Controlled simulation and animation in computer presentations

Veronika Stoffa

***Abstract**: The article deals with the simulation models, which are the basis of controlled animation. Visualization of simulation experiments on computer has a great significance in teaching-learning process. Animation helps not only to increase the illustrativeness but it also allows to acquire new knowledge based on own observation and own experience of the work with the model. Such computer models have to be relevant and implemented on the base of exact mathematical model. Computer animation has its meaning also for electronic presentation of a teaching material. Mathematical model includes a big amount of information about modelled object and enables to extrapolate a lot of knowledge about the object.*

***Key words**: Modelling, simulation, animation, e-learning, presentation of a teaching material on computer*

INTRODUCTION

Modelling and simulation is a science discipline concerned with the study of systems. System can be defined on any object (either real or fictional). When defining a system on an object, it is very important to specify the aims of modelling and the resolution level. According to these, the subsystems and elements of the system are chosen and also the adequate mathematical model for the realisation of the computer model of the system. Relevant computer model serves as the basis for simulation experiments and controlled animation. Only the knowledge acquired from the experiments based on the object's exact mathematical model is valid and applicable on the object of the study.

COMPUTER MULTIMEDIA PRESENTATIONS

Didactic multimedia applications mediate the information in various forms. They address more senses at the same time and this way they intensify the experience and make the process of understanding the mediated knowledge and remembering the provided information easier.

In didactic presentations the significant position belongs to the models that contain a huge amount of information and knowledge about modelled system in concentrated form – in the form of mathematical model. The mathematical model expresses the rules and causalities of behaviour of modelled system from the point of view of the aims of knowledge at the determined resolution level.

CREATION OF DIDACTIC MULTIMEDIA PRESENTATIONS FOR E-LEARNING

The creation of didactic multimedia applications for e-learning is usually a team work. Such a team consists of the specialists in pedagogy and psychology, the representatives of subject knowledge – teachers, and the programmers - experts in realisation means and environments with the corresponding skills of the usage of these means and environments in the creation of presentations.

The creation of didactic applications consists of several steps:

1. Specification of the topic, extend and content of teaching, gathering the materials together (collecting the materials), fundamental for the presentation, pictures, schemes etc.
2. Specification of the target group and recognition of their abilities.
3. Preparation of the textual part with necessary didactic transformation, transformation of the schemes and pictures into the adequate form, preparation of the sound sequences, choice of mathematical models that will be a part of the

application, specification of visualization of the outcome of simulation experiments, specification of necessary animations etc.

4. Specification of the structure of presentation, connection of particular information items and units, dynamics of particular windows (projection of pictures, texts, presentation of sound sequences etc.)
5. Choice of realisation means based on the possibilities they offer and on the possibility of realisation of determined aims and goals according to the target group.
6. Adaptation and modification of steps 3 and 4 according to chosen realisation means.
7. Realization: Implementation of particular fragments in case of the design from bottom upward. Preparation of control part gradually adding particular information wholes in case of the design from above downward. The processes can be combined. The important part is the clear structure of the presentation.
8. Testing of the system in fictional conditions and then in real conditions.
9. Elimination of insufficiencies, taking into account the comments and suggestion of the users and also own experiences from the work with the application.

Creation of didactic multimedia presentations has an iterative character and the steps can be cyclically repeated. Didactic software has to support all the phases of teaching-learning process: motivation, presentation of new information and knowledge, practice and fixation of new habits and skills and specification of the level of acquired knowledge (testing). These phases should be cyclically repeated and interchanged.

Steps 1-4 and 6 are the role of the teacher. The teacher determines what has to be done and how it should look like and work. The way of realization and the realization itself is the role of programmer. These are the steps 5 and 7. All the other steps are necessary to realize in close cooperation of both groups of realization team teachers and programmers. It is welcome and advantageous, when all the steps are fulfilled by one "universal creator". The teacher cannot appropriately fulfil his role without necessary information and knowledge about realizations means and environments that enables him to specify his requirements to the realisation. The process of creation can be compared with the creation of software applications. The analogy of both is obvious.

