EUROSIM
Simulation News Europe

Number 6 | A European Forum on Simulation Activities | November 1992


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PHILIN   MACRO       PH(LEFT),"polite

LUPE     ADVANCE     60,60
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         TABULATE    QSIZE
*-----------------------------------
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         GATE NU     P$RIGHT
         TRANSFER    SIM,GRAB,RETRY
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GETL

EATLR                            ,PH(RIGH
*-----------------------------------

THINK                            ,PH(RIGH
         SAVEVALUE   COUNT-,1
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         TERMINATE   1
         START       1
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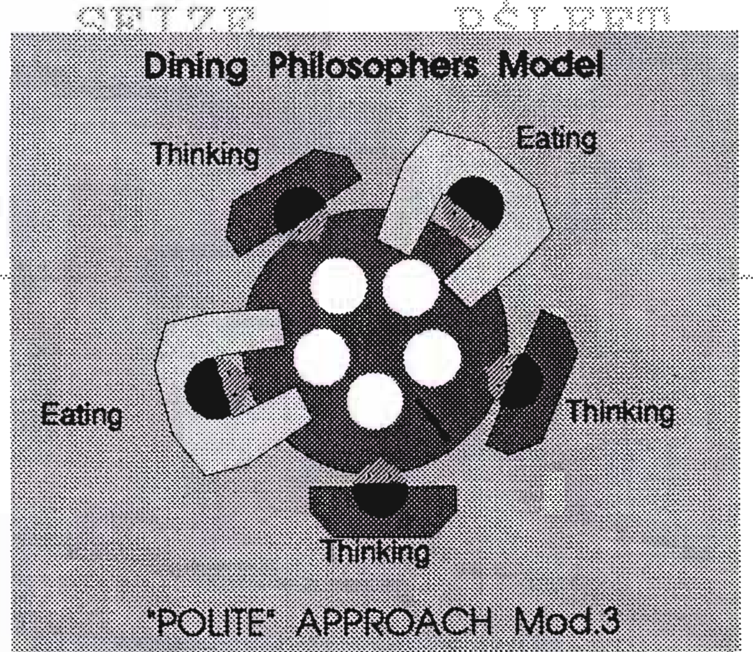

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Readership Information

EUROSIM - Simulation News Europe is published on behalf of EUROSIM (the Federation of European Simulation Societies) three times a year by the "ARGE Simulation News", a non-profit working group. Circulation is 2300. EUROSIM - Simulation News Europe is distributed by all member societies to their individual members (as part of the membership services). In order to promote the idea of simulation in Europe, EUROSIM - Simulation News Europe is distributed to institutions, libraries, and specific persons dealing with simulation, furthermore to simulation groups in the former East European countries. These activities are possible through advertisement sponsoring. For extra copies, product announcements, advertisements, and other organisational affairs please contact the editors.

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Editorial Board of the European Simulation Societies:

Editorial

The idea of the newsletter **EUROSIM - Simulation News Europe** is to promote simulation in Europe by dissemination of information related to simulation.

Following this purpose we publish essays on simulation, reports from EUROSIM and the founders of EUROSIM (the European simulation societies), reports from international societies, presentations of simulation centers, industry news, book reviews, discussion forum, calendar of events, etc. Furthermore a series on software comparisons tries to give an overview on features of simulation languages.

This issue has become quite comprehensive, due to two very interesting essays, numerous contributions from the European simulation societies and from international societies, software comparisons and many more.

We reported on the **software comparisons** at the first EUROSIM Congress in Capri (a report of the congress can be found on page 4) and encountered many positive reactions on the idea of the comparisons.

We again received a number of solutions with new tools. You can still send in solutions for the previous comparisons, there are several software tools that have not yet been introduced. For comparison 1 we have received 18 solutions up to now and have done a preliminary summary of some results. A new comparison for discrete event simulation is introduced.

In 1993 **Elsevier Science Publishers** will publish the newsletter EUROSIM - Simulation News Europe under our editorship. Furthermore the new journal "**Simulation Practice and Theory**" will include the newsletter three times per year (March, July, November) as an addendum. Members of the European simulation societies will continue to receive the newsletter, as in the past two years. Please see page 8 for more information on the new journal. The first issue of the newsletter published by Elsevier will probably be the July issue.

We say "thank you" to all authors who contributed to this issue. All readers are kindly invited to send letters, comments, suggestions or contributions to one of the editors. Deadline for the next issue will be March 2, 1993.

We wish you a Merry Christmas and success with your simulations in 1993!

F. Breitenecker, I. Husinsky

EUROSIM - Simulation News Europe

Scope: Information on simulation activities, membership information for European simulation societies

Published by: ARGE Simulation News

Editors: F. Breitenecker, I. Husinsky

Printed by: HTU-Druck

Address: c/o Computer Center, Technical University of Vienna, Wiedner Hauptstraße 8-10, A-1040 Wien, Austria.

EUROSIM News

EUROSIM, the Federation of European Simulation Societies was initiated in 1989. The purpose of EUROSIM is to provide a European forum for regional and national simulation societies to promote the advancement of modelling and simulation in industry, research, and development.

The following national and regional simulation societies founded EUROSIM: ASIM - Arbeitsgemeinschaft Simulation (Austria, Germany, Switzerland), DBSS - Dutch Benelux Simulation Society (Belgium, The Netherlands), FRANCOSIM - Société Francophone de Simulation (Belgium, France), ISCS - Italian Society for Computer Simulation (Italy), SIMS - Simulation Society of Scandinavia (Denmark, Finland, Norway, Sweden), UKSS - United Kingdom Simulation Society (UK). President is Prof. F. Maceri (ISCS).

Report on the EUROSIM '92 Simulation Congress

EUROSIM '92, the first international Congress of the EUROSIM Federation, was organized on behalf of EUROSIM by the ISCS (general chairman was Prof. Franco Maceri, EUROSIM President) in co-operation with ASIM, DBSS, FRANCOSIM, SIMS, and UKSS. It attracted more than 150 participants and was held at the Grand Hotel Quisisana and the Tiberio Palace in Capri, Italy, from September 29 through October 1, 1992.

This Congress involved more than 30 sessions with 6 invited lectures and 92 contributed talks, presented in three parallel sessions. Papers were selected from 154 submissions by the Scientific Committee under the chairmanship of Prof. G. Iazeolla (University of Rome "Tor Vergata"); the selection was a two-stage process based first on extended abstracts, and then on full paper texts. The large number of papers coming from Europe demonstrates the growing interest of the European scientific and industrial community in the field of simulation.

The contributions covered several topics, including theory, tools, and applications. In particular: Simulation Methodologies (13 papers), Simulation Tools and Languages (12), Simulation in Construction and Transportation (13), Simulation in Electronics and Control (8), Simulation in Computer Systems and Networks (8), Parallel and Distributed Simulation (8), Simulation in Factory and Automation (6), Simulation in Environmental and Biological Systems (6), Simulation in Electrical Engineering and Energy Systems (6), Simulation in Business and Management (7), Simulation in Education and Training (5).

The invited talks were:

"The simulation of dynamics in transportation networks: state of the art and future developments" (E. Cascetta, University of Naples, Italy),
"Numerical methods and software for ODEs/DAEs/PDEs" (W.E. Schiesser, Lehigh University, Bethlehem, PA),
"Collaborative enterprises" (R. Reddy, West Virginia University, Morgantown, WV),
"Advances in continuous and discontinuous simulation" (R.E. Crosbie, California State University, Chico, CA),
"Simulating dynamics and neural networks under DOS, OS/2 and Unix" (G.A. Korn, University of Arizona, Tucson, AZ),
"Cultural consumption, growth and chaos" (P.L. Scandizzo, University of Roma "Tor Vergata")

In addition to the exhibitor stands at the Congress site an Exhibitor Session was included in the program; simulation software was presented, among others, by Rapid Data.

The official proceedings of the congress will be published by Elsevier-North Holland at the beginning of 1993. Elsevier announced for the same period the first issue of the new journal "Simulation Practice and Theory", edited by Prof. L. Dekker (Delft University of Technology, The Netherlands).

This congress was also the occasion to hold several meetings (ACSL User Group, ISCS Annual Meeting, EUROSIM Board) and to give Dr. H. Hjelmgren (Sweden) the Giorgio Savastano Award for his paper "Numerical Modeling of Hot Electrons in n-GaAs Schottky-Barrier Diodes" in the electrical engineering field. Furthermore, an interesting session on "Simulation in ESPRIT projects", chaired by Dr. W. Krug (Dresden University of Technology), was held at the Tiberio Palace; three main topics were dealt with, i.e. Branches of simulation, Simulation software, and Support through expert systems.

In addition to the scientific program, several social events accompanied the stay of the participants: from the Welcome cocktail to the Open air dinner (where many participants had the occasion to dance and sing Neapolitan songs), to the Concert for violin and piano held in the theater hall of the Grand Hotel Quisisana, to the Conference banquet in Anacapri (where the place of the next EUROSIM Congress was announced: Vienna!).

M. Colajanni

Prof. Murray-Smith thanks Prof. Maceri and presents an umbrella with the signatures of the EUROSIM Board members.

Sensitivity Analysis and Optimization of Simulation Experiments, including Case Studies

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This essay was written at the request of the editors of 'EUROSIM - Simulation News Europe', which is published on behalf of the Federation of European Simulation Societies.

Abstract

This tutorial gives a survey of what-if analysis and optimization of simulation models, using statistical techniques for the design and analysis of experiments with these models. The simulation models may be deterministic or random. The statistical analysis uses regression (meta)models and Least Squares. The design uses classic experimental designs such as 2^{k-p} factorials, which are both efficient and effective. If there are hundreds of simulation inputs, then special techniques such as group screening and sequential bifurcation may be used. This overview emphasizes applications.

1. Introduction

By definition, simulation involves experimentation, namely with the *model* of a real system. Experimentation requires an appropriate *statistical design and analysis*. Pertinent questions are: which combinations of simulation inputs should be simulated, and how can the resulting output be analyzed? These questions arise in both random and deterministic simulations. Mathematical statistics can be applied to solve these problems, also in deterministic simulation; see Kleijnen and Van Groenendaal (1992, p. 154). In this tutorial I emphasize simple 'academic' examples and practical case studies; for details on statistical procedures I refer to the literature. To save space I refer to a recent introductory textbook, namely Kleijnen and Van Groenendaal (1992), which contains many references for further study. Note that sensitivity analysis and optimization are also addressed in *model validation, what-if analysis*, and *goal seeking*.

2. Regression Metamodels

It is good practice to present the results of simulation experiments in the form of graphs. Consider an 'academic' example, namely a single-server queuing system. Its average simulated waiting time (say) y may be displayed as a function of mean service time (say) x. If the simulation experiment is restricted to a small range of values for x, then $y = a + b\ x$ is probably an adequate approximation for the input/output behavior of the simulation model. An alternative presentation replaces x by 1/x (service rate). If the 'domain of experimentation' is wider or if the queuing system is nearly saturated (high traffic loads lead to 'exploding' waiting times), then an alternative display uses $y = a + b\ x + c\ x^2$: second-order approximation (based on Taylor series expansion). One more alternative, however, uses logarithmic paper: $\ln(y) = a + b \ln(x)$ (or $y = c\ x^b$ with $a = \ln c$). Moreover, even this simple simulation model has more than one input: besides mean service time there is mean interarrival time. One possibility is to superimpose upon the graph discussed so far, another graph for a different arrival rate. The latter graph lies above the former graph if the new arrival rate is higher. If there is no *interaction* between arrival and service rates, then (by definition) the two graphs are parallel. Queuing theory suggests that it is better to present average waiting time as a function of the traffic load (arrival rate/service rate), instead of the two individual inputs. This example may be extended: present one graph for one server, superimpose the graph for two servers, etc.; see Kleijnen and Van Groenendaal (1992, pp.159-162).

Regression analysis formalizes this graphic presentation of simulation results: least squares is used to fit a regression model (like $y = a + b\ x$) to the simulation input and output data; the regression model is generalized to include several simulation inputs ('multiple' regression analysis); and the importance of these inputs can be tested, under certain statistical assumptions. I call the regression model a *metamodel* because it models the input/output behavior of the underlying simulation model; the latter model is treated as a black box.

Before systems analysts start experimenting with a simulation model, they have accumulated *prior knowledge* about the real system: they may have observed the real system, tried different simulation models, debugged the final simulation program, etc. I propose to formalize this (tentative) knowledge in the form of a regression model (this model must be tested later on to check its validity; see below). This regression model specifies which *inputs* and which *interactions* among these inputs seem important. These inputs are not only simulation parameters (e.g., service and arrival rates) and variables (say, number of servers) but also 'behavioral relationships' (like priority rules). 'Interaction' means that the effect of an input depends on the values of another input. So a tentative regression metamodel may be

$$y = \beta_o + \sum_{j=1}^{k} \beta_j x_j + \sum_{j=1}^{k} \sum_{g=j}^{k} \beta_{jg} x_j x_g + e , \qquad (1)$$

where β_o is the overall simulation response; β_j is the main or first-order effect of simulation input j; β_{jg} is the two-factor interaction between the inputs j and g ($g \neq j$); β_{jj} is the quadratic effect of input j (curvature); e denotes fitting or approximation error; y is 'the' response of a simulation run. Actually, a simulation run yields a time series of output values. That time series, however, can be summarized by one or more characteristics such as its average, its maximum, or its value at the end of the run. Moreover, the simulation model has several responses that are of interest; e.g., average waiting time of customers and utilization degrees of servers. I propose to apply eq. (1) to each response type individually. More sophisticated multivariate regression analysis is not warranted; see Kleijnen and Van Groenendaal (1992, p. 164).

To estimate $\boldsymbol{\beta} = (\beta_o, \beta_1, \ldots, \beta_k, \ldots, \beta_{12}, \ldots, \beta_{kk})'$ (the effects of the simulation inputs), we fit a curve to the simulation data (**X**, **y**) where **X** denotes the nxQ matrix of inputs and **y** denotes the vector of n simulation outputs; in this case $Q = 1 + k + k(k-1)/2 + k = 1 + k + k(k+1)/2$. The classic fitting criterion is *Least Squares*. This criterion yields the estimator

$$\hat{\boldsymbol{\beta}} = (X'X)^{-1}X'y, \qquad (2)$$

where a necessary but not sufficient condition for **X** is $n \geq Q$; see the next section.

Once the regression model is calibrated (its $\boldsymbol{\beta}$ is estimated), the *metamodel's validity* must be tested. For deterministic simulation models I propose cross validation: delete one of the n input combinations and its output (drop x'_i, y_i), reestimate from the remaining simulation data

$$(\hat{\boldsymbol{\beta}}_{-i} = (X'_{-i} X_{-i})^{-1} X'_{-i} y_{-i});$$

predict the deleted simulation response y_i through the re-estimated regression model

$$(\hat{y}_i = x'_i \hat{\boldsymbol{\beta}}_{-i});$$

'eyeball' the relative prediction errors $\hat{y}_i / y_i$: are these errors acceptable to the user? For random simulations I prefer a lack-of-fit F-test (developed by Rao), unless the simulation-responses are not normally distributed (then cross validation is better). See Kleijnen and Van Groenendaal (1992, pp. 154-158).

The magnitudes of the estimated input effects $\hat{\boldsymbol{\beta}}$ quantify the importance of the corresponding inputs. Applications are numerous in deterministic and in random simulation. One case study concerns a set of deterministic ecological models (non-linear difference equations) that represent the effects that different gasses have on the global temperature: 'greenhouse' effect. These models require sensitivity analysis to support the Dutch government's decision making. Details are given in Kleijnen, van Ham and Rotmans (1992).

Optimization of the simulated system can be tried through *Response Surface Methodology* (RSM). In the first experiment a small area is explored, and RSM uses a first-order regression metamodel (see eq. (1) with the double summation term removed). The steepest ascent path (a search direction perpendicular to the regression plane) is followed to determine the next local experiment. After a number of local experiments, the 'hill top' is reached, and a (hyper)plane does not fit that (curved) top. Then a more extensive experiment is executed, which is analyzed through a second-order model (see eq. (1)). An application is provided by a decision support system (DSS) for production planning, developed for a Dutch company. To evaluate this DSS, a discrete-event simulation model is built. The DSS has 15 controllable inputs that are to be optimized. The effects of these 15 inputs are investigated, using a sequence of experiments (also see next section). Originally, 34 simulation response variables were distinguished. These 34 variables, however, can be reduced to one criterion variable, namely productive machine hours, that is to be maximized, and one commercial variable measuring lead times, that must satisfy a certain constraint. See Kleijnen and Van Groenendaal (pp. 181-185).

