EUROSIM - Simulation News Europe started a series on comparisons of simulation software. Based on simple, easily comprehensible models special features of modelling and experimentation within simulation languages, also with respect to an application area, shall be compared.

The idea has become quite successful. Here we would like to thank all the authors who took the challenge and the time, solved the problems, documented them and sent in their contributions.

Up to now the following comparisons have been defined:

Comparison 1: Lithium-Cluster Dynamics under Electron Bombardment, November 1990

Comparison 2: Flexible Assembly System, March 1991, comments July 1991

Comparison 3: Analysis of a Generalized Class-E Amplifier, July 1991

Comparison 4: Dining Philosophers, November 1991

Comparison 5: To State Model, March 1992, revised July 1992

We invite all institutes and companies developing or distributing simulation software to participate in this comparison. Solutions of comparisons 1, 2, 3, and 4 described in the previous issues will still be published.

Please, simulate the model(s) and send a report to the editors in the following form (on diskette, any word processing format, or per e-mail):

- short description of the language
- model description (source code, diagram, ...)
- results of the tasks with experimentation comments max. 1 page A4

For publication in EUROSIM - Simulation News Europe all contributions that exceed one page will be modified by the editors to fit into one page.

We also invite you to prepare demo programs, test versions, and animations on diskette and to make them available for interested persons. Please send diskettes to the editors first.

The series will be continued with about two comparisons a year. Preliminary evaluations of the comparison results are also planned.

Comparison 5: Two State Model

Comparison 5 has to be revised due to wrong numbers given for tasks c) and d). Please note that in task c) the time for the last discontinuity has to be changed, and consequently the final value for y_1. In task d) the value for parameter c_2 in state 2 has to be changed. For more information see also comparison 5 solution with SIL, page 38.

In many engineering problems simulation models turn out to be discontinuous. That is, the solution itself is continuous, but either the first or higher order derivatives have jumps. Discontinuities may occur either at specific time points or when certain conditions are satisfied.

When a discontinuity has been passed, not only the model may be changed, but also the function that determines the location of the discontinuity. Consequently, if this discontinuity is not correctly modelled and determined, respectively, the results may go wrong qualitatively.

This example tests the ability of the simulator to handle discontinuities of the forementioned type in a satisfactory way. The problem is as follows

$$dy_1/dt = c_1 * (y_2 + c_2 - y_1)$$

$$dy_2/dt = c_3 * (c_4 - y_2)$$

This ODE system is essentially a simple linear stiff problem with exponential decays as analytical solution. One of these is a very rapid transient, and the stationary solution of the slow decay varies from the two states of the model. This actually "drives" the model (and the discontinuity).

Parameters c_1 and c_3 remain unchanged during simulation: $c_1 = 2.7E{-6}$, $c_3 = 3.5651205$.

The model operates in two states:

c_2 is 0.4 and c_4 is 5.5 when the model is in state 1 (also the initial state). The initial values are $y_1(0) = 4.2$ and $y_2(0) = 0.3$. The model remains in state 1 as long as $y_1 < 5.8$. The choice of c_2 and c_4 ensures that y_1 will grow past 5.8.

When the model switches to state 2, parameters c_2 and c_4 change to $c_2 = -0.3$ and $c_4 = 2.73$. The model remains in state 2 as long as $y_1 > 2.5$. When passing this instance the model switches back to state 1; the choice of c_2 and c_4 ensures that this will happen.

The time interval is 0 to 5.

The tasks to be performed are:

a) Plot y_1 as function of time.

b) Printout the time for every located discontinuity and the final value $y_1(5.0)$.

c) Repeat question b) for the true relative accuracy varying between 10^{-6}, 10^{-10}, 10^{-14}.

Analytical solution values can be found, so for comparison we state that the last discontinuity occurs at time 4.999999646 and the $y_1(5.0)$ value should be approximately 5.369. If the last discontinuity is not located, the previous ones are not found with adequate accuracy. The value of $y_1(5.0)$ also reflects the accuracy of the locations of the discontinuities and any value between 5.8 and 5.1 can be expected.

d) Change the state 2 parameter values of c_2 to -1.25, c_4 to 4.33 and the condition to $y_1 > 4.1$ and rerun a) and b) with a true relative accuracy of 10^{-11}.

Niels Houbak, Technical University of Denmark, Laboratory for Energetics, Building 403, DK-2800 Lyngby.