It is necessary to realise that computer-supported teaching applies the basic principles of programmed teaching specified by Skinner. These, however, have to be actualised and modified for multimedia computer-supported e-learning.

- Electronic lesson consists of information items, which are presented in adequate batches.
- After certain batches of information follows the practice with feedback.
- Items of information are mediated in various forms so that more senses are involved into the internalisation of knowledge at a time – multimedia presentation is used.
- Active cooperation of a learner has to be ensured and fostered.
- Feedback is well supported – a learner responds to the stimuli from the presentation but also the programme adequately responds to the activities of a learner.
- Simulation models are used in necessary and appropriate situations – for presentation of new knowledge as well as for the experiments with the model to achieve own experiences.

- Pedagogic mastery of a teacher (creator of presentation) is reflected in didactic transformation of a content of teaching: appropriate formulation and expression of ideas, structure, organisation, and the way of presentation of new knowledge and also managing the learner and optimisation of his/her procedures.

STRUCTURE OF DIDACTIC APPLICATIONS

Structure of didactic multimedia application emerges from hypertext structures. The difference is that the information wholes connected into unified structure have different character. Information units which form the information items and which are interconnected into hyper-structure by hyperlinks can be: text, sound sequence, music, picture, animation, graph, etc.

The basic hyper-structures are: linear, hierarchic, screen, web and net (combined). When to use which structure is presented in information source (Stoffová, 1999). Chosen structure at the particular level has to emerge from the structure of teaching material. This has to be arranged into certain structure and should help to systematise the knowledge. Therefore the author of scenario of didactic application has to choose the structure of presentation with certain amount of pedagogic mastery.

Many psychologists consider the human long-term memory associative. That means that particular information and knowledge items are connected by associations. Therefore the elaboration of the structure of the presentation is regarded as a very important part of the creation.

The basic principles of elaboration of structure of didactic multimedia applications can be compared with structured programming. Information whole at higher hierarchic level can become information element at particular resolution level.

ANIMATIONS IN MULTIMEDIA APPLICATIONS

Animations in didactic multimedia application help not only to increase the illustrative ness of teaching-learning process but they also foster quick and correct understanding of dynamic phenomena, causalities, and principles of running processes that are the object of learning process. Animations in multimedia applications can fulfil various functions:

Animation for illustration and revival of presentation increases the illustrative ness and makes activate the learning process. Such animations usually only accompany the text of electronic textbook that deals with the content of teaching. Animation can be accompanied with short text sequences that comment on the animation (describe particular parts of moving picture) and/or sound sequences explaining the animation. These sequences can be activated automatically when the concrete part of animation is presented or at the movement of mouse etc. Into this group belong, for example, interactive animated fairy-tales, language applications, live picture multimedia dictionaries to widen the vocabulary etc. Particular objects in this kind of applications move spontaneously or they can be manipulated. For example, the clock can be set up, the stories are brought to life on the screen of computer, scene is dynamic, the characters move, etc. The action on the screen is accompanied with live word and/or the story is with credits. Such an animation, mainly the illustrative animation, can be replaced by video-recording.

Animation for illustration the basic principles - This kind of animation the most usually occur to explain how something works or functions. These animations can have **schematic character**, i.e. real objects do not necessarily have to be a part of the animations. They are replaced by their schematic representation. For example, when we want to explain how the instruction cycle is realised on computer we use schematic representation of registers, memory cells and their content, address alignment, data transmission, etc. Similar method can be applied when we want a learner to understand how the addition of two real numbers is realised or how the arithmetic of floating point and fixed point functions etc.

