SWISS METEOROLOGICAL WORKSTATION PROJECT

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The Swiss Meteorological Workstation is designed for meteorologists and forecasters at the SMI and at Swiss airports as well as for the in-house research department. During the last years, the SMI established a short range database (SRDB) for meteorological data accessible through NEONS. The Swiss Meteorological Workstation software is designed to map the generic data types of NEONS (point, image, grid and volume) into graphical objects (plane, graph, volume, sounding, text). For each of these graphical objects optimized viewing and animation modules will be realized.
The graphical user interface of the workbench software is divided into a main selection, a detailed parameter specification and multiple display windows. The main selection comprises modules for fast and easy visualization, efficient product generation and distribution, interactive manipulation of the weather element matrix and numerical forecasting assistance with checks based on empirical rules and artificial intelligence systems. Strong emphasis is placed upon an efficient Macro-mechanism for data visualization and forecast production.
The modular design of the software is intended for a good maintainability and expansibility from the developers point of view. The structuring of the interface according to physical weather element and the way of interaction worked out in cooperation with the meteorologists ensure the long term usability of the system.

1. INTRODUCTION

The Swiss Meteorological Workstation Project (or **metAP** for "meteorologischer Arbeitsplatz") is a long term project of the Swiss Meteorological Institute (SMI) raised in the context of the replacement of the mainframe computer architecture by a modern Client/Server architecture. The main goals of the metAP-project are a fast and easy visualization of weather data, the realisation of an efficient tool for forecast production and the integration of nowcasting methods.

In a first step the SMI split the huge functionality of the mainframe into several stand-alone applications. First, a long term database project was launched for archiving and retrieval of climatological data. Second, stand-alone applications for the visualization of satellite images, weather radar data, numerical weather products and point data from the Swiss automatic measuring networks (ANETZ, ENET) were realized. They are operative today. The production of the forecasts was split into two groups, due mainly to the dissemination facilities. About half of the forecast production functionality remained on the mainframe system, is still written with a crude text editor and sent off as TELEX mes-

sages. This mainly concerns the texts for radio stations, telephone readings and aviation. The other half of the forecasts evolved to desktop publishing (DTP) products, which are produced using FrameMaker™ and are distributed via FAX or as postscript files. This mainly concerns products for print media and special weather dependent customers (agriculture, tourism, gliding etc.).

The situation today is characterized by a rapid and ongoing change of the market for forecast products. Many new weather data offspring from successful research work, e.g. better numerical models, ensemble prediction systems (see the articles in this volume), expert systems for avalanche forecasts (*e.g. Schweizer* et al., 1994), nowcasting products etc. Thus in the present situation the forecasters are confronted with more and more data, more forecast products and warnings, more different computer programs. They have less time to evaluate the weather data properly and to think about the weather evolution (see also *Perby*, 1988). She/He asks for a speedy software with a simple to use, intuitive graphical interface, support in text generation and drawing.

The paper first discusses the data dissemination at the SMI. Next an overview of the forecasters working place and the interface concept of the workstation software (here called *metAP software*) is presented. The last section focuses on the macro mechanism.

2. DATABASE AND DATA DISTRIBUTION

2.1 Weather Centres in Switzerland

Switzerland is a mountainous country lying in the central part of the Alps. Its weather is strongly influenced by the orography and in general weather forecasting requires considerable local information and long term experience. The orography also influenced the cultural evolution and Switzerland today has four main tongues and a strongly federalistic political constitution. As a consequence the SMI is divided into three main weather centres (LWZ, CMG, CML), two offices at airports (FWZ, CMG) and a site for sounding rises (SAP, Fig. 1).

