The Use of Apple Macintosh Computers In Teaching at ETH Zürich

By A. VENTURA, W SCHAUFELBERGER, and A. FISCHLIN Project-Center IDA, ETH Zürich

Abstract

Several hundred Apple Macintosh computers are used in teaching at ETH. First, an overview on the different ways these computers are currently used is given. Then, some examples of educational programs are provided, and the "DialogMachine", an authoring system developed at ETH, is presented.

Introduction

Macintosh and IBM compatible computers are the main lines of PCs used in teaching at ETH. Lilith, Ceres, Sun and VAX are strongly represented in the workstation and midi range. The decision about what kind of computer to use in teaching is left to the individual faculty member.

The Institute for Informatics decided early to use the Apple Macintosh for the general two-term introduction to computer science provided in most departments. About 300 Macintosh Reflex are used to introduce about 1500 students to the basics of computer programming each year. The fast Modula-2 system MacMETH (Wirth et al., 1986) is used mainly for this purpose, but MacPascal is also available. Several faculty members from different departments got interested in using and extending this infrastructure of computer-based teaching.

In the Department of Architecture, Macintosh computers are mainly used for architectural drawing and calculations (Kramel et al., in Schaufelberger (1988a)). In the introductory courses to Technical Mechanics, all exercises are available on floppy disks (Sayir and Kaufmann, in Schaufelberger (1988a)). Mathematicians use computers for numerical and symbolic calculations. A set of programs for the basics of computer science, for systems analysis in natural sciences, and for control engineering have been developed by the current staff of the IDA Center which is responsible for the school-wide coordination of the use of computers in teaching. Some examples will be provided in the following.

Introduction to Computer Science

One of the main problems in teaching the basic algorithms of computer science is the purely static notation on blackboards or overhead projectors. The teacher usually plays the role of the machine executing the algorithms manually. This is a difficult task, prone to errors. Animation of algorithms by computers with good graphics possiblities on the other hand, is an easy task. The programs can be used for classroom demonstration and for individual exercises carried out by the students. With this in mind, a set of very easy to use programs has been created, treating the following subjects:

- Sorting algorithms
- recursion and iteration with graphics
- real arithmetics
- random number generation
- recursion

Fig. 1 shows the commands available to move through the sorting algorithms, and a typical screen out of the program is represented in Fig. 2.

For further details, see Ventura & Goorhuis (1987), and Ventura & Schaufelberger (1988).

Systems Analysis in Natural Sciences

Students in agricultural engineering and natural sciences are introduced to systems analysis in their 2nd and 3rd year. They learn to model dynamic