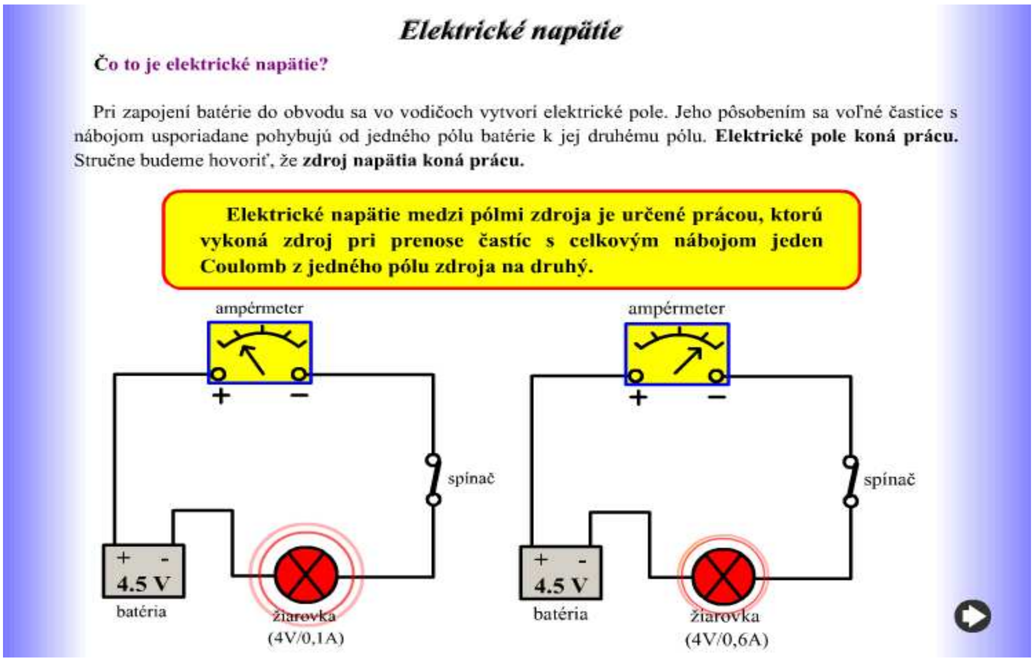

Fig. 1. Illustrative animation in e-books of physics (Theme: electric voltage)

In many cases we can **work with functional model, or prototype**. For example, when we want to explain how the four-stroke combustion engine works we can sufficiently use the prototype or the profile of the prototype. Sometimes it is enough to lessen the real object to get it whole on the screen and the dynamics of the system can be watched by the naked eye. This happens when we want to explain technological processes, e.g., papermaking, sugaring, etc.