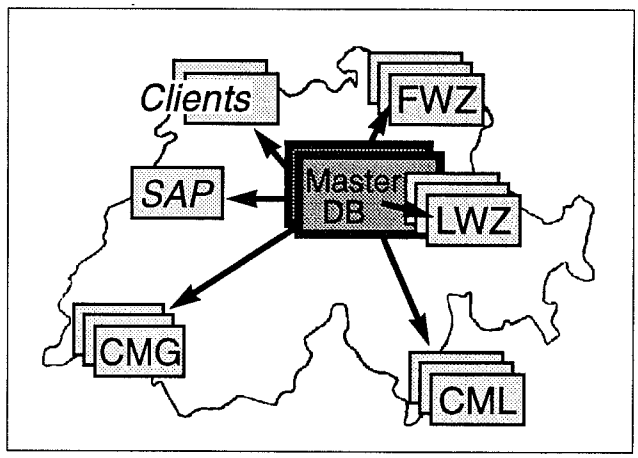

Fig. 1 Outline of Switzerland with main weather bureaus, offices on airports and sounding station. Shaded squares for master and client databases. Arrows for data dissemination.

The three weather centres produce forecasts and forecast products in German (LWZ), French (CMG) and Italian (CML). The medium and long range weather evolution is discussed twice a day in a common telephone briefing. This organization of the SMI imposes high demands on data dissemination.

2.2 Database and data dissemination

The SMI uses an EMPRESS RDBMS with a NEONS interface for data ingest and retrieval. There are two master systems running in parallel in Zürich (Fig. 1). From there the weather data are distributed to the client databases. The large amount of data, roughly 1 GByte per day, is at this time transferred by remote copy, but this will be changed to a more efficient IP-multicast distribution scheme in 1996.

2.3 Data formats

The NEONS data handling system is based on generic data types, thus presenting an abstraction of the many different forms of weather data to common, environment based formats. The generic data types used at the SMI so far are point data, image data, grid data and volume data. A new data type for forecasts, based on carefully defined geographic regions and specific weather parameters is under development. The advantage of the NEONS concept from the software point of view is the minimal set of browser and retrieval routines needed in the visualization software (Fig.2).

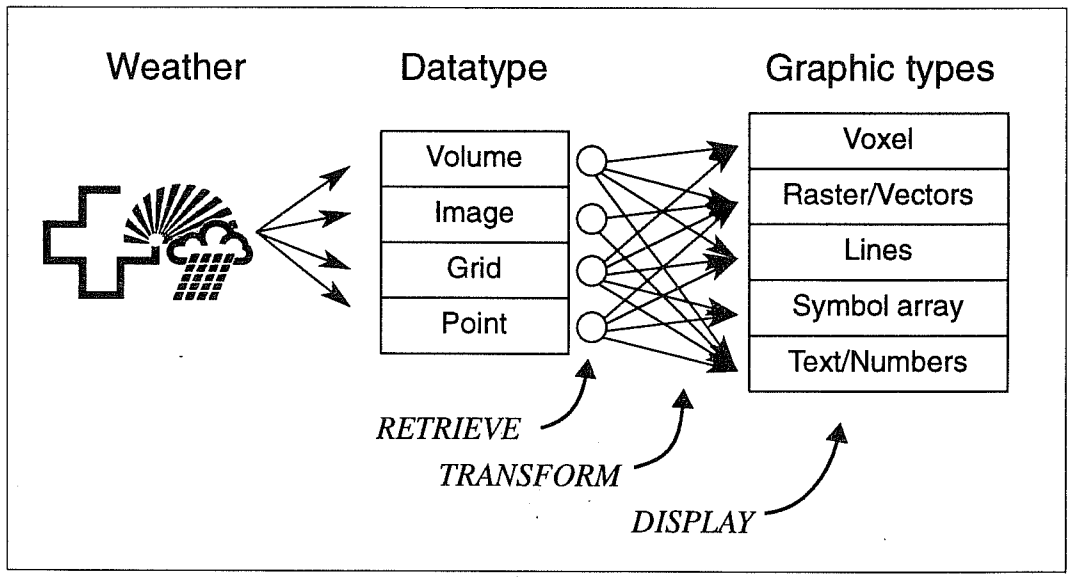

Fig. 2 Datatypes in the database and their transformation into graphic types in the meteorological workstation (metAP software). Note the relatively small set of retrieval, transformation and display/editing routines.