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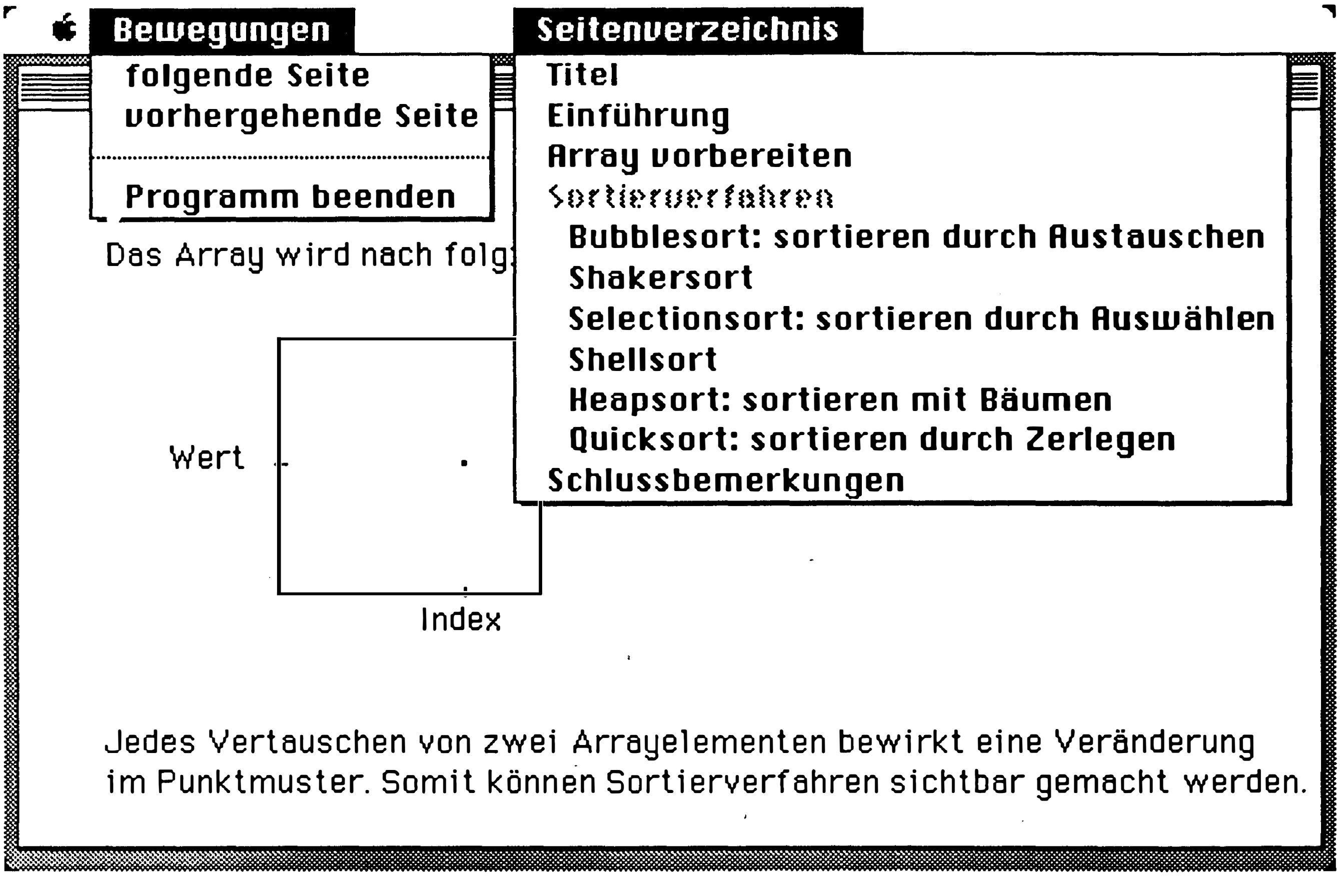