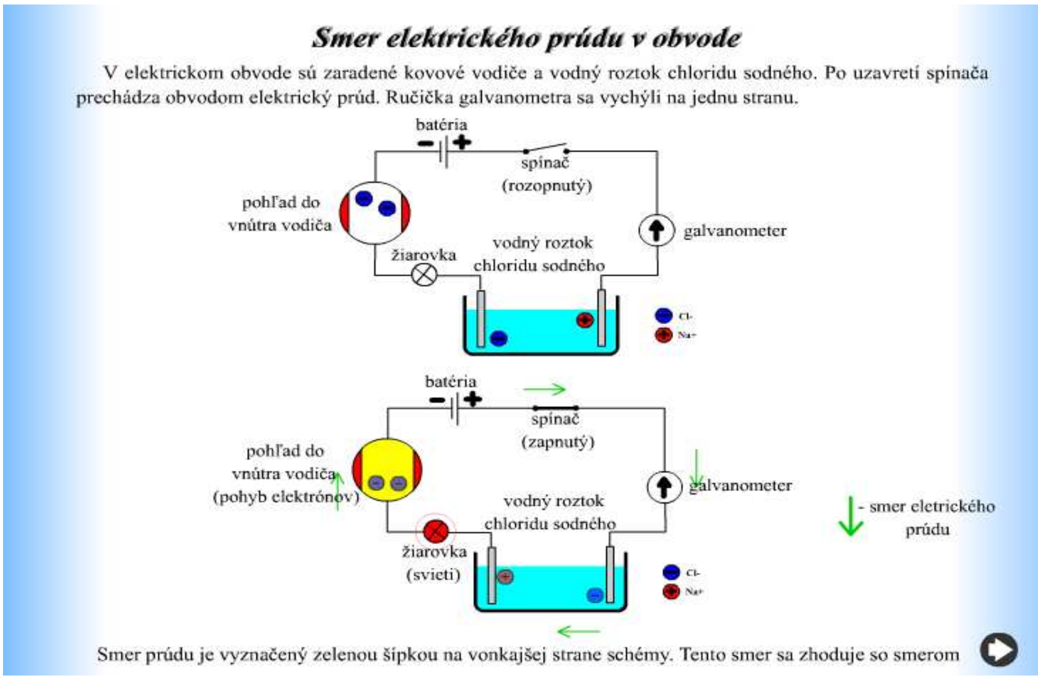

Fig. 2. Illustrative animation in e-books of physics (Theme: electric current)

Very often, the real objects and processes have to be magnified to be observable by naked eye. For example, production of printed wiring, observation of growth of cells, crystals, etc. Many times it is necessary to accelerate the natural phenomena for didactic purposes, e.g., when we want to watch the ontogeny of plant or animal kingdom, or the changes that in real world run too slowly to be watched by naked eye. There are also a lot of processes that run too quickly so that human eye is unable to notice the changes. To perceive these changes it is necessary to slow the processes down.

Animation to explain dynamic phenomena explored on the basis of their mathematical model. Here we usually work with simulation time, i.e. we can create deceleration or acceleration of the course of observed phenomena but the visualisation can run in real time, too. Mathematical model of such systems is normally presented by system of (differential) equations and various complex functional causalities. For example, path tracking of the body at controlled movements, observation of time-dependent chemical reaction, etc. Here the independent variable is always the time. (In this case, the animation could be replaced also by video-recording but it would be fixed to the values of parameters at which it was recorded.) Computer model of real system enables to experiment with the model and therefore to realize also the animation dependent on the parameters of experiment.