In the design of the metAP software (i.e. the Swiss Meteorological Workstation software properly) the concept of generic data types is carried further to the visualization (compare also *Brodlie* et al., 1992). The retrieved data is operated on by a set of pre-processing or transformation routines. This then leads to one of the five types of viewers that are used for display and editing of data (and eventually fore-

casts). There are viewers planned and partly realized for 3-D graphics (voxels), 2-D graphics (raster and vectors, meteo- and tephigrams), symbols (graphic elements, weather matrix) and Text (ideally with DTP functionality) (Fig. 2). In the development process a framework application, contributing the basic functionality of the metAP software such as the "Help", "Scheduling" etc., is realised. This framework can then be populated with the specific software modules for retrieval, transformation, visualization and editing.

This software design is independent of the interface the user is going to work with. In other words, the functionality of the metAP software can be realised, configured, maintained and expanded in a modular way.

3. METEOROLOGICAL WORKING PLACE

3.1 Forecasters main tasks

In the operational environment at the SMI there are forecasters and weather consultants. Today the consultants mainly handle telephone calls with customers and are doing end user forecast production with DTP programs. On the other side the forecasters properly do everything from the basic forecasts, DTP, interviews to specialized forecasts for aviation. Thus their working process not only consists of interaction with computers.

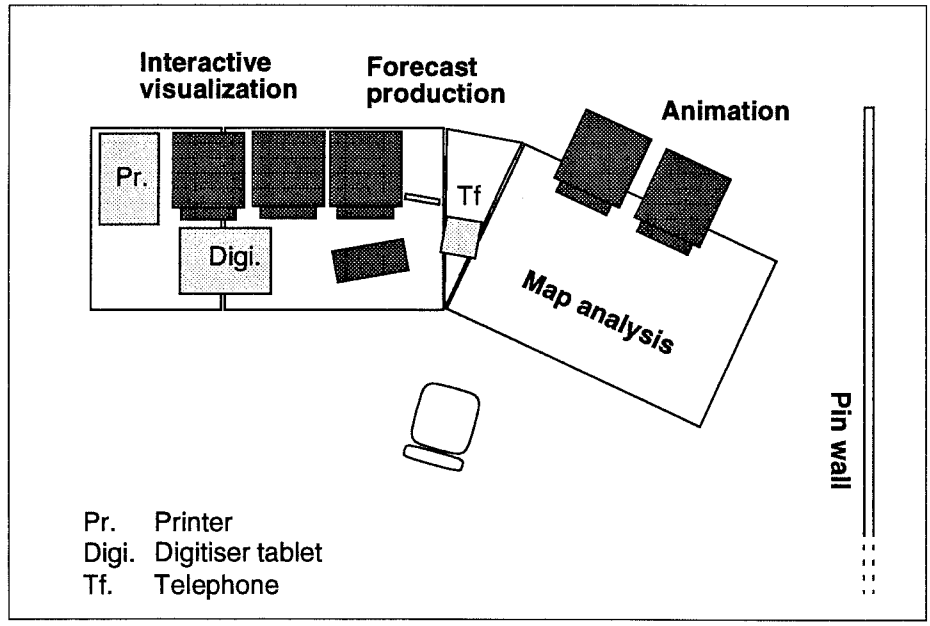

Fig. 3 Sketch of the place of work. Map analysis and the charts at the pin wall are important functions that need to be integrated in the working/forecasting process. The meteorological workstation (metAP software) is used in the interactive visualization, the forecast production and the animation (dark gray shading).

Figure 3 shows the main functions and organization at the working place. An important and very fast visualization and working tool is the paper output, used on the table for the weather map analysis and at

the pin wall. Paper won't be replaced in the near future, but its use needs to be optimized. Currently the map analysis is done by hand drawing on the synoptic map and allows the forecaster every three hours to actively work out an actual weather interpretation, i.e. to get a dynamic inner image of the weather situation and evolution. This analysis combined with visual cross-checks of the model output at the pin wall and the animated satellite and weather radar images provides the basis for a more detailed evaluation with help of the metAP software. Therefore the main focus of the metAP software properly is based on the interactive visualization of all sorts of weather data and the production of forecasts.