Figure 1. Commands to move through the sorting algorithms

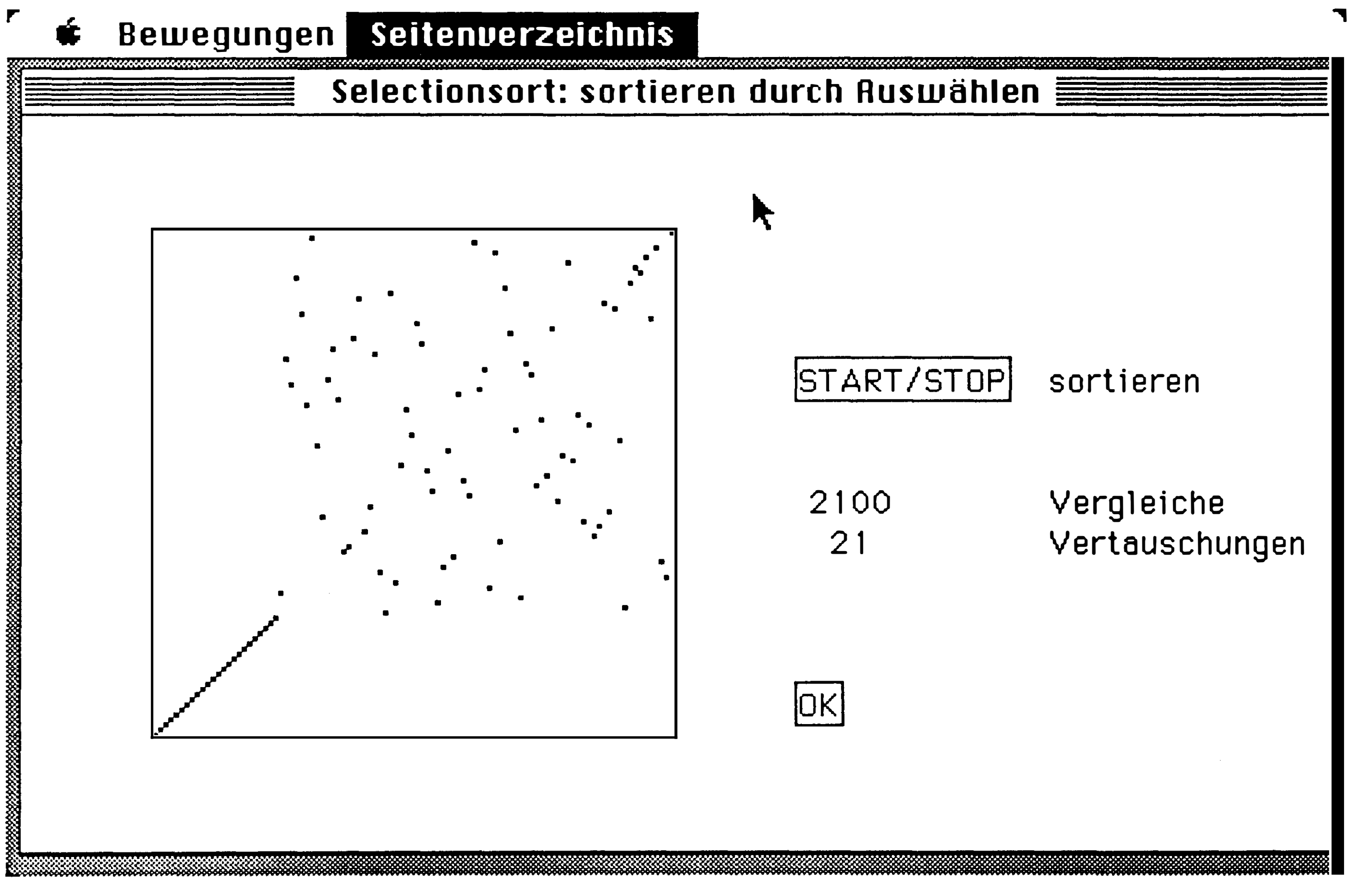

Figure 2. Screen of "selection sort"

