a new chart (or chart sequence) is created
  and shown to the user. To execute this command, at least
  one meteorological field/observation (GRIB or BUFR) must
  be previously selected.

- VIEW CHART: a stored chart (or chart sequence) is viewed.
  To execute this command, one chart must be selected in the
  DATA SEL menu.

- CONTROL CAROUSEL: Enables the carousel editing. In this
  version, the user can inspect the contents of the carousel
  and remove any slide from the carousel.

- ANIMATION CONTROL: Control parameters for animation
  generation.

- ANIMATE: Animate the carousel selected by the user.

In order to create an animation sequence, the necessary
steps are:

- plotting and displaying each specific chart that composes
  the animation (using the CREATE CHART and VIEW CHART
  commands).

- saving each chart as a slide (bit-mapped file) and
  creating a carousel, which may be manipulated by the
  CONTROL CAROUSEL command.

- running the animation sequence, with the ANIMATE command.

In the CREATE CHART command, the user probably will have to wait a few minutes until the chart is created. The graphics takes the central part of the screen. The user may then issue graphical editing commands, described below.

After each chart is generated, MICRO-MAGICS will save it as a slide, upon user request.

The commands available in the VIEW screen are:

- ZOOM: Enlarges part of the chart. The area to be zoomed may be chosen by using the graphical cursor.

- FIT: Fits all the chart in the graphics area.

- ACTIVE: Activates/Deactivates some parameters such as: grid lines, coastlines, texts and meteorological variables.

The CAROUSEL CONTROL command shows the list of the carousels available and their contents. Using a set of keys, the user may:

- Delete a slide,

- Move a slide from one carousel to another,

- Copy a slide.

In version 1.0, the ANIMATION CONTROL command enables the user to control the saving of each chart for animation purpouses. Note that the default setting is that the system saves each chart automatically.

4.2.4   THE PARAMETER MENU

The PARAMETER menu enables the user to inspect and modify the plotting parameters for any of the current action specification group and the current plot specification group.

In what follows, the word current only denotes the specification groups chosen by the user at the DATA SEL menu.

The PARAM menu has the following options:

- ACTION SPECIFICATION GROUP - shows the list of parameters belonging to the current action specification group.

- PLOT SPECIFICATION GROUP - shows the list of parameters belonging to the current plot specification group.

- MODE - change the mode of operation from simple to complex and vice-versa. In the complex mode all the parameters concerned in the current action and plot will be shown. In the simple mode only a set of the most important parameters will be shown.

If the user has changed any parameter, he will be asked by the system if he wants to:

- Save the current specification group as a new one,

- Save as the same specification group,

- Discard the current specification group.

4.2.5   THE UTILITIES MENU

The UTILITIES screen contains most of the house-keeping activities, such as:

- Transforming a simple array into a GRIB file.

- Transforming a simple set of meteorological reports into a BUFR file.

- Generating a new GRIB file from two fields on different GRIB files.

- Deleting a file from the user's directory.

- List of specification groups (and associated description).

- Creation of a new specification group.

There are some utilities considered as optional, which will be made available if project development time allows. These are:

- Generating a new GRIB file of coarser resolution based on a finer resolution GRIB file.

The list of the specification groups will be presented to the user with the following options: ACTION SPECIFICATION and PLOT SPECIFICATION. Each specification group will be followed by a descriptive text.

5. CONCLUSIONS

The MICRO-MAGICS interface is a useful feature for MAGICS users, in that it offers to the user a friendly way of generating meteorological charts. In its design, a cognitive model for man-machine interaction (already present in MAGICS/GKS) was used.

A natural future direction for MICRO-MAGICS is to migrate it to a 32-bit workstation environment, using UNIX. A possible path would be to use the X-Window interface software - which is establishing itself as a de facto standard - as a basis for the user interface.