3.2 Ergonomic aspects

The arrangement of the different functional areas as shown in Fig. 3 places the forecaster in a central position. Sitting in the centre of the arrangement the forecaster writes/draws its forecast or is involved in interviews. In this position he quickly has access to the different sorts of data.

One of the main ergonomic requirements of the software running at the working place is a short response time. In general speed of operation of an application can be reached in several ways. It is dependent on the hardware used (question of budget), on the source code quality (question of software design) and it is dependent on the quality of the interface (question of error rate and ease of handling). The human computer interaction issues, i.e. the interface design and the macro concept, is discussed in more detail below. In our opinion it is worth developing an interface especially for forecasters (a domain-specific design, *Gulliksen & Sandblad*, 1995), which means, a graphical interface that is adapted for the visualization and forecast production process.

4. INTERFACE CONCEPT

The interface is characterized by the three main parts or working steps of the metAP software. A main selection of the thematic area of interest is a first part. Secondly there is the selection and display of

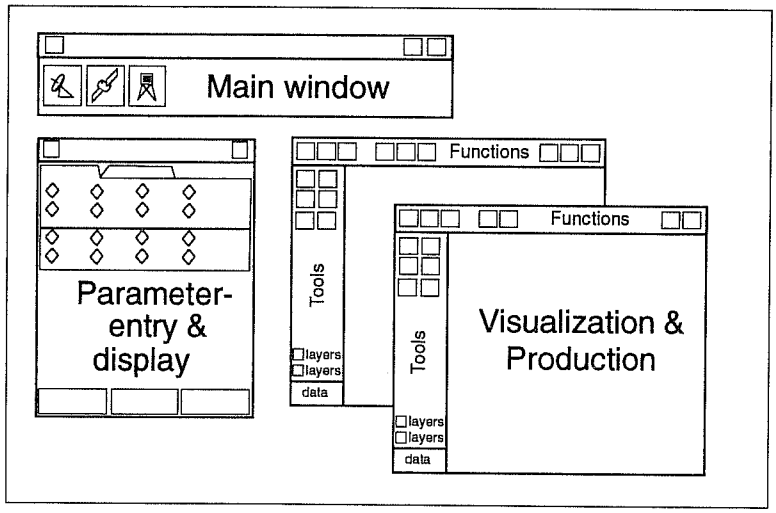

Fig. 4 Interface concept with the three main window types of the meteorological workstation software (metAP software). See text for discussion.

parameters. A third part is the visualization or editing of the selected dataset or product. Each of the parts has associated its window as shown on Fig. 4. Note that there is only one main selection and one parameter window, but there can be a multitude of visualization and working windows on the screen(s). The parameter window displays the parameters actually shown in the active visualization window. Thus its content changes when another visualization window is selected. The restriction to only one parameter window is done with a view to greater clarity. The main reason is not to transform paper jams on tables into window jams on the computer screen.

4.1 Main selection

The main selection window (Fig. 5) is the entry point of the metAP software and provides a means to select different areas of interest. These are grouped into a "functions" (F) part with smaller buttons in the upper part of the window, a middle part with "applications" (A) shown with the larger buttons and a lower part with a command line (C). Clicking on a "functions" button immediately produces a reaction such as (from left to right) "Quit", "Change User", "Status information", "Alarms" and "Help". The "Alarms-function" is somewhat different in that the button image can change if there is an incoming warning (from the expert system) or if (e.g.) strong winds have been detected in a predefined area of interest. In such a case an appropriate graphical display is prepared in the background and displayed if the button is clicked on.