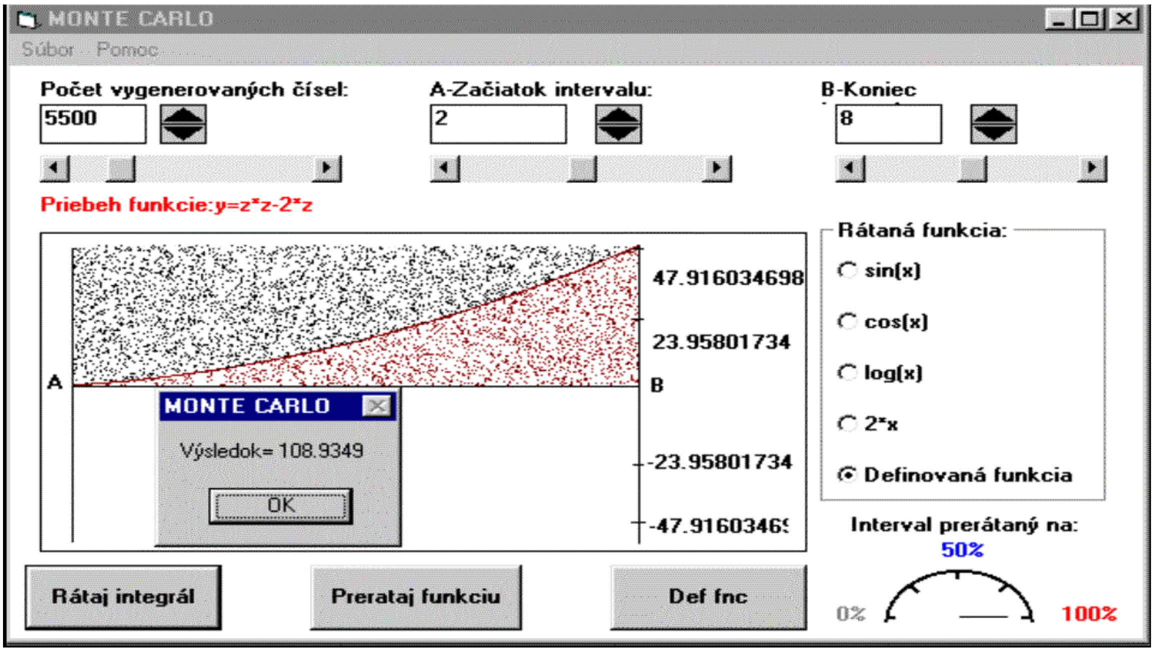

Fig. 3. The animation of Monte Carlo method for defined integral calculation

Animation as a visualisation of numeral results. In this case we quantify qualitative indicators. Usually we observe the values that are the outcome of measurement (often indirect measurement) and they are not observable by naked eye. For example, conduction of semiconductor in certain conditions, passage of current in certain point of electric circuit, state of calculation realised on computer, pressure characteristic in hydraulic system, etc. In these cases the independent variable does not have to be the time. This kind of animation is also dependent on the parameter of the model and therefore the representation is dependent on concrete results.

CONTROLLED ANIMATION

Controlled animation is the animation in which the motion of an object (objects) of animation is (are) controlled by parameters of mathematical model of an object. Animation expresses real behaviour of the system in definite conditions. Controlled animation is usually connected with simulation computer model of a system, which was defined on the object of study.

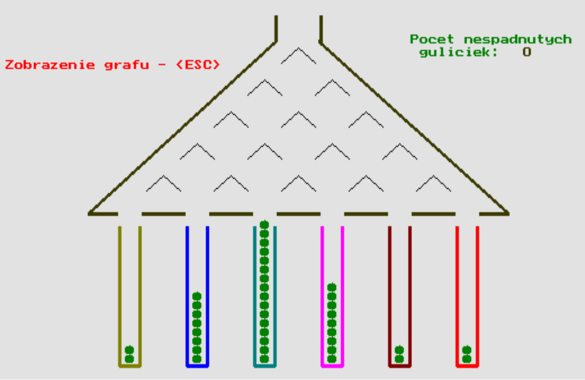

Fig. 4. The animation of Galton board

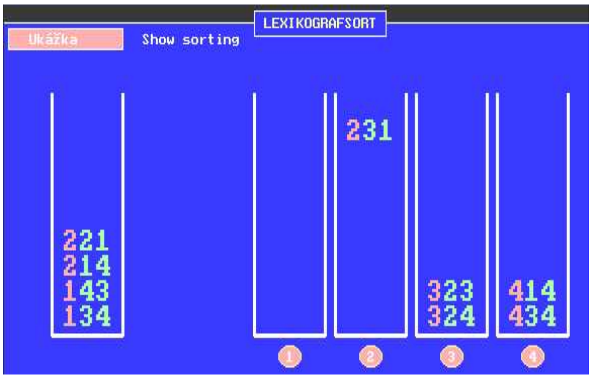

Fig. 5 The animation of Lexikograph-Sort

Animation-simulation model as the tool of a learner

Simulation is the method for acquisition of new knowledge. To achieve this, it is necessary to realise reasonable and meaningful simulation experiments. It is also important to devote enough time and attention to the preparation. First experiments of a learner point to **the knowledge of the model** (system) **itself** – on the base of animation (visualisation of results). After the mathematical model is understood, the learner studies **the effect of particular parameters** of the system (model) on the outcome of simulation experiment. Later on he/she is able to predict **the outcome of the simulation and only verifies them** by the experiment. Thereby the learner trusts the model and approaches to **experiments oriented to prognostication**, i.e. higher level of cognitive process where he/she can get new knowledge about modelled system based on the results of simulation experiment. After the verification, results can be associated to the real object, which is represented by the model.