In all experiments, analysts use models such as eq. (1), explicitly or implicitly. For example, if they change one input at a time, then (implicitly) they assume that all interactions are zero. Of course it is better to make the regression model explicit and to find a design that fits that model, as I shall show next.

3. Experimental Design

For pedagogical reasons I first discuss classic designs and then discuss new designs for the initial screening phase of simulation experiments.

The nxk design matrix $\mathbf{D} = (d_{ij})$ specifies the n combinations of the k inputs that are to be simulated. (In multi-stage experimentation such as RSM, this set of combinations is followed by a next set.) Classic experimental design theory gives designs that are both 'efficient' and 'effective'. *Efficiency* means that n, the number of input combinations or simulation runs, is 'small'. Below eq. (2) we saw the condition $n \geq Q$ (Q denotes the number of effects in the regression metamodel). For example, k + 1 runs suffice if the k inputs are assumed to have first-order effects only. A popular but inferior design implies that the analyst observes the base situation, and then changes one input at a time. For example, for three inputs this design is: base run (-, -, -) where - means that the input is at its base value (this row vector is row 1 of **D**), (+, - ,-) as input 1 is increased from its base value to its maximum value within the area of experimentation, (-, +, -) as input 2 is increased, and (-, - , +) for input 3. Note that $\boldsymbol{\beta}_o$ corresponds with a vector of n ones in **X** of eq. (2), so **X** is 4x4 in this example with three first-order effects and one overall mean.

Now consider the *fractional factorial* 2^{3-1} design: its four columns are (-, +, -, +), (-, -, +, +), (+, -, -, +) (these columns specify **D**). It is easy to check that the corresponding **X** is orthogonal. Hence eq. (2) reduces to the scalar expression

$$\hat{\beta}_{j'} = \sum_{i=1}^{n} x_{ij'} \; y_i / n \quad (j' = 0,1,\ldots,k). \qquad (3)$$

How can we choose between these two designs? Classic statistical theory assumes that the fitting errors e are *white noise*: e is normally and independently distributed with zero mean and constant variance (say) σ^2. Then the variance-covariance matrix for the estimated input effects is

$$cov(\hat{\beta}) = \sigma^2 (X'X)^{-1} .$$

It can be proved that an orthogonal matrix **X** is *'optimal'*. Actually, there are several optimality criteria; see Kleijnen (1987, p. 335). Anyhow, an orthogonal **X** minimizes the variances of the estimated effects (the elements on the main diagonal of eq.(4)). There are straightforward procedures for deriving 'good' design matrices in case n equals 2^{k-p} with p=0,1...; for other n values there are tables and software; see Kleijnen and Van Groenendaal (1992, pp. 167-186).

Classic designs are also *effective*: they permit the estimation of *interactions*. If the regression metamodel includes two-factor interactions, then Q (the number of effects) increases to $1 + k + k(k-1)/2$. For example, if $k = 5$ then a 2^{5-1} design specifies 16 simulation runs to estimate 16 effects. If the inputs are quantitative, then a second-order regression model includes k quadratic effects. In such a model, n must further increase and more than two levels per input must be simulated. See Kleijnen and Van Groenendaal (1992).

A case study concerns a Flexible Manufacturing System (FMS). The four inputs of the deterministic simulation consists of the 'machine mix', i.e., the number of machines of type j with $j = 1,...,4$. Intuitively selected combinations of these inputs give inferior results when compared with a classic design. The simulation data are analyzed through two different regression metamodels. These models are validated: a regression model with only two inputs but including their interaction, gives valid predictions and sound explanations. See Kleijnen and Van Groenendaal (1992, pp. 162-164).

For didactic reasons I present *screening* designs after the classic experimental designs. In practice, most simulation models have many inputs; of course the analysts assume that only a few inputs are really important (parsimony). So in the beginning of a simulation project it is necessary to search for the few really important inputs among the many conceivably important inputs.

One approach is *group screening*, introduced in the early 1960s by several authors. This technique aggregates the many individual inputs into a few groups. Some simulation applications can be found in Kleijnen (1987, p. 327); these applications are queuing simulations. Recently Bettonvil and Kleijnen (1992) further developed group screening into *sequential bifurcation*, which is a very efficient technique that accounts for white noise and interactions. They applied this technique to screen the greenhouse model (discussed above) with nearly 300 inputs!

More efficient but complicated approaches do not treat the simulation model as a black box, but use analytical differential analysis: *perturbation analysis* and *score function*; see Kleijnen and Van Groenendaal (1992, p. 181).

Experimental design theory concentrates on a single response variable (denoted by y in this paper). In practice we can use the resulting designs to specify simulation runs; next we observe *several* responses per input combination, and analyze these results through regression analysis, as explained in the preceding section. See Kleijnen and Van Groenendaal (1992).

4. Conclusions

Experimental design and regression analysis are statistical techniques that are gaining popularity in simulation. These techniques are used for sensitivity analysis and optimization of simulation models. A number of case studies have been published. The techniques need certain adaptations to account for the peculiarities of simulation. Their application to simulation is straightforward.

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Direct-executing Simulation of Dynamic Systems and Neural Networks

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Abstract

DESIRE (Direct Executing SImulation in REal time) software interprets an experiment-protocol program which sets parameters and displays and then calls repeated simulations, say for optimization or model matching. The first interpreter call for a simulation run automatically compiles the model description (typically differential and/or difference equations) directly into the computer memory and executes the run at once. The small runtime compiler produces efficient machine code in under 0.2 sec. Hence screen-edited programs appear to execute immediately for truly interactive modelling. DESIRE solves up to 1500 nonlinear scalar and/or matrix differential equations and offers many integration rules, complex frequency-response plots, and matrix inversion. DESIRE/NEUNET combines such dynamic-system simulations and neural networks constructed with simple vector/matrix assignments and difference equations. We exhibit simulations of a fuzzy controller and of a backpropagation encoder network.

The DESIRE Technique

Simulation is experimentation with models. Interactive modelling requires changing not only parameters but also model equations and experiment protocol - literally hundreds of times until the model works and the display looks good. Popular FORTRAN-based simulation packages (ACSL, DARE) frustrate such interactive experimentation because of the repeated, minute-long delays caused by program translation, compilation, and linking. In contrast, interpreter programs such as BASIC and some graphic-input block-diagram simulation interpreters, execute directly without annoying delays; but their interpreted differential-equation-solving code is invariably and necessarily too slow for realistically large simulations.

DESIRE (Direct Executing SImulation in REal time) systems offer a serendipitous way out [1]. We interpret an experiment-protocol program setting parameters, initial conditions, and displays for repeated simulations of a model, which is typically defined in terms of differential equations. When the experiment protocol asks for the first simulation run with **drun**, a small, very fast compiler writes the time-critical differential-equation code directly into the computer memory. The compiled code executes immediately to produce a simulation run. On 386 -or 486-class personal computers or SUN SPARCstations, DESIRE compiles even large simulation models in well under 0.2 sec. Screen-edited programs, then, produce solution graphics at once on a typed **run** command, and truly interactive modelling becomes possible.

DESIRE and DESIRE/NEUNET are fully described in two textbooks [1,2], which include complete student versions of the programs and many examples. Commercially available full program packages can solve up to 1500 differential equations in scalar and/or vector form, or up to 50 differential equations when stiff-system integration rules are used. Neural-network simulations may have thousands of interconnects, can deal with multiple neural networks, and may be combined with simulations of dynamic systems such as robots or physiological models.

```
--           FUZZY-SET APPROXIMATION OF A LINEAR CONTROLLER
---------------------------------------------------------------
FUNCTION min(u$,v$)=u$-lim(u$-v$) ¦ --  user-defined function
--
---------------------------------------------------------------
TMAX=16 ¦ DT=0.005 ¦ NN=4000 ¦ scale=2 ¦ display N15
--
e0=3 ¦ xD0=3  ¦ --                              range limits
A=0.8 ¦ w=.5 ¦ --                               input signal
k=20 ¦ r=3 ¦ maxtrq=0.85 ¦ g2=2 ¦ R=0.6 ¦ --   parameters
--
--        set up b$ and reciprocal for membership functions
--
b=1/(2*e0) ¦ bD=1/(2*xD0)
--
drun  ¦ STOP ¦ --                        make a simulation run
---------------------------------------------------------------
--                                              editing screen
label eee
  list 360-400
---------------------------------------------------------------
DYNAMIC
---------------------------------------------------------------
u=A*cos(w*t) ¦ --                                      input
e=x-u ¦ --                                       servo error
--
--                                      membership functions

E1=b*lim(e0-e) ¦ E2=b*lim(e+e0)
XD1=bD*lim(xD0-xDot) ¦ XD2=bD*lim(xDot+xD0)
--
--  fuzzy logic approximates PQ with min(P,Q) (4 rules only!)
--
V=(k+r)*(min(E1,XD1)-min(E2,XD2))+(k-r)*(min(E1,XD2)-min(E2,XD1))
--
torque=maxtrq*sat(g2*V/maxtrq) ¦ --   saturating motor torque
d/dt x=xDot ¦ d/dt xDot=torque-R*xDot ¦ --   servo dynamics
---------------------------------------------------------------
--                                  offset curves for display
OUT
M1=E1-scale ¦ M2=E2-scale ¦ X=x+0.5*scale ¦ U=u+0.5*scale
TORQUE=torque-0.5*scale ¦ ERROR=e+0.5*scale
dispt X,U,ERROR,TORQUE,M1,M2
```

Fig. 1. Complete DESIRE program simulating a fuzzy servomechanism.

Example: Simulation of a Fuzzy Controller

Figure 1 shows the complete DESIRE simulation program for a fuzzy-logic-controlled servomechanism [3]. The interpreted experiment-protocol program declares the user-defined function

```
min(u$,v$) = u$ - lim(u$ - v$)
```

where **lim(t) = max(t,0)** is a DESIRE library function; **min(u$,v$)** can now be freely used anywhere in the program. We next set simulation and display parameters (integratian step, number of display points, display scale, color) and then servo model parameters. Then **drun** calls one simulation run.

The DYNAMIC program segment defines the simulation model. We successively specify the servo input **u =A*cos(w*t)**, the (inverted) servo error **e = x - u**, the fuzzy controller, and the state differential equations for the servo dynamics.

The fuzzy controller approximates the classical linear control law

```
V = k*e + r*xDot
```

for the servo error **e** and the output rate **xDot** with only 4 rules,

```
if e < 0 AND xDot < 0 then V = - k - r
if e > 0 AND xDot < 0 then V = k - r
if e < 0 AND xDot > 0 then V = - k + r
if e > 0 AND xDot > 0 then V = k + r
```

We need only 4 very simple membership functions,

```
E1=b*lim(e0-e)        E2=b*lim(e+e0)
XD1=bD*lim(xD0-xDot) XD2=bD*lim(xDot+xD0)
```

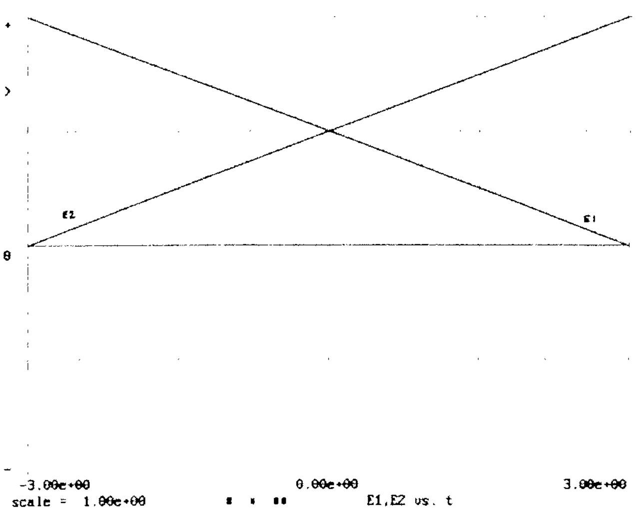

Fig. 2. Simple membership functions E1(t), E2(t) for two fuzzy sets corresponding to t < 0 and t > 0. We assume that the variable t will never exceed e0 in absolute value.

corresponding to fuzzy sets for **e < 0**, **e > 0**, **xDot < 0**, and **xDot > 0** (Fig. 2). Memberships for logical unions (**AND**) of fuzzy sets with membership functions **P**, **Q** are approximated with **min(P,Q)**. The controller output **V** is generated by averaging over all 4 possible cases:

```
V=(k+r)*(min(E1,XD1)-min(E2,XD2))
       +(k-r)*(min(E1,XD2)-min(E2,XD1))
```

The state equations then are

```
d/dt x=xDot              d/dt xDot=torque-R*xDot
```

Integration defaults to a second-order Runge-Kutta rule; users can select other rules.

The remainder of the DYNAMIC program segment produces displays of the servo input, output, error, and torque and also of the two error membership functions versus the time t. For display clarity, different graphs are offset to look like two stripchart records (Fig. 3). DESIRE can also scale displays automatically with an extra computer run [1].

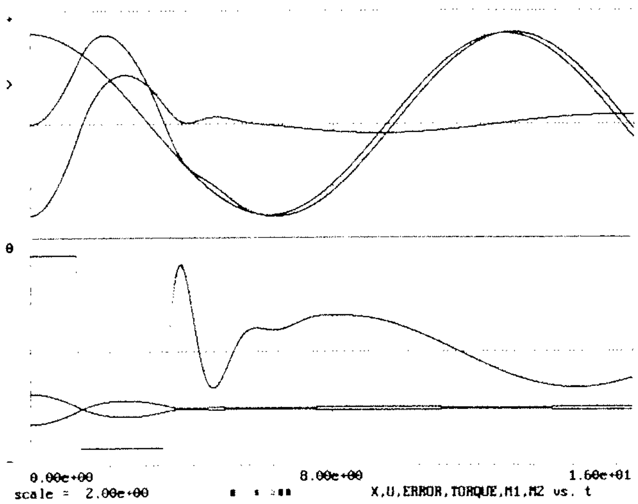

Fig. 3. VGA screen print showing the fuzzy-servo simulation. The original screen was in color; the square tablets at the bottom are color keys.

The controller performance shown in Fig. 3 closely approximates that of a linear controller. In fact, substitution of the membership-function product **P*Q** for **min(P,Q)** in our fuzzy-logic implementation would produce exact linear interpolation, but **min(P,Q)** is less costly in integrated-circuit controllers.

Interactive Modelling and DESIRE Editing Screens

The experiment protocol can be programmed to change parameters and/or initial conditions and call additional simulation runs. But we may just want to make a single run and then change, say, the servo damping coefficient **r** interactively and run again. We need not screen-edit our entire program. We simply type

```
reset
r = 15
drunr
```

reset resets all state variables to their initial conditions, and **drunr** is equivalent to the combination **drun | reset**; we can now try other parameter values and/or initial conditions without typing reset, e.g.

```
r = 17 | k = 25 | drunr
```

For more elaborate program changes, we still need not scan and edit the complete, possibly long, program. Referring to Fig. 1, the command **go to eee** (which is conveniently programmed into the function key **shift-F9**) executes the program segment starting with label **eee**. As seen from Fig. 1, this displays user-selected program lines for screen-editing. Such an editing screen typically comprises numbered program lines with parameter assignments, but can also contain any other numbered program lines, such as differential equations or function definitions which are changed frequently. In addition, editing screens can contain comments or instructions for users. Screen-editing changes only the program in memory; typed commands **save** or **save 'filespec'** can save the changes on disk. There are also commands to save program changes and/or comments in a journal file. Finally, DESIRE lets users create their own help screens and menus to help with interactive programming [1].

Neural-network Simulation: A Backpropagation Encoder

We next discuss the matrix/vector operations needed to simulate a neural network, the 3-bit backpropagation encoder of Fig. 4. We want to train the connection weights between the network layers to reproduce N selected input patterns at the output; the smaller hidden layer will then an encoded version of each input pattern [2].

