COMPUTER SIMULATION WESTERN

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ABSTRACT

Computer Simulation Western is a unit within the Department of Applied Mathematics. The purpose of it is the development of computational and mathematical methods for practical problems in industry and engineering and the application and marketing of such methods. We will describe the unit and our efforts in obtaining research and development grants. Some representative projects will be presented. Finally we will discuss our future plans.

1. Computer Simulation Western

This unit within the Department of Applied Mathematics, University of Western Ontario was formed about four years ago by a group of researchers within the department. Members of other departments, such as engineering and statistics, may participate in particular projects for which their expertise is required. The research experience of the members of the unit is mainly in the modelling of physical phenomena and the analysis of these models using a mixture of analytic and computational methods. The final project is usually some form of a computer simulation package.

The purpose of the unit is to encourage the development of numerical and mathematical methods for practical problems in industry and engineering and the application of such methods. We do this by soliciting projects from industry and government agencies and form teams to carry out the required research and development. Usually this has required the employment of a full time research associate.

There are several reasons why the department is involved in such activities.

a) We feel that it is beneficial that at least some of our graduate students work on thesis topics of a practical orientation.

b) We will obtain contacts in industry and government agencies which can be used in assisting students in finding employment.

c) This is a method for obtaining additional research funds which in the present climate of government constraint can be valuable.

d) This will bring some new and interesting research problems to our attention which will lead interesting publications.

2. Marketing

The process of obtaining contracts has been long and arduous, but has led to some very interesting research projects. However, it should be pointed that in average a large amount of time will be spent in obtaining a contract.

The marketing of the services of Computer Simulation Western consists of two parts.

a) Personal contacts

We have approached all the personal contacts we had in industry and government agencies, such as former colleges, former graduate students, etc and made them aware of the aims of CSW and what we thought we could do for their organizations. This led to several invitations to visit the organizations and describe our expertise in more details.

b) Cold calls

The main part of our marketing was to approach companies in which we had no contacts. This consisted of sending a letter to the relevant director of research or similar position describing CSW and informing the particular person that we would phone him a week later in order to see if it would be mutually advantageous for us to visit the company. If a project of interest to both could be found and the company had the necessary money, a proposal would then be prepared. In general our experience shows that

- One out of ten phone calls results in visit
- One out of 25 visists results in a proposal
- One out of two proposals results in a contract
- Best success with foreign owned companies

3. Examples of contracts

We will describe in more detail some of the research projects that we have completed. I will be happy to supply more details of these projects.

Adsorption simulation software

Canmet at Energy, Mines, and Resources

This program simulated the removal of unwanted nitrogen and sulphur compounds from the feedstock during the early stages of fuel production via an adsortion process using zeolites. Both batch and column models were simulated.The mathematical model consists of a coupled system of nonlinear partial differential equations which was solved using a method of lines. This resulted in a coupled nonlinear system of ordinary equations using the LSODI package. The numerical program was successfully run on a 386 microcomputer.

Production of fibre glass

Fiberglas Canada

Glass fibres for insulation purposes are manufactured by pouring molten glass into rotating drums,called spinners, with perforated cylindrical walls. We modelled the production of a single glass fibre. The glass comes out of a spinner at roughly 1000 degrees and is reduced in thickness by a factor of 1000. The model is a system of ordinary and partial differential equations which must be solved numerically. The main effort in this project was in the development of the mathematical model.

Simulation of an airbag crash sensor

Siemens Automotive Products

The sensor consists of a steel ball bearing in a steel tube. The ball is normally kept in one end by a permanent magnet while in the other end of tube there are two spring contacts. When the car is involved in a crash, the magnet cannot hold the ball in position and it rolls down the tube and closes the contact. This sends an electric signal to the airbag which is then inflated. After a considerable amount of analysis the model is reduced to a system of ordinary differential equations.

4. Present Stategy

We have concluded from our experience over the last four years that we should change our strategy. In the future we plan to develop simulation packages for industrial problems on our own time. We will then sell these packages to organizations who can use them. Quite often these packages will have to be customized for a particular project and this will create additional income for us.

This approach will have two advantages over our present approach

i) We can spread the development cost over several projects, and thus offer a lower price

ii) We think it will be easier to sell an existing product rather than a contract for developing the project with delivery at a later time.

At the moment we are in the process of carrying out the following development projects.

a) Simulation of passive ground water pollution

Since the pollutant is passive, the model effectively consists of the three-dimensional diffusion-convection equation. We have developed a fast and efficient procedure for solving it consisting of a Crank-Nicolson procedure for the time derivatives and a sparse matric techique for the resulting system of linear algebraic equations. The novel part of our work consists of

i) An efficient visualization technique

ii) Use of optimal control to design the placement and strength of pumping.

b) School bus scheduling

We are in the process of completing a software package for the optimal routing of school buses. The optimization is carried out using the method of simulated annealing and we are now testing the program on large realistic problems. The final design of the package will be done in conjunction with one of the local school boards which will supply us with advice and data.

The package can easily be adjusted to treat other forms of transportation problems such as routing of emergency vehicles.

c) Inverse problem of resistivity or induced polarization surveys

We have developed a package for the direct problem where the structure of the ground is known and we calculated the resulting field on the surface. The package uses finite differences and a sparse matrix procedure for solving the resulting large system of linear equations. This program can be run for three dimensional problems on a 386 microcomputer. We plan to do the inverse part, where the surface field is known and we wish to find the corresponding subsurface structure, using the simulated annealing technique matrix procedure. The latter part has been completed and is now being tested. We expect to have a first version of the package ready in April.

We will be pleased to supply additional details of these packages and present a demonstration of them.