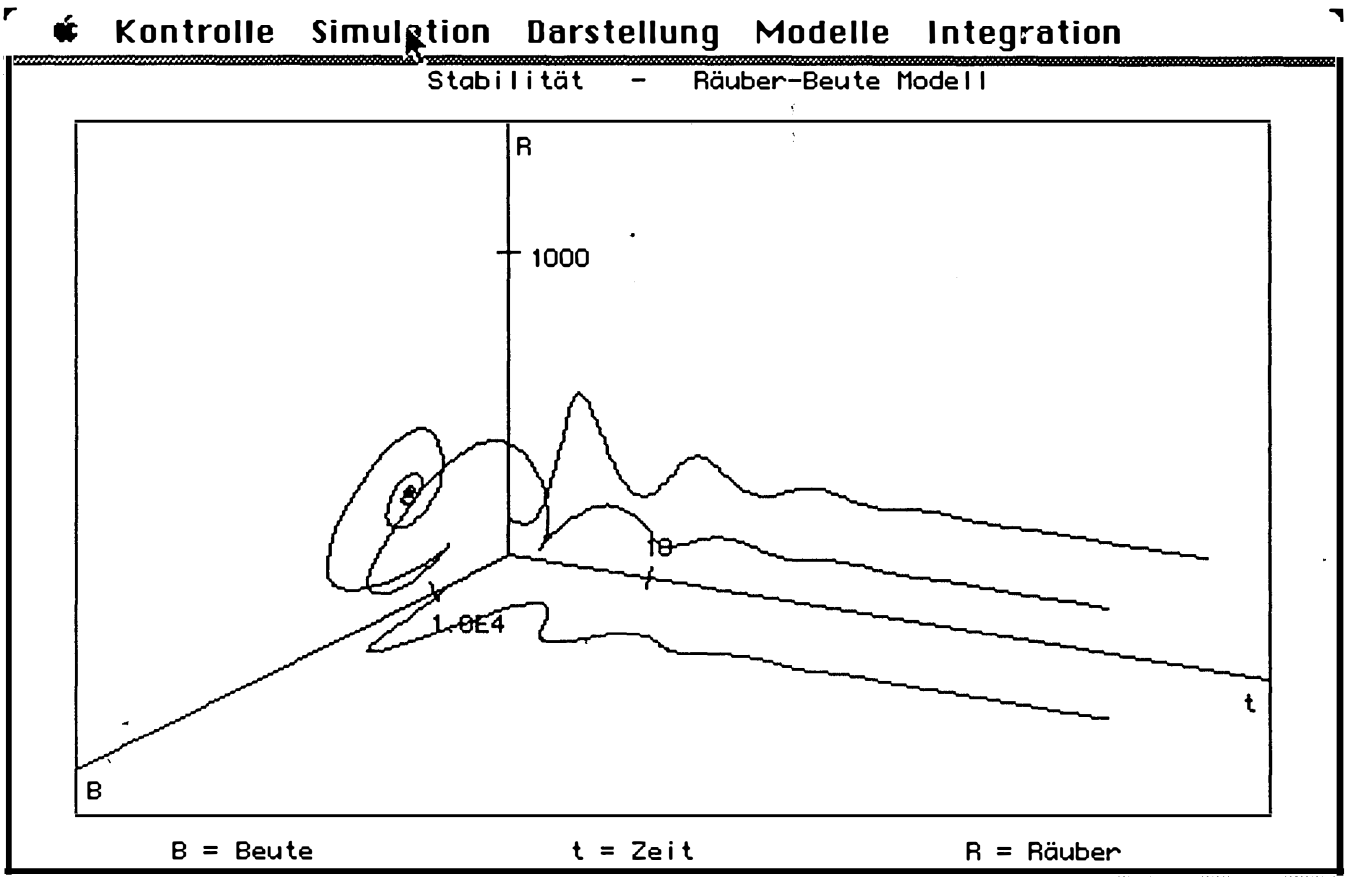

Figure 3. Simulation screen for prey-predator models

systems by means of differential and difference equations. Much emphasis is placed on simulations, to gain an intuitive insight into the dynamic behaviour of nonlinear models, and to complement the theoretical presentations in the classroom. A screen used for the simulation of prey-predator (Lotka-Volterra) systems is shown in Fig. 3

The following set of programs has been especially prepared for education in natural sciences:

- Feedback Systems (Demo)
- Drosophila (Demo/Exercise)
- Euler Animation (Demo/Exercise)
- Probability (Demo)
- Stability (Demo/Exercise)
- Automaton (Demo/Exercise)
- Identification (Demo/Exercise)
- World Dynamics (Demo/Exercise)

For more details see Fischlin & Schaufelberger (1987) or Fischlin, in Schaufelberger (1988a).

Control Engineering

Simulation is also an important aspect of a basic education in control engineering used both for classroom demonstrations and for individual exercises by students. The relation between pole-locations and the dynamic behaviour of a system can easily be studied by means of a corresponding computer program. The set of programs that is in use for this and related purposes consists of

- Tuning of two term controllers
- Anti-windup circuits
- State variable feedback and observer design
- Adaptive control
- LIP identification
- Rule based controller design (small expert system shell)
- Decision table analysis
- Petri net simulation and reachability

A typical screen is shown in Fig. 4:

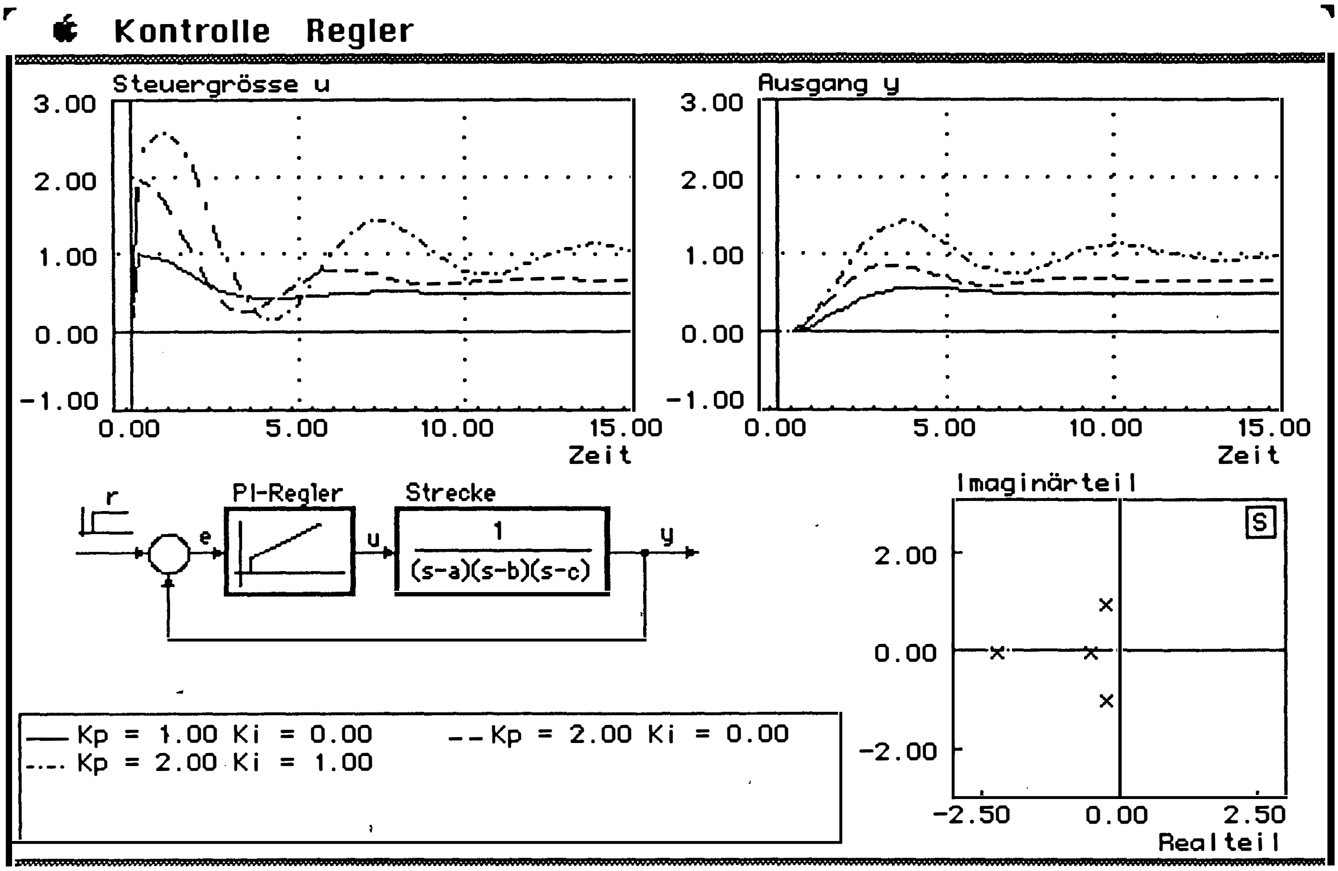

Figure 4. Tuning of a two-term controller on a third-order plant

Details may be found in Schaufelberger (1988b), and Schaufelberger (1988c).

Mathematical Tools

Tools differ from the special training programs presented so far in that they can be tuned to and used on many problems. The favorites in use in different courses at ETH are Matlab, the public domain version of the famous Matrix-Laboratory of Little and Moler (1985), and ModelWorks, a simulation environment based on MacMETH Modula-2 and developed at ETH (Fischlin & Ulrich, 1987). A solution of the Van der Pol equation is shown in Fig. 5:

Both Matlab and ModelWorks are available to all students of ETH.

Authoring Systems

During the last two years, several authoring systems have been developed at ETH. Since its appearance, Hypercard is widely used. Most of the programs presented here have been integrated into Hypercard stacks, providing a new learning environment for students and an innovative way of composing course notes in a joint effort by faculty and students.