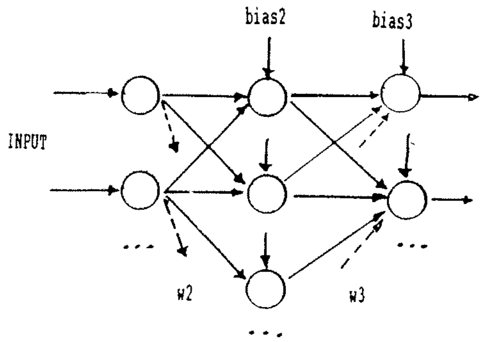

Fig. 4. A neural network (backpropagation encoder).

The DESIRE/NEUNET experiment protocol must declare one-dimensional arrays for each neuron-layer activation and bias-input vector,

```
ARRAY layer1[n],layer2[m],layer3[n],bias2[m],bias3[n]
```

with **n = 8** and **m = 3**, and two dimensional arrays for the connection-weight matrices joining **layer2** to **layer1** and **layer3** to **layer2**:

```
ARRAY w2[m,n],w3[n,m]
```

We also declare a pattern matrix **INPUT[m,N]** whose **N = 8** rows will be filled with N m-dimensional input-pattern vectors for our encoder,

```
1,0,0,0,0,0,0,0
0,1,0,0,0,0,0,0
...............
```

A compiled DYNAMIC program segment can now define the network operation in a simple matrix language, which is not difficult to read:

```
----------------------------
DYNAMIC
----------------------------
iRow=t | VECTOR layer1=INPUT#
VECTOR layer2=tanh(w2*layer1+bias2)
VECTOR layer3=tanh(w3*layer2+bias3)
```

Each **VECTOR** assignment modifies an entire vector of neuron activations as the time variable t increments through successive "trials". The first statement

```
iRow=t | VECTOR layer1=INPUT#
```

successively assigns the tth row-pattern of the pattern matrix **INPUT** to the activation vector **layer1** for t = 1,2,..., cycling back to t = 1 after t = n. **iRow** could also be chosen to present the same pattern N times, to present patterns in random order, etc. We have selected the neuron activation function **tanh** (soft limiter) for both **layer2** and **layer3**; many other library vector functions are available.

To simulate the training process, we need to declare additional vectors for the output-layer error and its derivatives:

```
ARRAY error[n],delta2[m],delta3[n]
```

Then the classical backpropagation algorithm is implemented with

```
VECTOR error=INPUT#-layer3 | -- backpropagation
VECTOR delta3=error*tri(layer3)
VECTOR delta2=w3%*delta3*tri(layer2)
---
---                                   update the weights
UPDATE bias2=gain2*delta2
UPDATE bias3=gain3*delta3
LEARN w2=gain2*delta2*layer1
LEARN w3=gain3*delta3*layer2
```

Here the library function **tri(x) = 1 - abs(x)** is an efficient approximation of the classical activation-function derivative 1= x*x, and

```
UPDATE vector = vector expression
   is equivalent to
VECTOR vector = vector + vector expression

LEARN matrix = matrix expression
   is equivalent to
MATRIX matrix = matrix + matrix expression
```

UPDATE and **LEARN** statements are seen to implement Euler integration of vectors and matrices.

It remains to produce and display a scalar squared-error measure **enormsq** as an inner product (**DOT** product):

```
DOT enormsqr=error*error | -- square-error measure
---------------------------------------------------
MSQ=4*enormsqr-scale    | -- offset display curves
dispt MSQ
```

Figure 5 shows the complete DYNAMIC program segment, and Fig. 6 illustrates a typical training run. The **layer2** activations converge to a binary code.

```
----------------------------------------------------
DYNAMIC
----------------------------------------------------
--                               weight-learning run
iRow=t
VECTOR layer1=INPUT#
VECTOR layer2=tanh(w2*layer1+bias2)
VECTOR layer3=tanh(w3*layer2+bias3)
------------------------------------
VECTOR error=INPUT#-layer3 | --       backpropagation
VECTOR delta3=error*tri(layer3)
VECTOR delta2=w3%*delta3*tri(layer2)
--
--                                    update weights
--
UPDATE bias2=gain2*delta2 | UPDATE bias3=gain3*delta3
LEARN w2=gain2*delta2*layer1 | LEARN w3=gain3*delta3*layer2
--
DOT enormsqr=error*error | --   squared-error measure
----------------------------------------------------
MSQ=4*enormsqr-scale | --       offset display curves
dispt MSQ
----------------------------------------------------
```

Fig. 5. DYNAMIC program segment for the backpropagation encoder network.

More General Neural-network Simulations

Most commercially available neural-network programs implement only a fixed set of "canned" network algorithms with menu-controlled parameters. But DESIRE/NEUNET's general matrix language lets users construct their own new neural networks or modify known algorithms to include new features. Reference 2 shows many examples, including competitive learning with and without "conscience" algorithms and adaptive-resonance emulation, non-square error measures, and simulations involving more than one neural network. Since DESIRE/ NEUNET also includes a complete differential-equation solving simulation system, it is possible to model not only neural networks, but dynamic systems like robots or physiological systems controlled by neural networks. This is an exciting, largely unexplored field for future research.

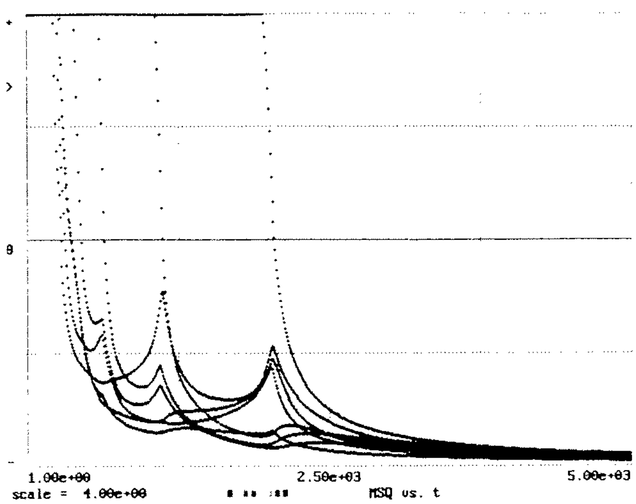

Fig. 6. A typical encoder-network training run. The program cycles through 8 different input patterns in successive trials, so that error-measure values for all 8 input patterns are plotted.

DESIRE programs run on 286, 386, and 486 PCs with math coprocessors and VGA or EGA graphics, and on SUN SPARCstations. A special UNIX version also generates ANSI C neural-network source code during interactive simulations.

References

1. Korn, G.A: Interactive Dynamic-system Simulation, McGrawHill, N.Y., 1989.
2. Korn, G.A: Neural-network Experiments on Personal Computers and Workstations, MIT Press, Cambridge, 1991.
3. Kosko, B: Neural Networks and Fuzzy Svstems, Prentice-Hall, Englewood Cliffs, NJ, 1991.

ASIM

ASIM (Arbeitsgemeinschaft Simulation) is an association for simulation in the German speaking area. ASIM was founded in 1981 and has now about 650 individual members.

Reports from ASIM

The last meeting of the ASIM board was on April 2nd, 1992 in Berlin. A report was in the last issue. The next meeting of the board will be on November 16th, 1992 in Frankfurt.

The founding meeting of the working group "*Simulation von Verkehrssystemen*" was held on July 2-3, 1992 in Xanten. About 25 engineers and scientists took part in the meeting, at the invitation of Prof. Baron from Universität Dortmund. It was resolved that the group will concentrate its work in the following areas: How can unnecessary traffic be avoided? How can the remaining traffic be controlled? How can simulation aid in solving transportation problems?

Contact Addresses

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ASIM Meetings to come

February 10-11, 1993: Conference on "*Simulation und Fabrikbetrieb*" in Aachen, organized by the Working Group *Simulation in der Fertigungstechnik*. For more information contact Prof. Dr. A. Kuhn.

March 8-9, 1993: 10th Workshop of the working group "*Simulation technischer Systeme*" in Erlangen. For more information contact Prof. G. Kampe.

March 15-17, 1993: *4. Symposium Simulation als betriebliche Entscheidungshilfe* in Braunlage (Harz), organized by the working group "*Simulation in der Betriebswirtschaft*". Contact: Fr. B. Hollenbach, Georg-August-Universität Göttingen, Inst. f. Wirtschaftsinformatik, Platz der Göttinger Sieben 7, Tel: +49-(0)551/394440, Fax: +49-(0)551/399679.

March 25, 1993: Meeting of the working group "*Simulation von Verkehrssystemen*" in Karlsruhe. For more information contact Mr. Karl-Heinz Münch.

April 22-23, 1993: Meeting of the working groups "*Simulation und künstliche Intelligenz*" and "*Simulationssoft- und -hardware*" in Karlsruhe. For more information contact Dr. J. Krauth.

September 28-30, 1993: *8. Symposium Simulationstechnik* in Berlin. This is ASIMs 1993 German speaking conference. For more information contact Ralf-Peter Schäfer, GMD-First, Rudower Chaussee 5, Geb. 13.7, O-1199 Berlin. A first call for papers can be obtained as well from Dr. Bausch-Gall.

Reports from the Working Groups

Working Group "Simulationsmethoden und Sprachen für parallele Prozesse"

Speaker of the working group: Dr. Hans Fuss, GMD-I1, Postfach 1240, W-5205 St. Augustin 1. Tel: +49-(0)2241/14-0, Fax: +49-(0)2241/14-2889, E-mail: fuss@gmd.de

Working Group "Simulationssoftware und -hardware"

See also working group "*Simulation und künstliche Intelligenz*".

Speaker of the working group: PD Dr. J. Halin, ETH Zürich, Institut für Energietechnik, Clausiusstrasse 33, CH-8092 Zürich. Tel: +41-(0)1/256-4608, Fax: +41-(0)1/262-2158

Working Group "Simulation und künstliche Intelligenz"

This ASIM working group investigates ways to combine artificial intelligence and simulation techniques. The origin of most of its members is simulation, and therefore the most interesting question for us is: How can simulation benefit from the achievements of AI? Nevertheless, we are also interested to learn, if and how simulation can be used to solve problems of AI research or application.

The group's understanding of AI is not dogmatic at all, and in our annual workshops we have also discussed such matters like object-oriented modelling and qualitative simulation. And we are very interested to get into contact with other groups working in the same or related fields.

The working group held its fifth workshop in May 1992 at the Fraunhofer-Institut für Materialfluß und Logistik in Dortmund. The proceedings of this workshop are now ready for distribution and can be ordered from Mr. St. Bernemann, FhG-IML, Emil-Figge-Str. 75, D-4600 Dortmund 50 (free for members of the working group, DM 10.- plus postage for others).

Next year's workshop will be organized together with the ASIM working group "*Simulationssoftware und -hardware*" in Karlsruhe on April 22 and 23, 1993. We will concentrate on optimization problems and techniques, but any other presentations or problem statements contributing to the relation of simulation and artificial intelligence are welcome, too. The workshop language is German, but English presentations are also possible. Please direct your application or any inquiries about this workshop to:

Dr. H. Szczerbicka, Inst. f. Rechnerentwurf, Postfach 6980, W-7500 Karlsruhe 1, Tel. +49-(0)721/608-4216.

Speaker of the working group: Dr. Johannes Krauth, BIBA, Bremer Institut für Betriebstechnik und angewandte Arbeitswissenschaft, Postfach 33 05 60, W-2800 Bremen 33. Tel: +49-(0)421/218-5531

Working Group "Simulation in Medizin, Biologie und Ökologie"

Speaker of the working group: Prof. Dr. Dietmar P.F. Möller, TU Clausthal, Institut für Informatik, Erzstr. 1, W-3392 Clausthal-Zellerfeld, Tel. +49-(0)5323/722402 or 722504, Fax +49-(0)5323/723572

Working Group "Simulation technischer Systeme"

The 10th workshop will be organized for March 8 and 9, 1993 at Erlangen-Nürnberg University by the Institute for control engineering. ACSL and SPICE user groups meet on March 8th. A call for papers will be distributed to all ASIM members. For more details please contact the speaker of the working group or Prof. Dr. W. Bär, Universität Erlangen-Nürnberg, Institut für Regelungstechnik, Cauerstraße 7, W-8520 Erlangen.

Speaker of the working group: Prof. Dr.-Ing. Gerald Kampe, FHT Esslingen, Flandernstraße 101, W-7300 Esslingen. Tel: +49-(0)711/3511-3740 or 3741

Working Group "Simulation in der Fertigungstechnik"

Der ASIM-Arbeitskreis "Simulation in der Fertigungstechnik" erstellt im Rahmen mehrerer universitäts- und firmenübergreifender Arbeitsgruppen einen Leitfaden zur Simulationstechnik, der als "Handbuch Simulationstechnik" im Frühjahr 1993 auf der Fachtagung "Simulation und Fabrikbetrieb" vorgestellt werden soll. Die Inhalte des Buches beschreiben verschiedene praxisorientierte Simulationsanwendungen und Projektstudien, geben einen Überblick über am Markt befindliche Simulationsinstrumente und diskutieren die an die Simulationstechnik anschließenden Aufgabenfelder wie Datenmanagement und Interpretationsverfahren. Ein Ausblick auf die Zukunft der Simulationstechnik rundet den Leitfaden ab. Das Buch soll sich speziell an potentielle Simulationsanwender richten und ihnen einen Einblick in die Umfänge und Facetten der Simulation im Bereich der Fertigungstechnik ermöglichen.

Die Fachtagung des ASIM-Arbeitskreises findet am 10. und 11. Februar 1993 zum Thema "Simulation und Fabrikbetrieb" in Aachen statt. Neben einem umfangreichen Vortragsprogramm, in dem über

- *Erfahrungen mit der Simulation im Fabrikalltag*
- *Simulation in der Fertigungssteuerung*
- *Arbeitsorganisation*
- *Kosten- und Nutzenaspekte in der Simulationstechnik*

berichtet wird, kann der Besucher sich an beiden Tagen in einer tagungsbegleitenden Fachausstellung über die neuesten Produktentwicklungen informieren. Darüberhinaus wird im Rahmen der Veranstaltung für die Mitglieder des Arbeitskreises ein Arbeitskreistreffen organisiert.

Speaker of the working group: Prof. Dr.-Ing. A. Kuhn, Fraunhofer-Institut, IML, Emil-Figge-Straße 75, W-4600 Dortmund 50. Tel: +49-(0)231/9743-130, Fax: +49-(0)231/9743-211

Working Group "Simulation in der Betriebswirtschaft"

The working group organizes its "*4. Symposium Simulation als betriebliche Entscheidungshilfe*" in Braunlage on March 15-17, 1993, now for the first time as ASIM working group. Subjects of the conference are:

- Methods and Tools
- Software and Hardware support
- Applications

For a call for papers contact the speaker of the working group or Dr. Ingrid Bausch-Gall.

Speaker of the working group: Prof. Dr.-Ing. W. Hummeltenberg, Universität Hamburg, FB Wirtschaftswissenschaften, Bundesstraße 55, 2000 Hamburg 13. Tel: +49-(0)4123-4023

Working Group "Simulation von Verkehrssystemen"

The following future main themes were discussed at the founding meeting on July 2-3, 1992 in Xanten: There are many opportunities to apply computer simulation across the whole spectrum of transportation problems and tasks. For example various scenarios can be represented, process parameters adjusted ("What happens if ...?") and an optimal solution quickly achieved. The group will organize its work under the following four themes:

- street traffic flow, taking large trucks into account
- rail based transportation
- freight traffic, including multiple transport
- city logistics and planning (regional basis also possible)

The first meeting took place at the Fraunhofer Institut in Dortmund. Current work by industry in the above mentioned areas was presented.

- microscopic and macroscopic simulation, using an example of street traffic
- investigation of traffic and modelling of rail traffic in Hannover, Germany
- a planning instrument for the simulation of automated public transportation in the Dortmund elevated rail system
- city planning: new approaches to commercial traffic in bottlenecks
- an approach to scientifically based simulation of route selection in public transportation.
- modelling of large traffic networks using an example of freight transportation system.
- simulation model for prediction of propulsion related parameters (exhaust, air, gas) considering the effects of traffic flow.

All papers will be published as ASIM-Mitteilungen. Everybody, who is interested in the activities of the working group (also non-ASIM members are welcome) is asked to contact the speaker of the group.