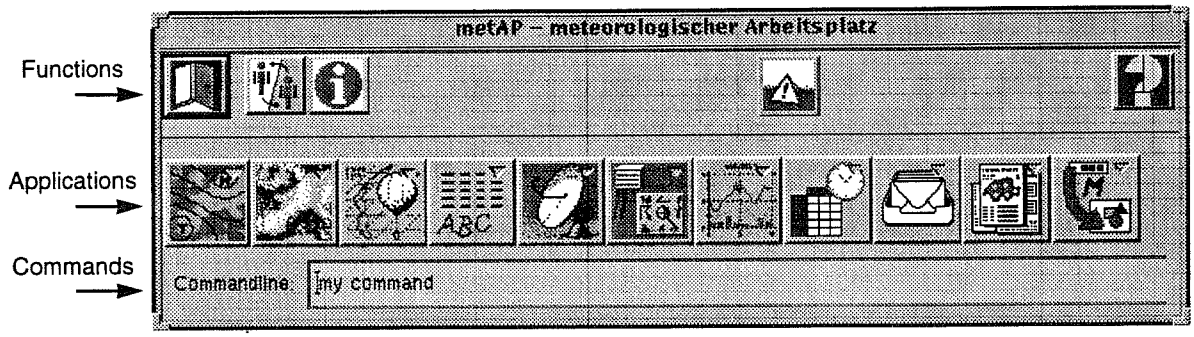

Fig. 5 Screenshot of the interface prototype of the main window of the meteorological workstation software (metAP software). See text for discussion.

"Applications" are selected by a simple click which is followed by the opening or the activation of the parameter entry window, respectively. From left to right on Fig. 5 there are windows for numerical model data, satellite data, sounding data, flight related reports and other ASCII based data, radar data, synoptic data, meteograms, a scheduler for staff and production info, a mail interface, a forecast production editor and an application for macros. The icons in the main selection reflect the world of the user, i.e. the forecaster. They do not reflect the underlying software design with generic data and graphic types. The buttons all have small triangles in the upper right, identifying them also as menus. This feature, as well as the functionality of the command line is discussed in the macro section.

4.2 Parameter entry and display

The parameter entry and display window (Fig. 6) generally is used going from top to bottom. The arrangements is sketched for a hypothetical case of weather data visualization. There naturally are different items in the context of configuration, preferences or for product selection. The parameter window is designed to answer the following questions:

What physical parameter do I want to look at?

Which area (i.e. where) has to be displayed and do the data come from?

When were the data measured or which time range / forecast period do I want to see?

How are the data displayed?

The sketch shown in figure 6 is schematic in that it encompasses items from different "applications". In operation the content of the lower sections of the window is dynamically adapted to the selection made

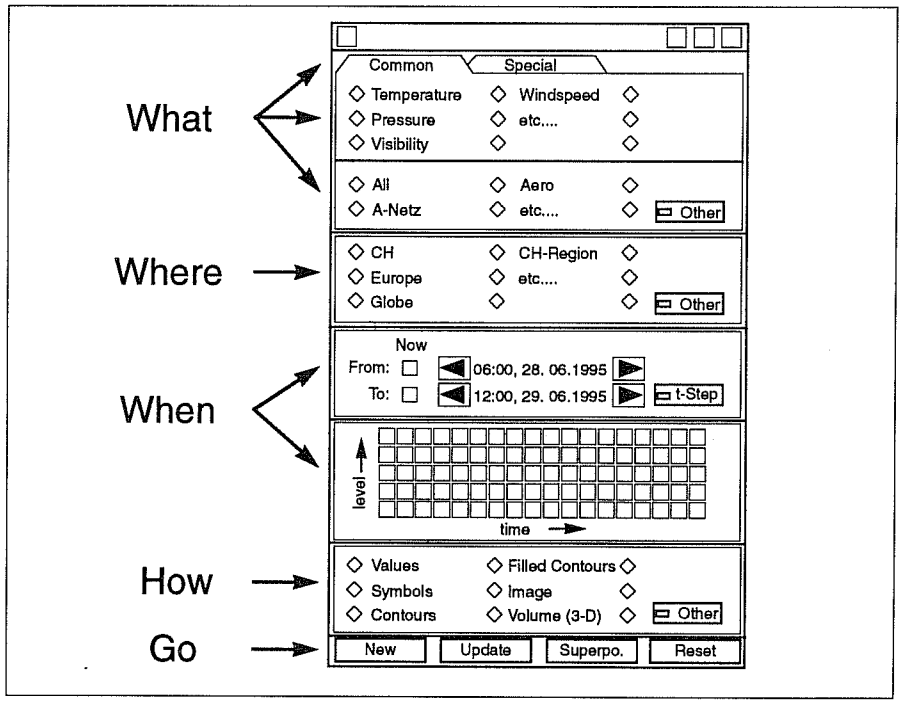

Fig. 6 Conceptual interface sketch of the parameter entry and display window of the meteorological workstation software (metAP software). See text for discussion.