The stack used for the computer science programs is shown in Fig. 6:

The "DialogMachine", the basic authoring system for simulations developed at the Project Center IDA will be briefly presented. It consists of 14 Modula-2 Modules (16K LOC, 700 K Code) which allow the easy programming of the Macintosh without ever consulting "Inside Macintosh". Menus, windows, input-output etc. are all available through a large set of procedures. Inversed control structure programming is used to simplify the author's task. The Dialog Machine is so far in use at about 80 locations. The import/export relations of the Modules are shown in Fig. 7:

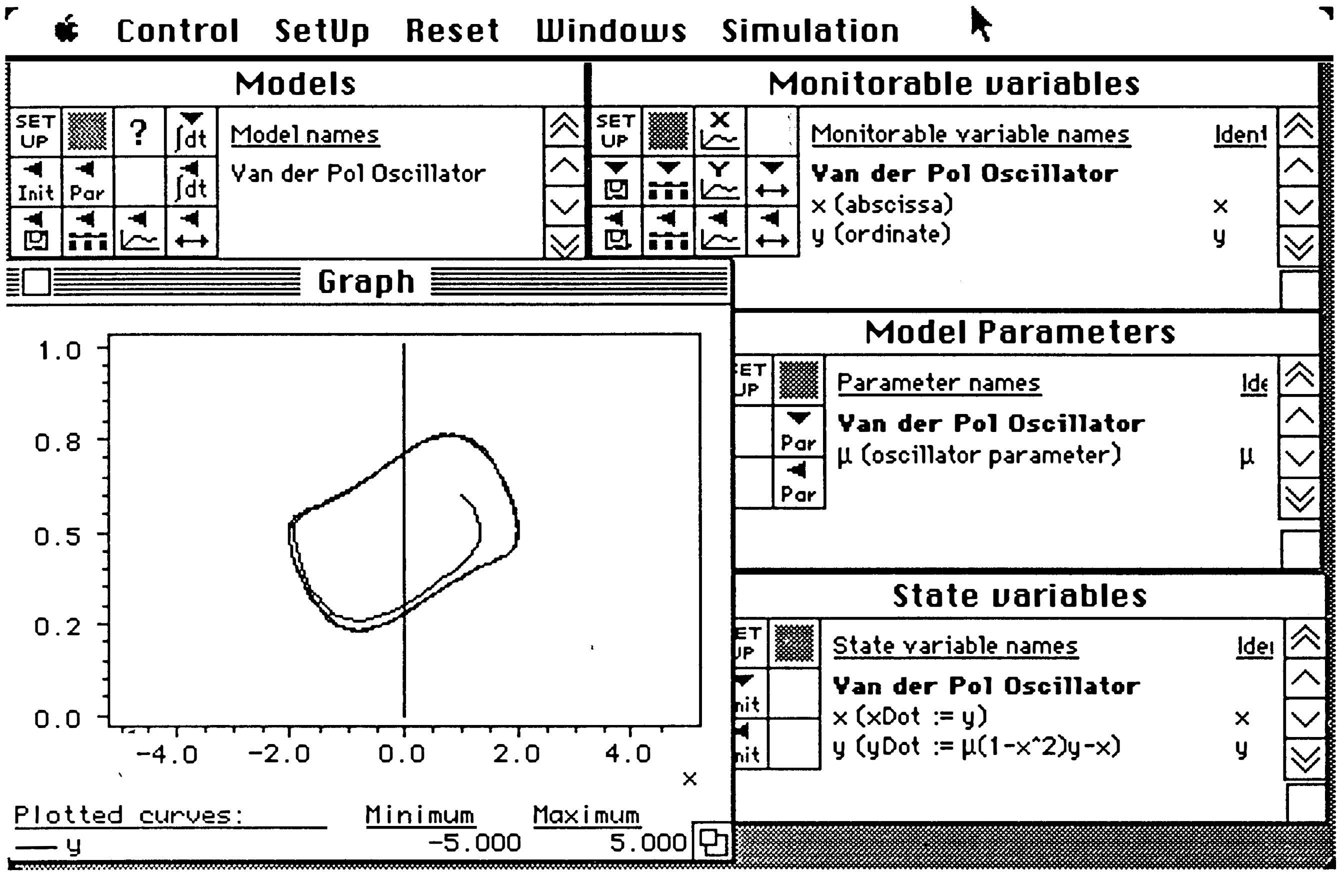

Figure 5. Phase plane of the Van der Pol equation

Figure 6. Hypercard stack integrationg several educational programs