CONCLUSION

Animation has a significant position in didactic multimedia computer applications. It is an important part of interactive electronic textbooks and therefore besides the illustrative function it has to fulfil also the other functions that originate in the basic attributes of e-learning. They have to be carrier of useful information according to the object of teaching and they also have to interactive and controllable. Controllability of an animation does not mean only the possibility of activation, acceleration or deceleration of presented picture sequences but mainly the control of presentation (depiction) of objective reality. However, the creation of parameter-controlled animation in popular graphic environments such as Flash, Dreamweaver, etc. is not directly supported. Creation of animation of this kind requires professional programmer approach, which comes out of mathematical model of studied process. Such an animation needs computer implementation of mathematical module that enables the user (learner) to realise interactive computer experiments with the model to acquire new information or solutions of given problems. To realise this kind of models we were helped by graphic libraries compatible with the programmer environments (e.g., we used the graphic library in Delphi).

REFERENCES

1. ELEK, I.: Médiakompetencia fejlesztése weboldalak elemzésével a tanárképzésben. In: *AGRIAMEDIA 2000*, Eger : EKTF, 2001. s. 103-113, ISSN 1417-0868
2. FANDELOVÁ, E.: *Psychológia rizika a zavádzanie multimediálnych prostriedkov vzdelávania*. Nitra : Univerzita Konštantína Filozofa, Filozofická fakulta, 1999, s. 96. ISBN 80-8050-239-0.
3. HAMBALÍK, S. – ELEK, I. – TÓTH – PARÁZSÓ L.: Weboldalak alkotóelemei a diákok és oktatók tapasztalatait tükrző intézménzeinek teljes körű feldolgozása alapján. In: *AGRIAMEDIA 2000*, Eger : EKTF, 2001. s. 220-230, ISSN 1417-0868

4. ŠAFAŘÍK, J. - ŠTOFOVÁ, V. - CVIK, P.: *Modelovanie a simulácia.* 1. vyd. Bratislava : Slovenská vysoká škola technická v Bratislave. Fakulta elektrotechnická, 1981. 132 s. ISBN 85-253-81
5. SIK-LÁNYI C.: Multimédiás oktatóprogramok tervezésének ergonómiai kérdései. In: *AGRIAMEDIA 2000*, Eger : EKTF, 2001. s. 189-201, ISSN 1417-0868
6. STOFFOVÁ, V.: O multimediálnom spracovaní učebnej látky. *Modernizace výuky v technicky orientovaných oborech a předmětech : Sborník II.* 1. vyd. Olomouc : Univerzita Palackého v Olomouci, 1999, s. 423-428.
7. TEPPERWEIN, K.: *Umenie ľahko sa učiť.* Šamorín : Fontána 1992. 171 s. ISBN 80-900492-7-3
8. TOMANOVÁ, J.: Grafická informácia vo vyučovaní. *In: Zborník III. vedeckej konferencie doktorandov*. Nitra : UKF – Fakulta prírodných vied (Edícia prírodovedec č. 88) 2002, s. 95-99. ISBN 80-8050-501-2
9. TOMPA, K.: Információs-technológiai szemlélet a kerettantervekben. In: *AGRIAMEDIA 2000*, Eger : EKTF, 2001. s. 313-321, ISSN 1417-0868

ABOUT THE AUTHOR

Prof. Ing. Veronika Stoffa, CSc., Department of Informatics, Faculty of Natural Sciences,

1) Constantine the Philosopher University in Nitra, E-mail: vstoffova@ukf.sk

2) J. Selye University, Roľníckej školy 1519, 945 01 Komárno, NikaStoffova@seznam.cz