in the upper part and (ideally) to the content of the database. For instance selecting windspeed in the context of satellite images would not be possible, also the "level versus forecast time"-matrix would not be shown. The prototype of this concept is in evaluation within a core forecasters group, and it will be refined in an iterative manner from now on.

4.3 Visualization and working window

The concept of a horizontal bar with functions and a vertical arrangement for tools that change the appearance of the visualization (similar to the parameter selection) is used in the visualization and

working windows (sketch in Fig. 7). These windows have standard "functions" such as "Save", "Load", "Print", but there are also functions for superposition of other suitable data sets and for animation (e.g. "Start", "Stop", "Forward Step" etc.). At the very top of this window there is a menu bar which contains all the necessary menus for text editing. In the metAP software text is confined to frames drawn on a separate layer. Text (and graphic) frames of forecast products are predefined and when possible pre-filled with data and text blocks generated earlier (or automatically).

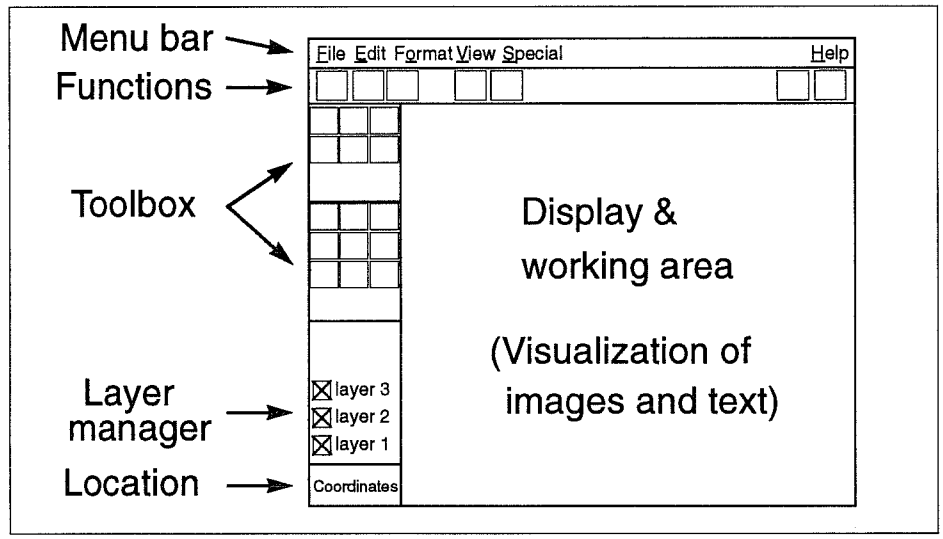

Fig. 7 Conceptual interface sketch of the visualization and production window of the meteorological workstation software (metAP software). See text for discussion.

Along the left side of the display and working area there is a toolbox, which contains various tools for the manipulation of the view (e.g. "Zoom", "Pan" etc.) and the manipulation of the visualization itself (e.g. "Change of contour interval", "Operations on histogram" etc.). Other tools will be added for drawing weather fronts etc. Note that, in contrast to "functions", tools may open a dialogue window for the definition of working parameters of the tool or for the change of the drawing parameters themselves. The metAP software treats each dataset, annotation or text frame separately and draws it on a separate layer. A manager part in the lower left will be able to activate or deactivate the individual layers, or to change their sequence. The location and actual data value under the cursor may be displayed with continuous updating in the lowermost part of the window.

