Real Time Interface for Fluidized Bed Reactor Simulator

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INTRODUCTION

Nowadays, the world witnesses a large technological revolution which has brought new information distribution forms, interpretation and storage. With that, computational tools can be used to sustain the education, as with the learning objects case. A learning object is any digital product that could be re-used for knowledge acquisition, with significant economy and reduction of computer time.

Learning objects have led to new solutions, which resulted in good structured and safe programs. Hereby, they rend possible creations of simple units, and the objects, which are associated with each other, can produce large units. Some of them are distinguished among the presence or absence of simulation functions.

The software SEREA has been developed to reach undergraduate and graduate chemical engineering for studies about fluid dynamics of fluidized bed reactors motivating students in order to acquire a successful learning process. Motivating students is certainly a stimulating and challenging problem, and is always present in teaching methodologies (Tannous, 2007). This article will present a comparison between two methodologies for interface creations, to sustain the chemical engineering learning and other correlated fields.

BACKGROUND

Since 2002, the Laboratory of Particle Technology and Multiphase Flow at State University of Campinas have developed new learning objects, mainly simulator modules, to evaluate their limitations as educational software.

Several denominations are found in the literature about the concepts of learning objects such as: instructional object, educational object, knowledge object, intelligent object and data object (Gibbons, Nelson, & Richards, 2000). Nevertheless, it does not matter what denomination has been improved, as the object can be practically the same.

The IEEE Learning Technology Standard Committee (2002) defines learning objects "*as any entity, digital or non-digital, which can be used, re-used, or referenced during technology supported learning.*" Chronological and instructional texts, class activities, books and revision aids are some examples of nondigital learning objects.

However, concerning digital learning objects, the main idea is to break the contents in small pieces that can be re-used in different learning environments, following the "spirits" of oriented-objects programming (Wiley, n.d., Verbert & Duval, 2004). According to Downes (2001), the idea of object-oriented tends toward the development of real pattern that, once defined, are copied and used in a part of the software. In this way, the simulators associated with the object-oriented programming can be classified in this definition.

According to Logmire (2001), for designing and developing material to be reused as learning objects, it should consist of features such as flexibility, easy to update, search and management, customization, interoperability, facilitation of competency-based learning, and increased value of content. All these characteristics show that the learning object models can make an easier and enhanced quality of learning, providing several facility tools for professors, students and administrators.

The simulation is a learning resource that allows the students to observe the different system behaviors through mathematical graphics or symbolical modeling of the phenomenon. In this context, the simulations have an important role to minimize the problems due missing equipment and laboratories for undergraduate students.

Tannous (2005) and Rimoli, Assis, and Tannous (2006) described some of the strategies and methodologies applied to develop learning objects (simulators with or without instructional program). It is important to remark that, in general a few works are applied to chemical engineering.

DEVELOPMENT OF LEARNING OBJECTS

General Information

SEREA (Fluidized bed reactors modules) is simulator software for undergraduate chemical engineering students. It was developed to simulate the fluid dynamics parameters of different fluidized bed reactors, being divided by behavior of particles and project of distributors. As SEREA expanded, it was split in one real time process named "slipping controls."

The following sections cover two modules for basic parameters that consist of the determination of minimum fluidization velocity and porosity, and bed expansion. The fluidization engineering concepts are based upon Geldart (1986), Kunii and Levenspiel (1991) and Martin (1998), and are also covered in other texts (Tannous, 1993).

Required Hardware

For an educational tool to be effective, it must be readily accessible to students. SEREA has been developed on personal computers sufficiently supplied with the necessary amount of memory and processing of operational systems. The exact hardware chosen was processor Intel Pentium 4 1.6 GHz, 768 MB of RAM memory, CD recorder, Monitor of 15," video board Nvidia Riva TNT 2, mouse and keyboard.

Software and Operating System

Nowadays, several technologies can be used to build the learning objects, including Java applets, flash, Modellus, Javascript and those more powerful and innovative resources as Java and C++ languages. Also, we found the most popular object-oriented programming languages to be Visual basic and Delphi. Each language has their own advantages and disadvantages depending upon the developers requirements. For our case a feasibility analysis was constructed identifying our problem and indicating available resources within the department to assist with our costs/benefits analysis. Justifiably, Borland Delphi 2005 IDE was chosen to develop the SEREA simulator. It has been successfully run in Windows XP.

The integration of this programming language with **graphics** resources causes easier and faster creation of software, with better results. Some of these characteristics are: elements repository, automatic inclusion of declarations of variables and classes upon the insertion of an element using the graphic mode, list of properties that allow modification of the parameters for each object easily and quickly, compilation and execution of codes with automatic syntax and verification of semantic error and integration with the Paradox 7.0 database, that allows for easy interaction between different modules of the software (Rimoli et al., 2006).

Other software employed in the development of SEREA was the open source application package OpenOffice.org which includes text, presentations, diagrams, mathematical equations and spreadsheet editors. The equation editor (OpenOffice.org Math) creates complex mathematical equations with only one line of code and OpenOffice.org Writer elaborates explanation texts for each field in the software.

Methodology Applied

The methodology adopted for creating the software modules followed the software engineering steps (Schaerer & Schauer, 1991; Rimoli et al., 2006): Analysis, Design, Coding, Testing, Production and Maintenance.

Analysis: it is the process of defining the problem. The requests are evaluated, selecting which factors are limited for the development and viability of the software. The factors are: cost, time, in and out data format, and concepts of the problem. If the software is practicable, we have a product of this process and the project specifications will be made for the next step.

Design: it starts with a known basic model to determinate an outline without details of product and a plan for the development of the software, making appropriate choices concerning the graph design, mathematical methods, languages and tools (e.g., IDE). The decision making in this process defines the final characteristics of the software, and can guarantee the success or failure of the whole project. However, it may be necessary after advancing to the next phase to return to this step within the software development cycle, in order to succeed in codification and to solve possible problems identified by the developer.

Implementation and final product: codification, function tests and others structures created, satisfying all requirements demanded in previous steps without execution errors, composes the program process. As a final product, the software is completed once it meets the initial requirements and solves the question in a satisfactory way. The project is then ready to be integrated into the rest of the system. In due course the final product will require continual maintenance.

User Interface

Users interface with SEREA using a mouse to activate objects and request information about parameters and identify the equations. Each result can be saved for the next module, keeping all data introduced or only one individual module in different order.

Getting Started

The simulator modules were developed to be objective and intuitive aiding the students to achieve better results in a complex mathematical analysis. The program SEREA is composed of five modules (traditional) with the same structure but with differences in the entrance variables, correlations and results: the module of basic parameters of fluidized beds (minimum fluidization velocity and porosity, bed expansion), the module of fluidisation regimes (transition velocities of different regimes), and entrainment of particles. All of them were applied for the hydrodynamic of homogeneous particles. For heterogeneous particles, until now, we developed

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