Speaker of the working group: Mr. Karl-Heinz Münch, Siemens AG, Bereich VT2 CIR, Ackerstraße 22, W-3300 Braunschweig, Tel: +49-(0)531/226-2225, Fax: +49-(0)531/226-4305. Vice speaker: Dr.-Ing. Hermann J. Benger, Universität Dortmund, FG Verkehrsplanung, Postfach 500500, W-4600 Dortmund 50, Tel: +49-(0)231/755-2268, Fax +49-(0)231/755-737519

I. Bausch-Gall

DBSS

General Information

In Europe there are several examples of regional simulation societies, covering a geographical area of a common language. One of those, DBSS, is grouping the Dutch speaking simulation people from the Benelux countries. DBSS is a member society of EUROSIM (Federation of European Simulation Societies).

DBSS has as primary goal to promote the advancement of systems simulation. In this respect the Society will actually promote the following:

- the study of systems, models and modelling (continuous, discrete and mixed systems); deterministic, stochastic and probabilistic systems; systems from specific disciplines; they all belong to the domain of interest;
- the development and application of methodological concepts, methods and algorithms with respect to systems, models, modelling, experimenting and tools:
- the development of hardware and software simulation tools and the advancement of their applicability.

To accomplish the above goals DBSS shall:

- stimulate the organization of meetings in the domain of systems simulation; in these local meetings the emphasis will be in informality and information exchange;
- activate the organization of conferences, symposia, workshops, courses;
- furnish information to the members about the state-of-the-art as well as advancements and activities in the domain of simulation of systems;
- co-operate with societies active in the domain of simulation;
- use other legal means which may serve meeting the goals of the society.

DBSS is closely co-operating with the other member societies of EUROSIM.

Moreover, for already many years, DBSS has affiliation agreements with IMACS (International Association for Mathematics and Computers in Simulation) and SCSi (Society for Computer Simulation International).

DBSS-Membership

Individuals (in particular Dutch speaking ones) and institutes etc. from the Benelux countries, active in the field of simulation, can become DBSS-member. Membership fee (per annum) is in 1993:

- personal member:
  50 guilders or 900 Belgium francs
- institutional member:
  100 guilders or 1800 Belgium francs

Those interested to become a member of DBSS are invited to write to the acting secretary:

Dutch Benelux Simulation Society
Secretariat, Computing Centre,
P.O. Box 354
2600 AJ Delft, The Netherlands

(Please mention your name, affiliation and address, and indicate whether you are interested in the personal or institutional membership).

The membership fee should be paid to:

Giro account 3582241
J.C. Zuidervaart, Leeuwerikplantsoen 27
2636 ET Schipluiden, The Netherlands

with the mention: DBSS membership 1993

DBSS-members receive "EUROSIM-Simulation News Europe" and can benefit in many cases from special discounts on conferences, meetings, organized by DBSS or other member societies of EUROSIM, IMACS and SCSi.

Meeting Reports

Prof. Jon R. Sauer from the Opto-Electronic Computing Systems Center of the University of Colorado, Boulder USA has given a guest-lecture on **Optical Interconnects in Massively Parallel Computers** Wednesday June 17, 1992. The lecture was jointly organized by the Computer Systems Architectures Group and the Dutch Benelux Simulation Society (DBSS).

The contents of his presentation:

Of the components necessary to build a massively parallel teraflop computer - processors, memories and interconnects - the interconnects are the farthest from the required performance. Better use of optics holds the promise of substantially improving current electronic interconnects. The interconnect architecture discussed here is an optical multistage, multi-path topology with electronic network access at each switching node. At these nodes, optical throughgoing data remains in optical format during switching, with each packet a single computer word, all the bits in the word transmitted simultaneously at different wavelengths. This is the optical analog of internal computer networks, specifically that of the Tera supercomputer currently under construction, which transmit and switch single words with the electronics bits in a word spatially separate on different wires. The goal is to transmit and switch 80bit optical words every 4 ns, equivalent to 20 Gb/s serial bit rate. Such a network would allow systems with architectures similar to Tera to extend over much greater geographical areas, greatly increasing flexibility and ease of construction. Two optical payload formats are being attempted. One in short- and medium-distance linear encoding with each simultaneous bit in its own wave-length band. The other is a non-linear encoding, using an ensemble of simultaneous solitons, densely packed in wavelength. This encoding format required new theoretical and practical developments concerning soliton behaviour in optical fibers. The immediate few-year goal is to interconnect a few high-performance workstation systems to demonstrate closely coupled multiprocessing with every high interconnect performance demands and to extrapolate credibly from a few nearby nodes to thousands of possibly widely separated nodes. As part of this effort, an optoelectronic 2x2 prototype has been built that resolves output path contention for the two incoming optical packets in flight, without conversion to electronics. This allows the optical data to remain that way while being intelligently switched with extremely low latency. This seminar described the philosophy, architectural concepts and possible hardware implementations of this network.

The Dutch Benelux Simulation Society has organized - by Mr. K. Lemmens and Mr. J. Steine - a symposium concerning **Massive Parallel Computing Systems.**

This symposium took place in the Dish Hotel in Delft on July 2th, 1992. Hereafter a short overview of the lectures is given.

1. Arcobel: Mr. G. Genendes from Parsytec Germany, Parsytec has recently announced their new MPP system the GigaCube, ranging from 64 processors (min) to 16k processors (max). Average per Gigaflop will be approx. DM 0.5 million. Mr. Genendes strongly emphasized the need for fault detection systems, because the statistical possibilities for hardware and/or memory failures increase rapidly with the number of processors used. Many of these fault detection and correction systems were implemented in their GC, such as a spare processor nr 17 in each 16p cube, that will automatically replace a failing processor in the cube.

2. Convex: Mr. R. v.d. Pas, Convex C-series systems contain 1-8 scalar/vector processors, using a shared memory system. Convex thinks to combine in the future parallel and vector features in one computer. The software (i.e. compilers) will be capable of automatically using vectorisation or parallellisation in programs. Mr. v/d Pas stressed the fact that the MPP world still lacks good software such as compilers and tools. To show what Convex thinks is good software, he gave an overview of the possibilities of their new Appliction Compiler and of their debugger XDB.

3. Shell: Mr. Peter Hilbers Shell has a MPP system based on 400 T800 transputers at its laboratories in Amsterdam. This system is being used for simulation of molecular behaviour in several situations, i.e. the application of the Lennard-Jones model on systems of several thousands molecule or more. The T800 system proved to be very reliable, in fact they do not even have a support contract, because Shell thinks this is not necessary! As for the costs: especially for larger simulations with many molecules the price/performance rate is - according to Mr Hilbers - much better than for a vector (Cray) computer system.

4. Thinking Machines: Mr. Jos v. Trier, Thinking Machines has recently introduced their new CM5 (Connection Machine). As compared with the older CM2: this machine is a full Multiple Instruction, Multiple Data Machine, which means that every processor can also run its own program. Mr. v Trier gave a lot of information about the architecture, such as a description of the hypertree configuration. He also showed some examples of parallel programming with the Fortran compiler on the CM5, which is conform to the new ANSI Fortran 90 standard.

5. Cray: Mr. Tanqueray, Cray proposes that future high performance computing will require a heterogenous computing environment. The existing parallel/vector/scalar architectural approach will be complemented by a closely coupled massively parallel capability and appropriate programming methodology. Cray announced their first MPP platform to be available in the first half of 1993.

Meetings Planned

International Symposium: DBSS plans to organize - in co-operation with AKZO, CAP GEMINI and Delft University of Technology - an international symposium on: Massive Parallel Processing, Practice and Development.

The provisional date for the symposium will be end of June, 1994.

Via this way we take the opportunity to wish our members a Merry Christmas and a Happy New Year.

J.C. Zuidervaart

FRANCOSIM

Contact Address

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"La simulation, les outils modernes de développement"

This conference, co-organized by AIM and FRANCOSIM, took place in Liege (Belgium) on October 29 in a building of the Belgium company ELECTRABEL.

About fifty participants attended this event. Eight speakers developed their thoughts on simulation code generators, i.e. simulation CASE tools. The presentation fell into three categories:

- existing simulation generators presented by their author companies
- practical experience of existing simulation generators presented by users
- analysis of the need for future simulation generators

The interest of the participants was quite high so that further conferences on this kind of subject could be organised in the near future.

Proceedings of this conference (mainly in French) can be obtained from AIM or through FRANCOSIM.

Events to come

"Journées 2A-O" (automatisme assisté par ordinateur) organized by E.S.I.E.E. in Noisy le Grand and in co-operation with FRANCOSIM will take place on November 19.

A BondGraph school on Mechatronics will take place in March 22-26 in Roanne (France). Dr. Dauphin, Dr. Lebrun, Pr. Scavarda from France, Pr. Thoma from Switzerland and Pr. Margolis from the University of Davis, California, are going to speak.

For further information please contact: N. Sarles, Société IMAGINE, Maison de la productique, Roanne, Tel: +33 77 70 80 80, Fax: +33 77 70 80 81.

M. Lebrun

ISCS

General Information

The Italian Society for Computer Simulation (ISCS) is a scientific non-profit association of members from industry, university, education and several public and research institutions with common interest in all fields of computer simulation. Its primary purpose is to facilitate communication among those engaged in all aspects of simulation for scientific, technical or educational purposes.

The affairs of the ISCS are directed by a Steering Committee presently consisting of the following persons:

G. Iazeolla	(chairman)
F. Cennamo	(vice-chairman)
V. Grassi	(treasurer)
M. Colajanni	(secretary)

Membership

At present ISCS counts 128 members: 6 institutional, 4 honorary, 116 regular and 2 affiliate.

Charges per annum are Lit. 30,000 for regular and affiliated members and Lit. 400,000 for institutional members.

Contact address

For further information or application for membership, please contact:

ISCS
c/o Dipartimento Ingegneria Elettronica
Università di Roma "Tor Vergata"
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Activities

The ISCS Annual Meeting, held in Capri at the end of EUROSIM '92, promoted the following activities:

1. The organization and sponsoring of the "*Seminario di Informatica*", a periodic scientific seminar held at the University of Roma "Tor Vergata". Main topics are simulation, performance evaluation and parallel and distributed computing.

2. The organization of Working Group meetings among ISCS members interested in the same simulation field, in order to provide a forum for presentation of results, exchange of ideas and scientific discussions.

At present the following Working Groups have been established: Simulation in Industry and Management, Simulation in Agriculture and Environmental Sciences, Simulaton in Training and Education, Simulation in Biology and Medicine, Simulation in Electrical Engineering, Concurrent and Distributed Simulation, Software and Hardware for Simulation, Expert Systems and Simulation.

ISCS members are warmly invited to promote new Working Groups or to join existing ones. Contact the ISCS secretariat at the address reported above for further information.

3. The promotion of Summer Simulation Schools with the aim of developing and extending the knowledge about simulation and its applications. To this end, they should be mainly addressed to graduate and PhD students or young researchers working both in industry and academia.

During the next year most efforts of the ISCS will be devoted to the organization of **Performance '93** (16th IFIP W.G. 7.3 *International Symposium on Computer Performance Modelling, Measurement and Evaluation*). This international conference, one of the most important in the performance evaluation field, will take place in Roma, from September 29 through October 1, 1993.

Topic areas include, but are not limited to:

1) Performance evaluation of:

Communication networks, Memory systems, Computer system architecture, Operating systems, Database and transaction processing systems, Parallel algorithms, Distributed systems, Parallel systems, Fast packet switching, Real-time systems, Fault tolerant systems, Scientific computers, File and I/O systems, Telecommunication systems, Interconnection networks, Very high speed networks.

2) Methodological or theoretical work in:

Concurrent simulation, Reliability analysis, Fast simulation, Stochastic models of computer systems, Model verification and validation, Teletraffic and network management, Performability modelling, Workload analysis and program optimization, Performance optimization.

Important deadlines: **November 30, 1992** (tutorial proposals, full papers and extended abstracts for poster session), **April 10, 1993** (author notification), **May 15, 1993** (camera ready copy due).

M. Colajanni

SIMS

The Scandinavian Simulation Society, SIMS, has about 250 members from Denmark, Finland, Norway, and Sweden. For more than 30 years SIMS has served as the regional simulation society in Scandinavia, gathering individuals and organizations involved in simulation. The activities have been concentrated on arranging annual meetings and courses, delivery of information letters, and co-operation at European and international level in the field of simulation.

How to join SIMS ?

If you or some of your Nordic collegues are interested in simulation but are not yet a member of SIMS, then just send an informal application or recommendation for membership to the SIMS secretariat:

E.K. Puska
Technical Research Centre of Finland
P.O.Box 208 (Tekniikantie 4)
SF-02151 Espoo, Finland
Tel.+358 0 4561, Fax+358 0 456 5000

SIMS Conference

The 35th SIMS Conference will be held on June 9-11, 1993 at Kongsberg College of Engineering in Kongsberg, Norway.

The conference will cover all aspects of applied simulation in industry, including, but not limited to the following topics:

* Modelling Tools
* Model and Data Exchange Standardisation
* Simulation Tools and Technology
* User Interface and Visualisation
* Engineering and Training Simulators
* Integrated Process Design
* On-line Use of Simulation Models
* Simulation in Factory Planning
* Simulation in Production Management
* Simulation in Chemical Engineering
* Simulation in Control Engineering
* Simulation of Mechanical Systems
* Simulation of Electronic Systems
* Simulation of Marine Systems

The conference is open for poster sessions and exhibitions. Demonstrations of commercial simulation systems are particularly welcome. The official conference language is English. Participants from outside Scandinavia are also welcome. Deadline for extended abstracts is January 20, 1993.

Kongsberg is located 80 km west of Oslo, and is easily reached by car or train. It is known as a high-technology centre in Norway today, but has also taken good care of the special culture and traditions going back to the era of silver mining. Possible vacation activities include fishing, mountain hiking, canoeing, horse-back riding and hiking in the silver mines. Join us for a few enjoyable days in Kongsberg.

For more information about the conference, please contact:

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E.K. Puska

UKSS

The Annual General Meeting of UKSS was held in London on Monday 26th October 1992. A meeting of the Committee was also held on that date.

A one day meeting on the topic of 'Simulation in Circuits and Systems' will be held at the University of Manchester on Wednesday 27th January 1993. A meeting at Cambridge concerned with 'Real Time Simulation and Simulators' is being planned for a date in May and a further one day meeting will be held, at a venue still to be decided, in March on the subjcet of 'Graphics in Simulation'.

Plans for the UKSS Conference to be held in Keswick in September 1993 are progressing well and further details can be found in the following call for papers.

D.J. Murray-Smith

AES

Asociacion Espanola de Simulacion
(Spanish Simulation Society)

Contact Address:

AES
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E-mail: albornoz@esaii.upc.es

United Kingdom Simulation Society Conference UKSS 93

Keswick Hotel, Lake District, Cumbria, U.K.

13-15 September 1993

1st Call for Papers

A EUROSIM Member Society Event, co-sponsored by SCSI

Papers are invited on any aspect of simulation to be presented at a three day event organized for both scientific and cultural interest. The event will be held in Lakeland, one of the most beautiful parts of England. Access is easy via Manchester International Airport or London Heathrow/ Gatwick and coach or rail to Keswick. The conference venue is a recently renovated Victorian Hotel within walking distance of the town centre. There is ample space for exhibitors in the Garden Room where coffee is served right outside the main lecture room.

Cultural activities include local lakeland history; fell walking in the beautiful hills; boat trips on Derwent Water which also features wind surfing and canoeing, all within walking distance of the hotel.

Please send abstracts by 1st March 1993 to:

Dr. R. Zobel, Dept. of Computer Science,
University of Manchester, Oxford Road,
Manchester M13 9P1, U.K.,
Tel: +44 61 275 6189,
Fax: +44 61 275 6236,
Email: rzobel@cs.man.ac.uk

Abstracts (two pages of A4 without figures) are invited on any aspect of simulation and its applications. The following list of suggested topics is a guide, but papers on other topics are also welcome:

Simulation methodology and practice, languages, tools and techniques (continuous, discrete and mixed). Models and modelling tools. GUIs and data/object bases. Analysis tools. Simulators and simulation hardware, training simulators. Integration of simulation with concurrent engineering, integrated design and simulation systems. AI in simulation. Parallel and distributed simulation, neural networks, performance.

Simulation applications. Aerospace simulation, including man/hardware-in-the-loop. Simulation in electronic circuits and systems, computer systems and networks. Leisure industry. Business applications, management, finance, banking, economics. Environmental simulation. Simulation in emergency systems, biology, medicine and public health. Simulation in manufacturing, planning, process simulation, robotics, control systems, measurements and monitoring. Plant simulators. Energy and safety critical systems, transportation, oil and gas industries. Simulation in education and training. Military simulation and simulators.