5. MACRO MECHANISM

The SMI operates many automatic weather stations (~ 100 over Switzerland) that measure the actual weather in 10 minute intervals. The forecasters at the SMI are used to this data and display them frequently in the way of a nowcasting tool. Also these stations from the lowest Swiss points (~200m) to the Jungfraujoch (~3600m) provide very valuable data for all kind of forecast products. The straight forward visualization of this data set, e.g. temperature, wind, sun and precipitation, by selecting the

"synop-application" in the main window, entering the parameters in the parameter window and a final tuning in the visualization window is not acceptable in the routine operational environment. Therefore great care has been taken to make the visualization not only as flexible as possible, but also to provide means of a "one hand - one click" operation (especially if the forecaster is holding the telephone in the other hand). This functionality is here summarized under the term macro mechanism.

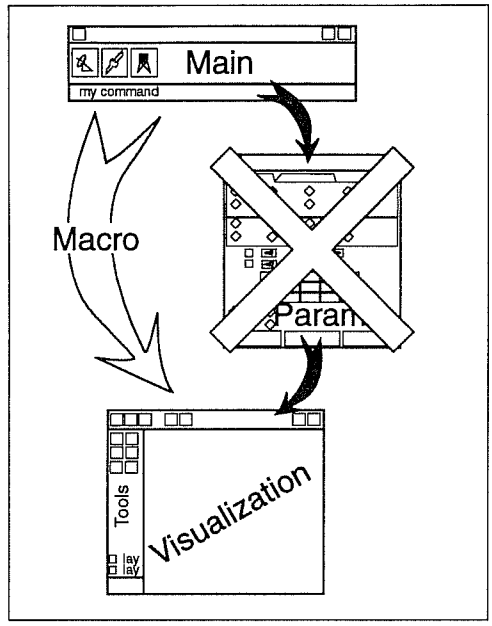

Fig. 8 Illustration of the macro mechanism. See text for discussion.

The macro mechanism consists of two parts, one is the pre-calculation of visualizations via the scheduler module of the metAP software, the other is its dynamic and easy to use integration into the user interface concept.

Once a specific visualization is made, it can be recorded as a macro (= database query & graphical options). In the main window it has been mentioned that the application buttons do as well behave as menus. The menus can be configured to contain these macros and the macros are automatically grouped. When selected the macros are executed with actual data and both the visualization and the parameter windows appear at the same time. The commandline (Fig. 5) is the other way to activate a macro, but it also presents a means to continue using mainframe script commands.

The scheduler and the production "applications" may contain more specific, time and product related macros. These allow an easy access to forecast products the forecaster or consultant has to deliver in the next hours. The macro application itself may be used to open up several windows at once. This allows to quickly setup a complex or completely different desktop.

In order to have short response times it is possible to use the scheduler of the metAP software to pre-calculate certain visualizations depending on time or event. The pre-calculation can be done on the workstation itself, but it will also be possible to use dedicated servers for more complex cases (e.g. 3-D visualizations in animation).

6. CONCLUSION

The Swiss Meteorological Workstation Project includes the working place, the working processes and the workstation software (metAP software). The software has a modular design based on the generic data types of NEONS. This concept is extended to specific graphic types. For each of the graphic types a viewer/editor is designed. The software architecture is modular and independent of the design of the user interface.

The metAP software has its own user interface and interaction philosophy. It is developed especially for forecasters in the operational environment, in other words the graphical user interface is adapted for the visualization and forecast production process (task oriented). The interface concept relies on three main window types - a main selection, a parameter entry and display and a visualization and working window. The definition of standard positions of functionality on the interface has the advantage of a fast navigation, low training expenditure, fewer mistakes in operation and an overall faster and better usability. Adding new functionality does not change the handling but merely extends it. The modular design of both calculation and database parts as well as the interface allows a stepwise implementation of the functionality. Without changing the interaction philosophy the long term use of the metAP software in this way is possible.

In 1996 it is planned to realize prototypes and a first robust version with a limited functionality. These will be extensively tested and worked over. The first version is then are ready for further refinement according to the priority list of the weather department.

7. REFERENCES

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