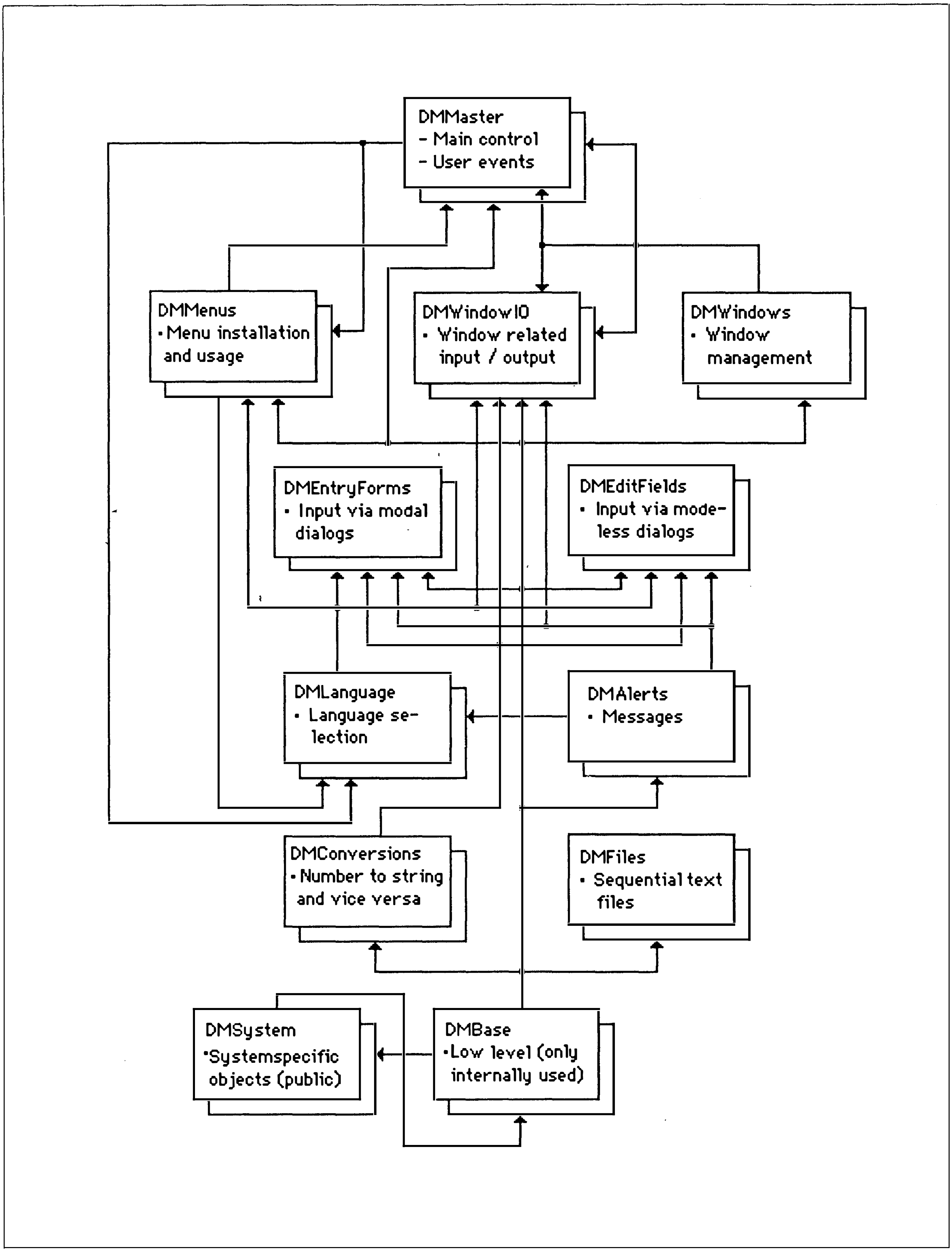

Figure 7. Module structure of the DialogMachine

Conclusions

The computer is a new mass medium allowing two-way communications. As we have shown by our examples, there are many different approaches to using computers in education. It will take time until the characteristics of this new medium are completely understood. Experimentation and analysis of the possibilities are therefore important. Our experience shows that computers will play an important role in the education at Technical Universities. In our opinion, the widely spread availability of small and relatively inexpensive computers will drastically change not only university education, but also post-graduate formation and life-long learning habits.

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