Although this conference is a national event, presenters and participants from any country have always been very welcome. Naturally, the conference language is English, which is also the language of most international simulation events. Vistors are especially welcome from EUROSIM member countries, in addition to North America, the Pacific Rim and elsewhere.

Members of EUROSIM Societies, SCSI, JSST, CSSC will be offered the reduced rate of registration fee. Simulationists from Eastern Europe may be offered special rates. A variety of accommodation is available. Details of registration fee and accommodation will be sent to intending participants.

Deadlines:

Abstract (four copies, 2 pages of A4): **1st March, 1993**

Notice of provisional acceptance: **15th May, 1993**

Camera ready paper and registration fee: **1st July, 1993**

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- Resource Management
- Data structure and flow modeling

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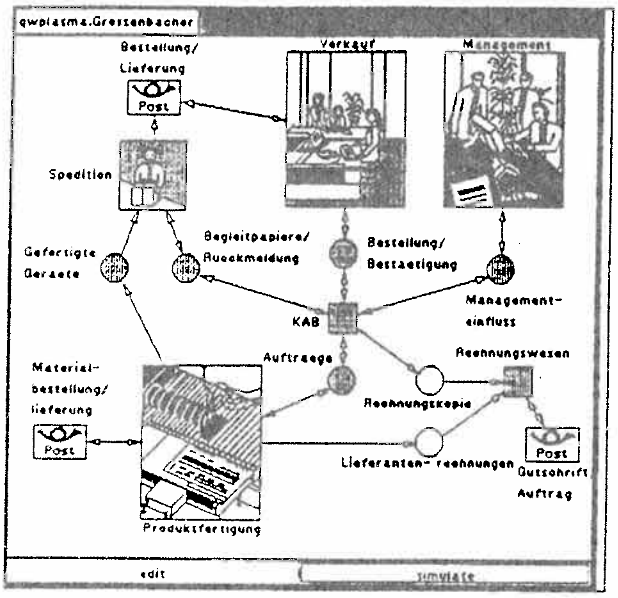

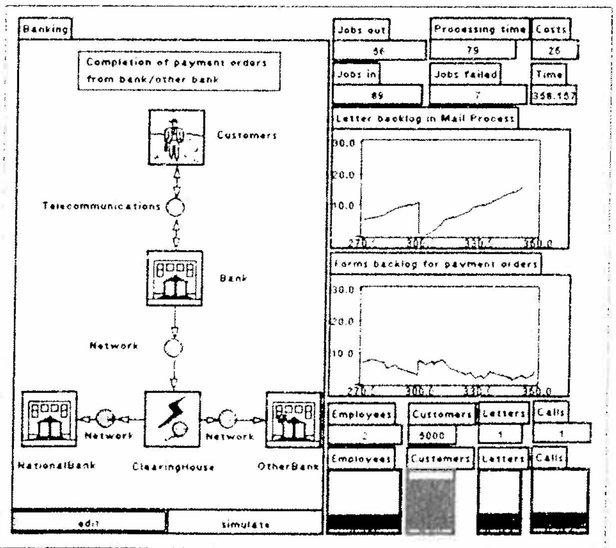

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Spinnereistrasse, 8
CH-9008 St.Gallen

Tel.: +41 71 26 31 51
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* Reference list available upon request

CROSSIM

CROSSIM (The Croatian Society for Simulation Modelling) was founded on 28th March 1992 in Zagreb. CROSSIM is a non-profit society with the following main goals: promotion of knowledge, methods and techniques of simulation; establishment of professional standards in simulation; development of education and training in simulation; organization of professional meetings and publishing in the field; co-operation with similar domestic and international institutions. CROSSIM recently sent a letter of intention to EUROSIM with a request to become a full member of the EUROSIM federation. The Society is also in the process to become an affiliation institution with SCS (The Society for Computer Simulation, USA).

Membership

The annual membership fee is equivalent to 8 German marks for regular members, and 2 German marks for students. CROSSIM currently has 38 individual members.

Contact Address

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Activities

- Co-organizing the 14th International Conference *"Information Technology Interfaces" ITI '92*, held in Pula from 15-18 September 1992. The conference had the simulation session, two international invited lecturers in the field of simulation (Prof. Andrew Seila, University of Georgia, and Prof. Felix Breitenecker, Technical University of Vienna), and the round table on "EUROSIM Federation and its activities" with Prof. Felix Breitenecker, the Editor of EUROSIM - Simulation News Europe, as a guest.
- Co-organizing the *2nd Operations Research Conference* in Croatia, held from 5-7 October 1992 in Rovinj.
- Organizing a simulation seminar which is regularly held at the Faculty of Economics, University of Zagreb. The speakers were:
  Prof. John Bernardo, University of Kentucky, USA
  Prof. Andrew Seila, University of Georgia, USA
  Dr. Peter Long, Sheffield Hallam University, UK
  Dr. Ivica Veza, Faculty of Mechanical Engineering and Naval Architecture, Split
  Mr. Davor Antonic, Faculty of Electrical Engineering, Zagreb
- Co-operation in founding of the new international journal *Computing and Information Technology*, to be launched from 1993 (including computer modelling topics). *Anybody interested in receiving information about the journal may contact the CROSSIM Chairman.*
- Work on several scientific projects in discrete and continuous simulation, and applications of simulation in such diverse fields as engineering, economy, medicine, ecology etc.
- Publications (one simulation textbook in Croatian in press, papers in international and domestic journals and conference proceedings).
- Co-organizing the 15h International Conference *"Information Technology Interfaces" ITI '93*, to be held in Pula, Croatia from 15-18 June 1993. The conference traditionally has a strong simulation session. Two invited lecturers in the field of simulation next year will be Prof. Jerzy Rosenblit, University of Arizona, USA, and Prof. Axel Lehmann, University of Bundeswehr, Munich, Germany. In the near future CROSSIM intends to send a proposal to the EUROSIM federation and to SCS to sponsor and help organizing the simulation stream at the ITI '93 conference. *Anybody interested in receiving the Call for Papers or other information about the conference may contact the CROSSIM Chairman.*

V. Ceric

CSSS

Czech & Slovak Simulation Society

8th Prague Symposium on Computer Simulation in Biology, Ecology and Medicine

On November 9, 1992, shortly before the closing date of this issue, the 8th Prague Symposium on Computer Simulation in Biology, Ecology and Medicine was opened. This - as the name itself suggests - traditional event organized by CSSS was held for the first time as an open meeting of scientists and experts not only from the countries of Central and Eastern Europe but also from the other side of the today no longer existent iron curtain. Another organizer of the Symposium was SCSI, which provided support to CSSS not only in terms of moral but also of constructive assistance.

The opening session was addressed by the vice-president Europe SCS, Eugene Kerckhoffs, and secretary of Europe SCS, Philippe Geril. From the Czechoslovak part the participants were welcomed by the vice-president of the Czechoslovak Academy of Sciences and General Chair of the Symposium, Milan Straskraba, and by the chairperson of the Czechoslovak Scientific and Technological Society for Applied Cybernetics and Informatics, Dagmar Trkalová (CSSS is a technical section of this society).

The conference room of the Club of Technicians, located in the close neighbourhood of world famous Charles Bridge, hosted more than 60 scientists and experts from 15 European countries and USA. The scientific programme included 45 papers divided into four sections: theory and methodology of systems simulation, computer simulation in biomedicine, computer simulation in ecology, computer simulation in health care.

The proceedings distributed to participants at the registration contain 30 contributions, some other papers were available in separate copies. More information about the Symposium will be presented in the next issue.

M. Kotva

Hungarian Simulation Group IMACS/Hungary

In September in the journal **Mathematics and Computers in Simulation**, Volume 34, Number 3-4, extended versions of selected papers presented at the *IMACS European Simlation Meeting on Problem Solving by Simulation*, organized by IMACS Hungary and held in Esztergom, Hungary, 1990, were published in a special volume, guest edited by the chairman of IMACS/Hungary.

A part of the contributions dealt with novel concepts and methods to encounter the problems of increasing complexity. On the other hand, solutions of concrete problems were presented.

In the papers selected, *Ameling* deals with an application of advanced multiprocessing hardware architectures to increase the efficiency of simulation. *Ören et al.* describe a concept of "reverse engineering" to promote simulation program understanding, being of great importance. *Breitenecker* presents a new concept with regard to the architecture of simulation systems. The article of *Rozenblit and Hu* is a significant contribution to knowledge representation and management with respect to simulation. *Jávor* introduces demons in simulation providing for the dynamic, distributed AI controlled modification of models and experimental frames. *Kleijnen*'s contribution is a tutorial on the sensitivity analysis of simulation experiments. *Ceric and Paul* discuss conceptual questions of diagrammatic approaches to simulation models.

Another group of the contributions - as mentioned already above - are concerned with various applications. *Yolles and Pirani* describe a methodology for a transnational project management system, being now of increasing importance in Europe. The paper of *Wen* deals with the problems of a flight training simulator as an entirely different sort of simulation application. The simulation of optimal placement of heat resources by *Cahlon et al.* and that of a combustion wave presented by *Pistella and Casulli* are interesting examples of solving concrete problems.

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LSS

Latvian Simulation Society

Any information concerning LSS and its activities may be obtained from:

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or Yury.Mercuryev@f10.n495.z2.fidonet.org

Giorgio Savastano Award

One important recent reaction of the EUROSIM Board of Directors was to establish the Giorgio Savastano Award to honour the memory of the first President of EUROSIM, Professor Giorgio Savastano. It was decided that the Award should be to the author (or authors) of the best paper published by June 30th 1991 in the field of Simulation in Electrical Engineering. Only young researchers (less than thirty years of age on June 30th 1991) could participate and only papers published in refereed journals could be considered.

The EUROSIM Board of Directors nominated three judges, Professor W. Ameling (Rogowski-Institut, Aachen), Professor A. Langella (Universita di Napoli) and Professor D.J. Murray-Smith (University of Glasgow). The judges' decision was to recommend that the Award be made to Hans Hjelmgren for his paper entitled "Numerical Modeling of Hot Electrons in n-GaAs Schottky-Barrier Diodes" which had been published in the IEEE Transactions on Electron Devices (Vol. 37, No. 5 (May 1990), pp. 1228-1234). The paper described the use of a drift-diffusion model to study the d.c. properties of n-GaAs Schottky diodes at high forward bias voltages. The work described in the paper was carried out while Mr. Hjelmgren was with the Department of Applied Electron Physics, Chalmers University of Technology, Göteborg, Sweden.

The Award was presented to Hans Hjelmgren during the opening session of the recent EUROSIM Congress in Capri.

D.J. Murray-Smith

Comparison of Simulation Software

EUROSIM - Simulation News Europe features 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, are 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.

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: Two State Model, March 1992, revised July 1992

This issue introduces a new comparison for discrete simulation languages, Follow-up treatment in an Emergency Department of a Hospital. For comparison 1 a preliminary summary of the published results is given.

We invite all institutes and companies developing or distributing simulation software to participate in this comparison. Solutions of all previous comparisons 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.

Comparison 1: Preliminary Summary of Results

Up to now 18 simulation languages or simulators, resp. took the challenge to solve EUROSIM comparison 1 (Lithium-Cluster Dynamics under Electron Bombardment). The comparison is based on a stiff third order system of ODE's. The tasks to be performed were: i) simulation of the stiff system, comparing integration algorithms, ii) a (logarithmic) parameter sweep, and iii) the calculation of steady states.

First it has to be noted that all simulation languages fulfilled the tasks with sufficient accuracy. The results of the comparison reported here are: i) effectiveness of numerical algorithms, ii) comfortability of parameter sweep, iii) steady state calculation in time domain or by iteration, iv) preventing problems by analytical transformations.

The languages used can be divided roughly into three groups: equation-oriented languages, (graphical) block-oriented languages, application-oriented languages.

The equation-oriented languages are ESACAP, NAP2, ACSL, SIMUL_R, HYBSYS, ESL, DYNAST, PROSIGN, DESIRE, STEM, SIL; the block-oriented languages are FSIMUL, XANALOG, HYBSYS, ESL, SIMULAB (SIMULINK), DYNAST, PROSIGN, EXTEND, I Think; (also) application-oriented languages are ESACAP, NAP2, MATLAB. Some languages offer different modelling approaches, so they may belong to more than one group.

Table 1 summarizes the modelling features of the languages in general and indicates the modelling technique used in the solution of EUROSIM comparison 1 (marked with (*), see column 2 of table 1). Furthermore table 1 remarks special features or essential properties of the simulation languages (column 3).

It is relatively difficult to compare the results of taks i), the **simulation of the system in the time domain, comparing the integration algorithms**. Although most languages offer exact CPU-times for the different algorithms, these results suffer from side effects like I/O-time, straight-forward or tricky modelling, well tuned algorithm parameters (model-dependent!) or standard values, etc. Therefore, for comparison of the algorithms the relation between the different algorithms within one language may be of more significance than the absolute CPU-times.

Most simulation languages offer quite different algorithms. Table 2, summarizing results, is restricted to three algorithms: Gear stiff algorithm, Euler algorithm and Runge-Kutta algorithm, which work well with the model under consideration. If one (or more) of these algorithms is missing, others are shown (preferably Adams-Moulton, Adams-Bashforth, Runge-Kutta-Fehlberg). Table 2 generally shows that the Gear algorithm is the best for this model. The system is stiff, indeed.

Eigenvalue analysis of the linearized model results in three eigenvalues being negative real numbers. At $t = 0$ the eigenvalues are -0,00898, -11,06, -1005,66, at $t = 10$ the values are -0,0978, -1,018, -1003,4. The third eigenvalue is the biggest (absolute value), the first eigenvalue is the smallest (absolute value). Dividing the absolute value of the biggest eigenvalue by the absolute value of the smallest eigenvalue results in a stiffness factor. At $t = 0$ this factor is approximately 120000, at $t = 10$ the factor is about 10000. Figure 1 shows this stiffness factor (a system is said to be

LANGUAGE	MODEL DESCRIPTION	REMARKS
ACSL	equations (ODE's)	General purpose simulator, event handling
DESIRE	equations (ODE's)	Combination with neural network simulation
DYNAST	equations (DAE's) (*) graphical blocks (submodels) port diagrams (graphical)	For linear systems semi-symbolic analysis
ESACAP	equations (DAE's) (*) nodes/branches arbitrary expressions	Based on numerical algorithms for circuit analysis
ESL	equations (ODE's) (*) graphical blocks (submodels)	Interpretative and Compile Mode, graphic postprocessor
EXTEND	graphical blocks	Continuous and next event modelling
FSIMUL	graphical blocks (submodels)	'Control-Engineering' - features, optimization features
HYBSYS	blocks (elementary) (*) equations	Interpretative simulator, direct data base compilation
I Think	graphical blocks	Modelling based on System Dynamics
MATLAB	equations (MATLAB-functions)	Tool for mathematical and engineering calculations
NAP 2	blocks (electronic circuits)	Specialized for circuit simulation
PROSIGN	equations (ODE's) (*) graphical blocks (submodels) application-oriented components	Combin. of modelling techniques, interfaces to C, etc.
SIL	equations (ODE's, DAE's) (*)	Simulation of continuous and discrete systems
SIMULAB	graphical blocks (submodels) (*) equations (MATLAB-function)	Based on MATLAB, analytical solution of linear parts
SIMUL_R	equations (ODE's) (*) bond graphs (graphical preproc.) blocks (graphical preprocessor)	Open system (C-based), combined simulation
STEM	equations (ODE's)	Based on Turbo Pascal
XANALOG	graphical blocks (submodels) (*)	Sophisticated linearization, realtime - features

Table 1

stiff if the stiffness factor is bigger than 1000) changing over the time (logarithmic scales). From figure 1 more can be seen: fast transients happen at the very beginning of the simulation: between 0 and 0,005 the stiffness factor (and also all three eigenvalues!) change rapidly, afterwards the factor nearly does not change (the systems is very "linear" between 0,005 and 10).

Consequently, the Gear algorithm must be the best. Unfortunately some reports don't indicate which order the Gear algorithm had to choose in order to fulfill the constraints on the relative or absolute errors, resp. Insight into these questions offers the ESACAP language, which compares different BDF-algorithms (Backward Differential Formulas, the predecessors of the Gear algorithms) on the basis of number of steps, function evaluations, calculations of the Jacobian matrix, etc. Furthermore, the most efficient Gear algorithms or BDFs are offered by languages (DYNAST, ESACAP, SIL) using model description on basis of DAEs (Differential Algebraic Equations) - but often also in case of a model description with an ODE system the model has to be reformulated as DAE system (DYNAST, ESACAP). But also languages (NAP2) modelling electronic circuits mainly offer fast Gear algorithms.

The classical RK4 algorithm works well, if an appropriate stepsize and an appropriate relative error is chosen, being approximately 20 times slower than the Gear algorithm. RKF algorithms (Runge-Kutta-Fehlberg) speed up the integration time using stepsize control. But it is of interest that also the simple Euler-algorithm yields appropriate results.

It is known from theory that the Adams-Moulton and /or Adams-Bashforth-algorithms are not suitable for this kind of systems; but it is astonishing that they are really very slow.

Another astonishing phenomenon is the result of the Linsim algorithm of SIMULAB, which is twice faster than the classical Gear algorithm. This algorithm extracts the linear parts of the models and calculates the linear dynamics via power series, while the nonlinear parts are integrated in the usual manner. Up to now it was not published which algorithm is used for the nonlinear parts and how the algorithm exactly works, the manual indicates only that Linsim - especially for the solution of linear models - may also work well with systems with relatively few nonlinear components or with nonlinear components multiplied by only small weighting factors. Both is the case in EUROSIM comparison 1. Figure 1 shows that the stiffness factor (and consequently the eigenvalues) change rapidly (indicating strong nonlinearity) only in a very small interval at the very beginning, and that it is nearly constant over a long period of time indicating that the system is almost linear so that the Linsim algorithm could be faster than a Gear algorithm.

Two sent in solutions showed that it is worth-while thinking over a model before simulating it. The authors knew that fast transients happen only at the very beginning and that the results had to be plotted in double logarithmic scales.

LANGUAGE	SNE-NR. C1-NR.	COMPUTER	ALGORITHM	STEPSIZE ACCURACY	CPU - TIME OTHERS
ACSL	SNE - 1 C1 - 3	PC 80287/12	Adams-Moulton	5.E-3 iss	155.055 sec
			Gear	5.E-3 iss	3.460 sec
			RKF 4/5, vs	5.E-3 iss	55.035 sec
ACSL	SNE 5 C1 - 17	MicroVAX / / Sun 4	Euler	1.E-5 - 2.E-1 ss	8.43 sec / 0.47 sec
			RK 4	1.E-5 - 2.E-1 ss	16.7 sec / 0.85 sec
			Gear	1.E-8ae, 1.E-5 iss	1.99 sec / 0.15 sec
DESIRE	SNE 4 C1 - 14	PC 80387/16	Gear	1.E-5 ae, 1.E-6 iss log.	10 sec
		Sun 4c	Gear	1.E-5 ae, 1.E-6 iss log.	1.7 sec
DYNAST	SNE 3 C1 - 12	PC 80387 N.CI 30.1	Combined Gear - Newton-Raphson	1.E-3 re, 1.E-5 iss	2.25 sec
				1.E-6 re, 1.E-5 iss	4.45 sec
ESACAP	SNE 1 C1 - 1	PC 80387	BDF 1o, vs	1.E-3 re / 1.E-7 re	118ns,237f /10271ns,20547f
			BDF 3o, vs	1.E-3 re / 1.E-7 re	53 ns, 105f / 316 ns, 632f
			BDF 5o, vs	1.E-3 re / 1.E-7 re	51 ns, 102f / 185 ns, 370f
ESL	SNE 2 C1 - 8	PC 80387 SX 16 MHz	RK 4	1.E-3 ss	12.00 sec
			Adams Bashforth	1.E-1 iss	21.00 sec
			Gear	1 E-1 iss	0.20 sec
EXTEND	SNE 5 C1 - 15	Macintosh IIfx	Euler impr.	12000 ns / 10000 ns	1.0 sec / unstable
			Trapezoidal rule	30000 ns / 20000 ns	2.3 sec / unstable
FSIMUL	SNE 1 C1 - 4	PC 80387 25 MHz	AB 2o, vs	5.E-4 iss / 1.E-3 iss	104 sec / unstable
			Implicit Heun	5.E-4 ss / 1.E-3 ss	182 sec / 90 sec
			RK4	5.E-4 ss / 1.E-3 ss	187 sec / 93 ssec
HYBSYS	SNE 2 C1 - 7	DECStation 3100/16	Euler	1.E-4 ss	8.47 sec
			RK4	2.E-4 ss	9.31 sec
			Adams-Moulton	1.E-5 iss	16.8 sec
I Think	SNE 5 C1 - 16	Macintosh IIfx	Euler	1.E-4 ss / 1. E-3 ss	7.0 sec / unstable
			RK2	1.E-4 ss / 1. E-3 ss	9.0 sec / unstable
			RK4	1.E-4 ss / 1. E-3 ss	12.0 sec / unstable
MATLAB	SNE 3 C1 - 10	PC 80387 (PS/S80)	RKF 2/3	1.E-5 re	739 sec
			RKF 4/5	1.E-6 / 1.E-7 re	563 sec / 752 sec
NAP 2	SNE 1 C1 -2	PC 80387 Norton CI 25.6	Mod.Gear, vs,vo	1.E-5 iss	4.56 sec
PROSIGN	SNE 3 C1 - 13	not given	Simpson 2o, vs	1.E-3 mss	470 sec (40 sec. compiled)
			AB 4o, vs	2.5 E-3 mss	204 sec
SIL	SNE 2 C1 - 9	PC 80387/16	Stiff alg., vs, vo	1.E-2 re / 1.E-4 re	2.64 sec / 4.01 sec
				1.E-6 re / 1.E-10 re	5.60 sec / 11.43 sec
SIMULAB	SNE 3 C1 - 11	Sun 4	RK 5, vs	1.E-3 re, 1.E0-1.E-4 ss	10.4 sec
			Gear	1.E-3 re, 1.E0-1.E-4 ss	0.37 sec
			Linsim	1.E-3 re, 1.E0-1.E-4 ss	0.19 sec
SIMUL_R	SNE 1 C1 - 5	not given	Euler	1.E-3 ss, 1.E-5 re	1
			RK4	2.E-3 ss, 1.E-5 re	1.90 relativ to Euler
			Euler implicit	1.E-1 ss, 1.E-3 re	0.22 relativ to Euler
STEM	SNE 5 C1 - 18	PC 80287/20	RKF 1/2o, vs	1.E-6 re, 1.E-3 ae	18.84 sec
			RKF 4/5o, vs	1.E-6 re, 1.E-3 ae	10.82 sec
			Gear, vs	1.E-6 re, 1.E-3 ae	0.5 sec
XANALOG	SNE 2 C1 - 6	PC 80287/16	RK4	1.E-3 ss / 2.5E-3 ss	225 sec / 88 sec
			Euler	1.E-3 ss / 2.E-3 ss	82 sec / unstable
			Mod. Euler	1.E-3 ss / 2.E-3 ss	118 sec / unstable

Legend: ss ... stepsize, iss ... initial stepsize, (i)ss log ... logarithmic stepsize, mss ... maximal stepsize
re ... relative error, ae ... absolute error, ns ... number of steps, f ... function evaluations
vs ... variable stepsize, vo ... variable order, 4o ... 4th order, etc.
RK4 ... classical Runge Kutta, RKF ... Runge-Kutta-Fehlberg
AB(M) ... Adams-Bashforth(-Moulton), BDF ... Backwards Differential Formulas

Table 2 (column 2 indicates in which issue the solution was published and in which chronological order it was sent in)

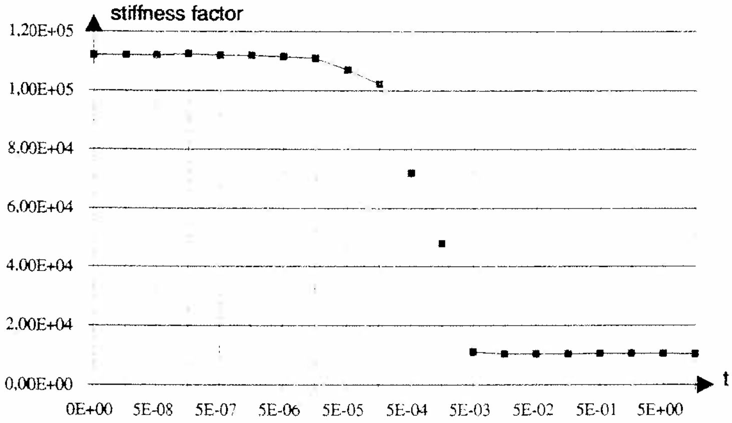


Figure 1

The second ACSL solution choose sample points exponentially spred over time, so that at the beginning the (initial) stepsizes for the algorithms are very small, then the communication intervals and consequently the stepsizes become larger. Another advantage is that this grid of sample points is well suited for logarithmic plots.

The DESIRE solution performed this exponential time shift directly in the model equations by choosing a new independent variable which produced a logarithmic time scale (shifted by any desired initial time instant). As a consequence of this transformation the integration algorithms became (much) faster, the system became nearly a non-stiff system.

The second task should test whether a simulation language offers **parameter sweep** commands or not. Table 3 summarizes the results in column 2, based on the solutions received.

Table 3 tries to distinguish between parameter loops in the model description and at run-time level. In case of graphical model description model frame and experimental frame are mixed, so that this distinction becomes difficult (the same happens with batch-oriented languages, where experimental frames are formulated as batch command files). Furthermore, it turned out that the additional requirement of a logarithmic parameter sweep and logarithmic plot was no further challenge: if parameter loops are available, different increments can be used; if the parameter sweep has to be formulated in a "manual" way, the logarithmic sweep is also simple. The third column in table 3 therefore indicates only, whether logarithmic representations are supported directly ("standard") or not ("manual" transformation).

The third task should check which languages offer features for **steady state calculation**. The EUROSIM comparison 1 is simple enough to calculate the steady states analytically, so all results could be compared with the exact values:

$f_s = p / lf, \quad m_s = (k_f.p^2) / (d_m.lf^2),$

$r_s = (k_r.k_f.p^3) / (d_r.d_m.lf^3)$

For p = 10000 and the original parameter values these formulas result in

$f_s = 10, \quad m_s = 10, \quad r_s = 1000$

For p = 0 all stationary values are zero.

Languages with steady state finder (indicated in column 3 of table 3 by "trim command, iteration") calculated the results for both cases with sufficient accuracy. Usually the iterative solution of the steady state equations (model equations with derivatives zero) started with the initial values for f, m and r.

Languages without a steady state finder (indicated by "long-term simulation in time domain") simulated over a long period observing the changes of the derivatives. Usually they stopped at t = 100 getting as accurate results as the steady state finders.

This preliminary summary will be continued if solutions with new languages are sent in. People who sent in a solution are asked to check the comparing tables and to contact the editors if there are misunderstandings or corrections to be done.

F. Breitenecker

LANGUAGE	PARAMETER VARIATION	LOG.	STEADY STATE CALCULATION
ACSL	manual variation at runtime	standard	trim - command, iteration
DESIRE	parameter loop in model description	manual	not given
DYNAST	manual variation in model description	standard	long-term simulation in time domain
ESACAP	parameter loop in model description	standard	long-term simulation in time domain
ESL	parameter loop in model description	standard	trim-command, iteration
EXTEND	manual variation in graphic model description	standard	long-term simulation in time domain
FSIMUL	parameter loop in graphic model description	standard	long-term simulation in time domain
HYBSYS	parameter loop at runtime	standard	trim-command, iteration
I Think	manual variation in graphic model description	standard	long-term simulation in time domain
MATLAB	parameter loop in model description	standard	trim-command, iteration
NAP 2	manual variation in model description	standard	long-term simulation in time domain
PROSIGN	parameter loop in graphic model description	standard	trim-command, iteration
SIL	parameter loop at runtime	manual	trim-command, iteration
SIMULAB	manual variation in graphic model description	standard	trim-command, iteration
SIMUL_R	parameter loop at runtime	standard	trim-command, iteration
STEM	manual variation in model description	manual	trim-command, iteration
XANALOG	parameter loop in graphic model description	standard	trim-command, iteration

Table 3

Comparison 6: Emergency Department - Follow-up Treatment

Casualties from accidents are admitted to an emergency department for dressing of wounds. Broken limbs are put in plaster. After a few days a follow-up examination must be performed to monitor the healing process. If necessary, additional treatment will be administered.

Follow-up treatment in the emergency department of a hospital is the discrete process to be investigated in this comparison.

The emergency department comprises the following facilities for follow-up treatment:

- Registration (one person): casualties are assigned to casualty wards 1 or 2; the necessity of further treatment is established.
- Waiting area (people waiting to enter casualty wards 1 and 2).
- Two casualty wards (CW1, CW2; with two doctors each but CW2 staffed only by inexperienced doctors for attention to simple cases).
- X-ray room with two X-ray units (but all people waiting in one single queue).
- A room where plaster casts are applied or removed (one person).

Patients start arriving at 7.30 a.m. and queue for registration. Doctors start work at 8.00 a.m. They attend to four types of patients:

1) Patients requiring X-raying. Patients are first examined in the casualty ward, then sent to the X-ray room. Before they leave their X-ray photographs are examined once again in the casualty ward.
2) Removal of plaster casts. Patients enter a casualty ward, are sent to the plastering room, then leave the department.
3) Plaster casts requiring X-raying and renewal. Patients enter the casualty ward, are sent to the X-ray room and given new plaster casts. After checking of the new plasters by X-raying again patients are readmitted to the casualty ward. They then leave the department.
4) Changing wound dressings. Patients are admitted to a casualty ward, then leave the department.

The statistical parameters are as follows:

- The time between arrivals of patients is distributed exponentially with parameter 0.3 minutes.
- The percent distribution of patients over the four groups described above is as follows:
  1: 35%, 2: 20%, 3: 5%, 4: 40%.
- 60% of patients waiting for admission to a casualty ward are admitted to ward CW1, 40% to CW2. The parameters of the single treatment points show a triangular distribution (minimum value / mode = most likely value / maximum value):

Registration:	0.2 / 0.5 / 1.0 (min)
CW1:	1.5 / 3.2 / 5.0 (min)
CW2:	2.8 / 4.1 / 6.3 (min)
X-ray:	2.0 / 2.8 / 4.1 (min)
Plaster:	3.0 / 3.8 / 4.7 (min)

- Patients wait in queues before every treatment point (only one queue for X-raying!).

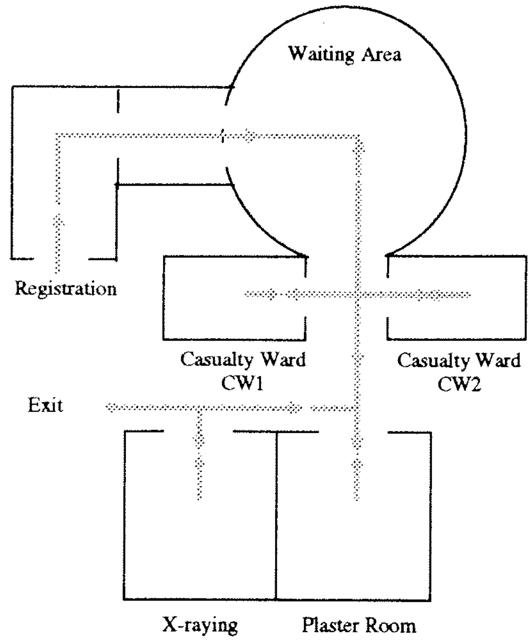
The following experiments should be performed:

a) Determine average overall treatment time for 250 patients and classify these patients by types 1) to 4).

b) Assume that a doctor from CW1 (experienced) replaces one of the inexperienced doctors in CW2 as soon as the queue for CW2 is in excess of 20 patients. Note that the working time of the doctor from CW2 now working in CW1 is increased by 20% due to the more complex cases he/she has to deal with. As soon as queue for CW2 is down to five people the inexperienced doctor still working in CW1 is returned to CW2. Perform Task a) on this assumption.

c) Try to minimize the standard deviation of overall treatment time by introducing a priority ranking. One option: patients entering one of the treatment points for the second time (type 1 patients, type 3 patients) rank higher in priority than all other patients. Other priority rankings are of course also conceivable.

F. Breitenecker, Technical University of Vienna



Emergency Department

Comparison 2 - SIMFLEX/2

Description of SIMFLEX/2

SIMFLEX/2 has been developed by the section Production Systems of the Department for Mechanical Engineering at the University of Kassel. It is an element orientated simulator for material flow systems. Out of a given set of standardized elements material flow systems are constructed via a menue oriented, graphic user interface. The elements' graphic depiction can be taken from existing plant layouts with a CAD-interface. The elements' function is influenced by means of technical (e.g. speed, capacity) and logistic parameters (e.g. strategies). When required the user can modify the steering programs of the elements. In this way even plants with complex logistics can be modelled. Having started the model a graphic animation and a statistic registration system can be added. Thus the user is enabled to intervene in a running simulation. A special feature of SIMFLEX/2 is its real time interface for communication with Programmable Logic Controllers (PLC). Through this it is possible to use the simulator for controlling real plants.

Description of the model

The type of problem allows several sequences of operations. Therefore each pallet is assigned with a note which states the jobs already done. A pallet's note and the number of pallets waiting to be worked on by a specific submodule decide whether a pallet is accepted for processing by some submodule or whether it passes by. The decision is made by a controller at a submodule's entrance. Figure 1 shows the complete structure of a submodule. At the construction of the model the CAD-interface has been used for the plant's scale depiction (figure 2).

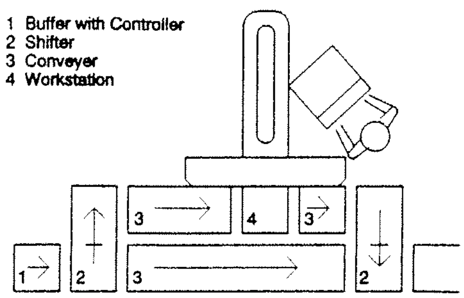


Figure 1: Submodule

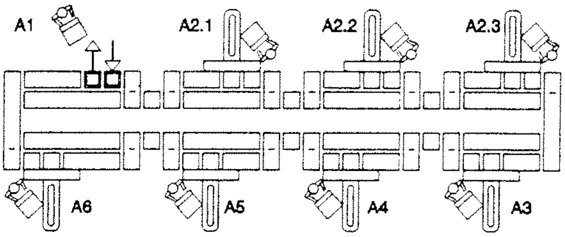


Figure 2: Plant Layout

Results

In order to find out the optimal number of pallets, 10 experiments were run. We started with 5 pallets and increased their number up to 50 by steps of 5. We measured the pallets' average throughput time, the total throughput within 8 hours and the stations' efficiencies.

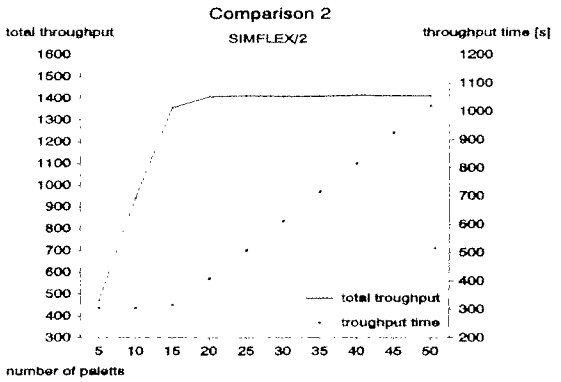


Figure 3

The optimal number of pallets in the system was found to be between 15 and 24, since then the throughput is already high while the throughput time is still low (figure 3). With fewer pallets the throughput is considerably and the throughput time only slightly reduced. An increase of pallets to more than 20 leads to only little more throughput but considerably prolongs throughput time. In addition, the jobs of station A3, A4 and A5 shift to the substitute station A6.

number of pallets	total troughput	average throughput time
5	470	306,0
10	941	306,0
15	1359	318,0
20	1409	408,6
25	1412	509,4
30	1410	612,6
35	1410	715.8
40	1414	816.0
45	1412	924,0
50	1412	1020,6

no. of pa.	efficiencies [%]							
	A1	A2.1	A2.2	A2.3	A3	A4	A6	A7
5	24,48	100,00	0,00	0,00	34,60	34,61	34,61	0,00
10	49,01	100,00	100,00	0,00	69,25	69,19	69,25	0,00
15	70,82	100,00	100,00	88,95	100,00	100,00	100,00	0,00
20	73,38	100,00	100,00	99,88	93,47	97,70	99,55	29,57
25	73,54	100,00	100,00	100,00	92,30	97,02	99,18	33,79
30	73,44	100,00	100,00	100,00	89,88	94,09	97,30	44,36
35	73,45	100,00	100,00	100,00	92,50	96,13	98,29	35,64
40	73,65	100,00	100,00	100,00	94,12	97,41	99,14	29,87
45	73,56	100,00	100,00	100,00	96,27	99,09	99,73	23,67
50	73,53	100,00	100,00	100,00	97,82	99,74	99,97	19,78
operation time and pallet changing time are taken into account								

For more information and comments please contact: B. Kreuzer, G. Lührs, A. Reinhardt, S. Schneider, FG Produktionssysteme, Universität Gh Kassel, Mönchebergstr. 7, W-3500 Kassel, Germany, Tel: +49-(0)561-804-2693, Fax: +49-(0)561-804-2330.

Comparison 2 - EXTEND

Description of EXTEND

EXTEND is a general purpose simulation system supporting both continuous and next event modeling. It is library-based and uses a block diagram approach to modelling. You can use libraries of pre-built blocks to set up models with no programming (for example Manufacturing) or you can use MODL, a built-in modeling language, to modify existing blocks or create new ones. The Manufacturing library allows you to create complex factory simulations.

Since version 2.0 EXTEND supports hierarchical modeling. We worked with version 1.1.

EXTEND runs on Macintosh computer. EXTEND™ is a product of Imagine That Inc., 151 Bernal Road, Suite 5, San Jose, CA 95119 USA.

Model Description

Figure 1 shows a model description by default blocks of EXTEND's Sample Manufacturing Library (a freeware child of the Manufacturing library) and the general Discrete Event Library. The times to change the conveyors are added to the conveyor working times. It is difficult to describe flexible control strategies by the default blocks.

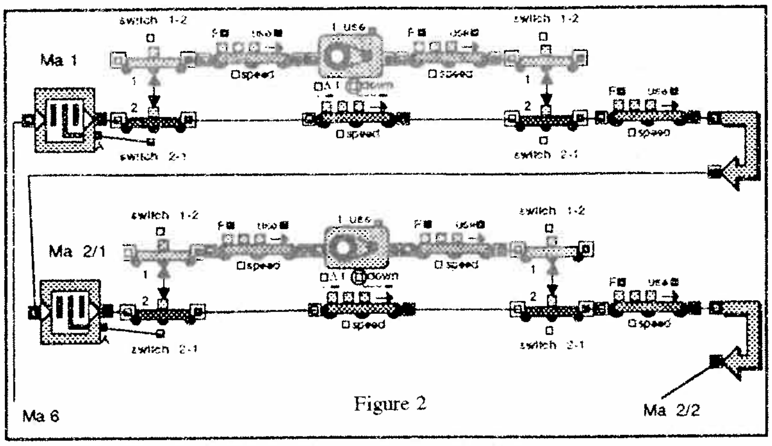


Figure 2

We developed a second model with modified and new created blocks (machine, conveyor switcher, control) to handle flexible control strategies. Figure 2 shows the general model layout for two machines. The "machine" block modifies item attributes, which are evaluated by the "control" block. The control strategies are described for each "control" block by a decision table (figure 3). The new features of version 2.0 allow a control description by logical equations and to model in hierarchical levels.

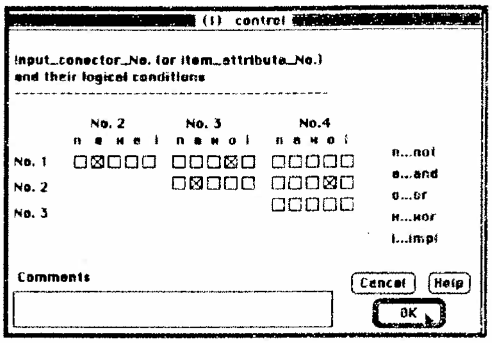


Figure 3

Simulation Results

The simulation experiments were executed with 10 pallets in the system up to 30 by steps of 5. The experiments showed that 20 is the favourable number of pallets. The simulation results are summarized for 20 pallets in table 1.

20 pallets machine No	finished items (throughput) 0...2 hours	 0...10 hours	 2...10 hours
2/1	120	600	480
2/2	120	600	480
2/3	118	598	480
3	347	1787	1440
4	345	1785	1440
5	344	1784	1440
6	5	5	0
finished items	346	1786	1440
circulations of pallets (with 1 item)	11	11	0

Table 1

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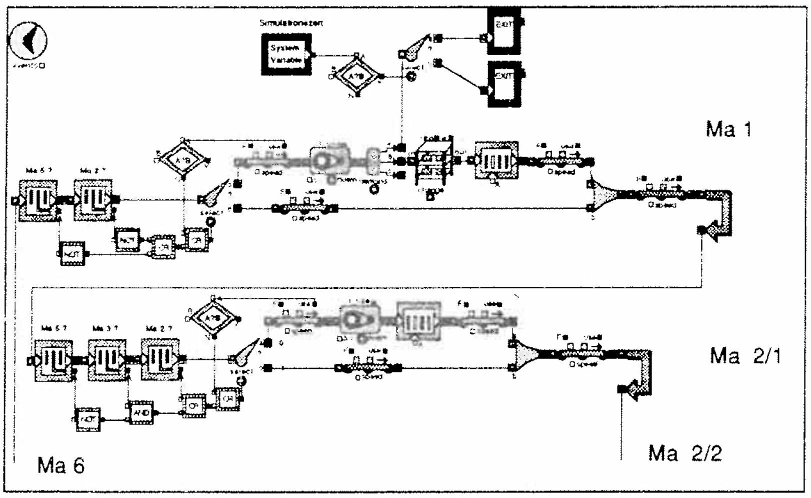


Figure 1

Comparison 4 - PAN

PAN and CPAN are tools for computer-aided analysis of models based on Petri nets. PAN is able to handle place-transition nets, CPAN extends to colored Petri nets. Both programs are written in MODULA-2 and can be implemented on every platform with a M2-system. Available are, amongst others, versions for IBM/PC, DEC-workstations under VMS and SUN-workstations under UNIX.

PAN offers the following methods for analyzing a Petri net:

* methods based on calculation of the reachability graph
* methods based on calculation of invariants
* methods based on structural properties.

PAN (CPAN) offers within an interactive session all methods suitable for the Petri net under consideration.

The Petri net for the Dining Philosophers problem (fig.2, p.29, EUROSIM 3, Nov. 1991) is formulated within an ASCII input file resulting in the following echoed input when starting the interactive PAN session:

```
.....
place 1,....,5 := C1,...,C5;
place 6,...,10 := M1,...,M5;
place 11,..,15 := E1,...,E5;
transition i = 1,...,5 := philosopher i starts eating
transition i = 6,..,10 := philosopher (i-5) starts meditation;
```

A first analysis gives information on elementary structural properties:

```
Properties of net
Places:          15    [1...15]
Transitions:     10    [1...10]
The net is pure.
The net is not statically conflict-free.
Static conflicts :
tr.nr:
    1:     2.go2eat2 ,    5.go2eat5 ,
    2:     1.go2eat1 ,    3.go2eat3 ,
    3:     2.go2eat2 ,    4.go2eat4 ,
    4:     3.go2eat3 ,    5.go2eat5 ,
    5:     1.go2eat1 ,    4.go2eat4 ,
The net is not conservative.
The net is an ordinary one.
The structure [P,T,F] is not extended simple.
```

Based on this analysis PAN offers only suitable methods, indicated in the status row with following menues:

```
BND LIV CFF DTr DMa REV ORD HOM FtC tFC Fp0 pF0 SM
 ?   ?   ?   ?   ?   ?   Y   Y   N   N   N   N   N

EFC ES  DTP SMC SMD SMA
 N   N   ?   ?   ?   ?
```

In order to check boundedness the semipositive place-invariants are computed resulting in:

```
The net is covered by semipositive place-invariants.
The net is structurally bounded.
The net is bounded.
There are no proper semipositive T-surinvariants.
```

Computation of the T-invariants prepares for calculation of the reachability graph resulting in:

```
The net is safe (1-bounded).
The initial marking is repoducible.
The net has no dead transitions at the initial
marking.

Reachability graph:
===================
     Transitions:
Nodes:  1  2  3  4  5  6  7  8  9 10
------------------------------------
   1:   .  .  2 10  . 11  .  .  .  .
   2:   .  .  .  .  .  3  .  1  .  .
   3:   2  .  .  .  4  .  . 11  .  .
   4:   .  .  .  .  .  .  .  5  .  3
   5:   .  6  4  .  .  .  .  .  . 11
   6:   .  .  .  .  .  .  5  .  .  7
   7:   .  .  .  8  6  . 11  .  .  .
   8:   .  .  .  .  .  .  9  .  7  .
   9:  10  8  .  .  .  .  .  . 11  .
  10:   .  .  .  .  .  9  .  .  1  .
  11:   1  7  3  9  5  .  .  .  .  .

Transition-Conflicts:
=====================
  1:  3 #  4;
  3:  1 #  5;
  5:  2 #  3;
  7:  4 #  5;
  9:  1 #  2;
 11:  1 #  2;   1 #  5;   2 #  3;   3 #  4;   4 #  5;
The net is not dynamically conflict-free.
```

These investigations show, that each state is reachable (each philosopher could eat and think), but there may be conflicts (at marking nr.1 transition 3 and 4 are in conflict etc.).

Further analysis can be done by setting priorities. In the following a conspiracy of philosophers 2 and 5 against their common neighbour philosopher 1 is modelled by giving them a higher priority:

```
Least transition nr: Priorities:
  1:  0  2  0  0  2  0  0  0  0
The net is safe (1-bounded).
The initial marking is reproducible.
The net has dead transitions at the initial marking.
The net is not live.
The following transitions are dead:
     1.go2eat,
......
The net is not reversible.
The initial node is not reachable from the following
nodes:
  3,   4,   5,   6,   7,   9,  10,  11,
There are transitions, dead at the following nodes:
  3,   4,   5,   6,   7,   9,  10,  11,
Live transitions:
       2,   5,   7,  10
```

This conspiracy was successful, philosopher 1 is going to starve.

Remarkable savings in time and space can be achieved by computing and using the symmetries of the net, which is also a feature of (C)PAN (for more information see P. H. Starke: Reachability Analysis of Petri Nets Using Symmetries. J.Syst.Anal.Model.Simul. 8 (1991) 5/6, 294-303).

Prof. Dr. H. P. Starke, Humboldt-Universität zu Berlin, Fachbereich Informatik, Postfach 1297, D - O - 1086 Berlin

shortened version

Comparison 4 - PACE

PACE is a software-tool with a remarkable range of application capabilities. Its method, based on the theory of Petri-Nets, is as simple as revolutionary. It allows one to "program" complex tasks by simply describing logically the systems in an object-oriented, graphical way.

Complex systems can therefore be easily modelled and simulated. This capability allows to analyze, optimize, evaluate and validate a broad area of different applications like:

- Data-structure and -flow modelling
- Resource management
- Information flow analysis
- Logistical planning

This simulation, realized through the animation of the Petri-Nets on the screen, permits, in addition the checking and validating of the proposed (programmed) solution.

A code generator, a run-time module for the target system and an automatic documentation generator complete this CASE tool of the new generation.

The customer benefits can be summarized as follows:

- Object-, task- and data-oriented graphic programming
- Transparent modelling of complex systems
- Substantially shorter development time
- Optimal reusability of programmed code
- Excellent visualization through graphic animation of the data flows
- Actualized documentation at all times
- Comfortable and user-friendly programming and simulation environment
- Fully integrated Smalltalk-80 object-oriented programming language
- User definable statistic functions
- Rich in features - user-definable icons, backtracing and many more...

Demonstration of a *PACE*-model with an example of "Dining Philosophers"

The "Dining Philosophers" usually meet in groups of five sitting around a large round table. Because our Chinese philosophers are poor they have only five chopsticks lying left to each of the bowls - and for normally eating Chinese food you need two chopsticks. If a philosopher is hungry, he starts eating. It may now happen that the neighbour at the left becomes hungry at the same time. At the latest if he wants to take his right chopstick, he understands that he can't start eating.

If a philosopher has finished eating, the chopsticks will first be cleaned before given back to the table.

Now an approach to the mentioned problem is the following - naturally modelled in ***PACE***!

The shown situation confirms many aspects. A clear picture, explaining icons and a simple possibility to manipulate the simulation with aid of several bar gauges on the right side. It allows to fix the time, which a philosopher needs to eat or meditate.

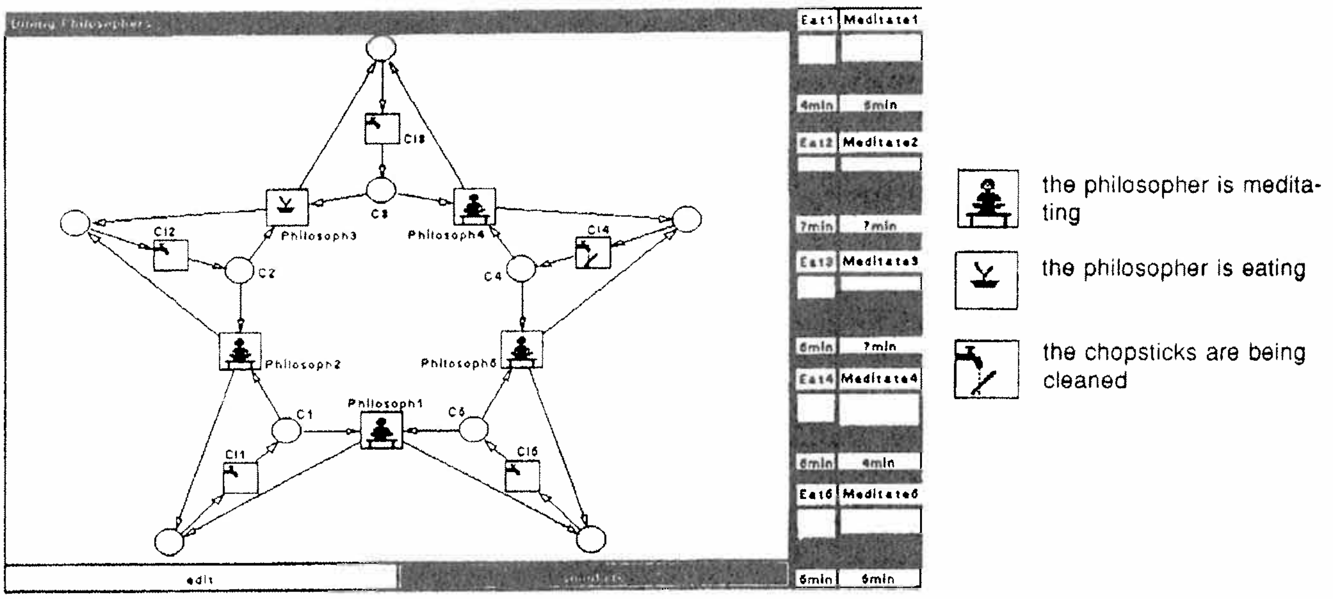
With the help of those icons it is very easy to understand the situation and connection (also for a non-professional). The moving tokens are also replaced with the icon "chopstick" so that it is possible to see also which "information" flows.

The buttons "edit" and "simulate" allow the user to change directly the mode of the net. That's because there is no compilation necessary in ***PACE***. At every time you are able to simulate - even if the net isn't finished already. So you can use ***PACE*** for feasibility studies too.

For the simulation it took us only one hour for modelling and less than two hours for optimizing with the help of icons, bar gauges and message prompts.

A weighty feature is the possibility to write any data in ASCII-format to a file that can be analyzed by common spreadsheet programs like MS-Excel.

For any information please feel free to call us at: ***Grossenbacher Elektronik AG,*** *PACE - Product Line, Spinnereistrasse 8, CH-9008 St.Gallen, Switzerland, Tel: +41-71 26 31 51, Fax: +41-71 24 04 06*



Comparison 5 - SIMUL_R

The Language

SIMUL_R is a compiling simulation language for continuous and discrete systems, implemented on PCs, under MS-Windows, workstations, Transputer nets and parallel computers. It has been introduced in EUROSIM - Simulation News Europe, numbers 1 to 5. SIMUL_R 2.30 double precision and the DASSL integration routines, which are available as a free-of-charge extension to SIMUL_R, have been used for this comparison.

The Model

Figure 1 shows the model. The SSCHEDULE command in this case invokes - when a condition is fulfilled - the specified DISCRETE section, which contains another scheduling and prints an information message.

```
eurosim5 {

  CONSTANT tend=5;                    " constants "
  CONSTANT c1=2.7E6, c3=3.5651205;
  CONSTANT c2_1=0.4, c2_2=-0.3, c4_1=5.5, c4_2=2.73, b_2=2.5;
  CONSTANT y1_0=4.2,  y2_0=0.3;

  float c2, c4;                     " variables "
  c2=c2_1; c4=c4_1;

  DISCRETE state_change_to_2 {
 DO { simprintf("changed to state 2 at t=%20.11f y1=%20.11f\n",t,y1);};
    c2=c2_2; c4=c4_2;
    SSCHEDULE state_change_to_1: y1   2;
  };

  DISCRETE state_change_to_1 {
  DO {simprintf("changed to state 1 at t=%20.11f y1=%20.11f\n",t,y1);};
    c2=c2_1; c4=c4_1;
    SSCHEDULE state_change_to_2: y1=5.8;
  };

  SSCHEDULE state_change_to_2: y1=5.8;    " first schedule "

  DYNAMIC {
    DERIVATIVE {                    " the model "
      y1 = INTEG(c1*(y2+c2-y1),y1_0);
      y2 = INTEG(c3*(c4-y2),y2_0);
    }
    TERMINATE t=tend;
  }
}
```

Figure 1: The SIMUL_R model

The Results

The SSCHEDULE commands try to find the exact value of the state change by back tracking. The accuracy of this computation can be specified by the system variable acc_sched. In this case acc_sched is set to the value of the relative error each time. The DASSL routines contain very stable, but sometimes slower, step controlled integration algorithms.

The plot for task a) is shown in Figure 2. Figure 3 shows a comparison of results for different accuracies (1E-14 really shows the "exact" values). The last switching point is found with accuracy 10E-6 with SIMUL_R, because of the scheduling done by SSCHEDULE!

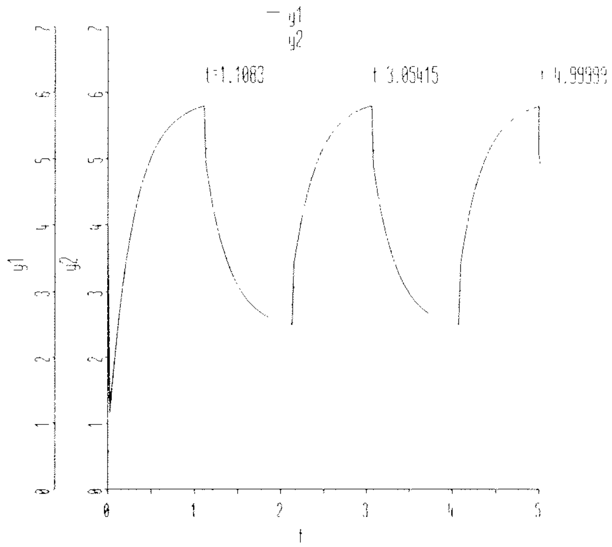


Figure 2: Plot for task a)

Error	1E-6	1E-10	1E-14
#1	1.10827307102	1.10830616558	1.10830616777
#2	2.12964647324	2.12968534738	2.12968535516
#3	3.05409796447	3.05415289398	3.05415290700
#4	4.07545367964	4.07553207622	4.07553209438
#5	4.99989522642	4.99999961918	4.99999964622
Y1(5)	5.0990067426	5.3503515936	5.3693154297

Figure 3: Results for Tasks b) and c)

Figures 4 and 5 show the results for the corrected values for task d).

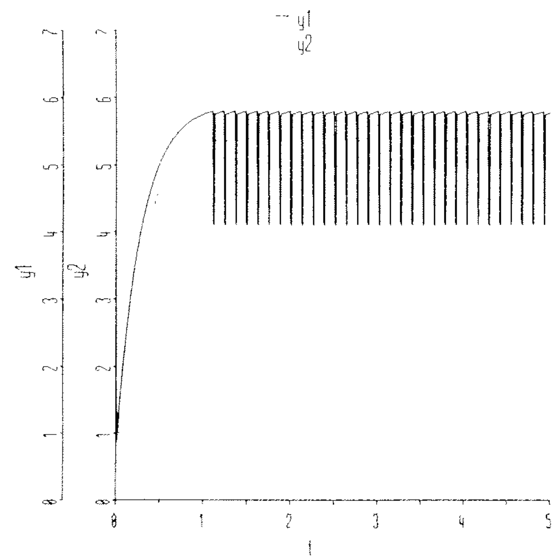


Figure 4: Plot for task d)

Error	1E-11
#1	1.10830616905
#2	1.12172996923
#3	1.23546396724
...	
	4.93646391801
Y1(5)	5.7804025164

Figure 5: Results for Task d)

For information and comments, please phone or fax or write to R. Ruzicka, SIMUTECH, Hadikgasse 150, A-1140 Vienna, Austria. Tel: +43-(0)222-894 75 08; Fax: +43-(0)222-894 78 04.

Book News

Jack Kleijnen and Willem van Groenendaal "Simulation: A Statistical Perspective"

John Wiley & Sons Ltd.

This text is aimed at those readers who wish to acquire a basic knowledge of simulation. The authors combine simulation theory and statistical theory with practical applications to show how certain problems in the areas of management science, operations research, economics, business administration and mathematical statistics can be analysed by means of simulation.

The book includes many examples of different types of simulation, an introduction to Forrester's Industrial Dynamics or System Dynamics, and the evaluation of pseudorandom number generation. It also discusses the application of simulation in mathematical statistics and operational research, with particular reference to inventory and queuing systems.

Book Reviews

This section provides readers with detailed information on new books on modelling and simulation. Books are reviewed in detail. Because of the scope of this newsletter also non-english books are reviewed. We ask our readers the following:

- If you are the author of a book or know an author please send the book to the editors to be reviewed (ask the author to send the book).
- If you have studied a new book please send a detailed review to the editors.
- If you are willing to review a book please contact the editors to set up a review staff.

Horst Tempelmeier "Simulation mit SIMAN"

Physica-Verlag Heidelberg

The simulation language SIMAN developed by Dr. C.D. Pegden, Systems Modeling Corporation, Sewickley USA, offers today with the newest release SIMAN/CINEMA IV a wide range of modeling concepts. Since 1983 SIMAN is also very popular in German speaking countries, although there was no reference book in German available. Prof. Tempelmeier, currently teaching at the Technical University of Braunschweig, is one of the well known SIMAN users and his simulation courses are very popular throughout Europe.

The book "Simulation mit SIMAN" by Prof. Tempelmeier, published by Physica-Verlag Heidelberg, is available since 1991. The object of the author was to offer a wide, practical orientated introduction using SIMAN IV. The concept of this book is based on the course material of Prof. Tempelmeier's lectures at universities and industrial sites. The book demonstrates and explains the concepts of the simulation language SIMAN and is mainly assumed as a reference guide for German speaking SIMAN users. A number of practical examples of material handling and production systems is described and the commands and their syntax are explained.

Additionally the author demonstrates and describes the self-developed, so called SIMAN Modul Processor (SMP) and the block-based graphical animation SIMANIM.

Unfortunately, although SIMAN offers statistical analysis tools, called the INPUT/OUTPUT processors, and a powerful animation system, called CINEMA, these topics are not considered in the book.

German speaking SIMAN users from universities and industry now have a reference book in German, which is a great contribution to spreading the popularity of this simulation language.

Dr. H. Weigl, Institut für Fertigungstechnik, Technische Universität Wien, Austria

Classes on Simulation

January 1993

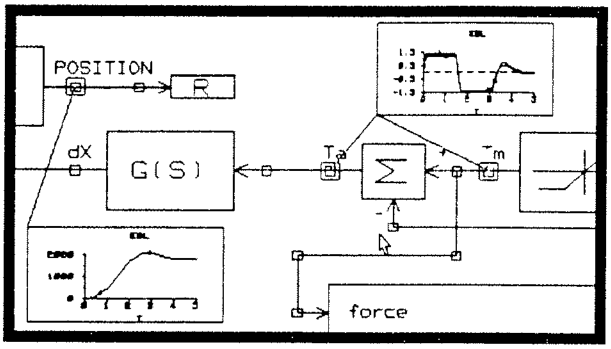
12-14 **Comnet II.5** (WAN Communication Simulation). Camberley, UK
Contact: CACI Products Division, Suite 11, Coliseum Business Centre, Watchmoor Park, Riverside Way, Camberley, Surrey GU15 3YL, Tel: +44 276 671671, Fax: +44 276 670677

19-21 **Simscript II.5** (Discrete Event Simulation), Maastricht, The Netherlands.
Contact: CACI Products Division, Suite 11, Coliseum Business Centre, Watchmoor Park, Riverside Way, Camberley, Surrey GU15 3YL, Tel: +44 276 671671, Fax: +44 276 670677

April 1993

19-23 **Simulation kontinuierlicher Systeme** (in German),CCG-Lehrgang, Munich, Germany.
Contact: Carl-Cranz-Gesellschaft, Ges. f. technisch-wissenschaftliche Weiterbildung, Flugplatz, W-8031 Oberpfaffenhofen, Tel: +49-(0)8153 28444, Fax: +49-(0)8153 281345

21-23 **Modelling & Simulation Shourt Course (ACSL)**, Eastbourne, UK.
Contact: Rapid Data Ltd., Crescent House, Crescent Road, Worthing, West Sussex BN11 5RW,UK.



ESL: THE LANGUAGE OF SIMULATION

With over seven years development maturity, ESL is **THE** simulation language for advanced applications.

Developed with the support of the European Space Agency and used on several advanced projects, ESL offers a full range of simulation facilities.

Whatever your process, if it can be modelled, it can be simulated by ESL.

* Advanced language features for handling continuous mathematical models with discontinuities.
* Advanced graphical interface for generating simulation models and displaying results.
* Interpretive running for checking, or compiled Fortran 77 code for optimum performance.
* Hardware support includes PC-AT, SUN and DEC workstations, IBM RS6000, VAX, Prime and Gould Minicomputers.
* Low cost evaluation copies available.
* Regular seminar and training course programme.
* Alternative textual or pictorial block model definition.

For more information contact:-

Dr J L Hay

A Division of Salford University Business Services Ltd
Technology House
Salford University Business Park
Lissadel Street
SALFORD
M6 6AP
England

Tel: +44 (0)61 745 7444
Fax: +44 (0)61 737 7700

SCS

SCS in response to the ever increasing activity of Computer Simulation related meetings has as you can see intensified its activities in order to cater to the proposals put forward to the office. Next to its own conferences in Europe SCS has decided to co-sponsor over the next few years the ITEC (International Training and Equipment Conference), TILE (Technology in Leisure and Entertainment) and CEEDA (Concurrent Engineering in Electronics Design and Automation). Furthermore SCS is looking into the requests by some of you to co-sponsor and co-organize some smaller events in Europe.

Next to these conferences SCS Europe has also been instrumental in helping to set up the Belgian Society for VR, which had its first meeting on Saturday October 24th, and in which 250 people took part.

Conference Report

The 1992 ESM took place from June 1-3, 1992 in the historic city of York and was one of the most successful conferences to date with 139 presentations, 192 participants and 15 companies exhibiting. Next to the scientific program we were also able to set up a very interesting social event, in the British National Railway Museum where we could enjoy the conference dinner surrounded by steam locomotives. During that dinner, Prof. Soemon Takakuwa was presented with the best paper award for his presentation entitled "Machine Loading and Analysis of a Machining/Measuring Type of the Flexible Manufacturing System". The prize entitles the author to attend any SCS conference worldwide free of charge.

Furthermore the Proceedings of that conference entitled "Modelling and Simulation 1992", edited by John Stephenson are now available from the European Office of SCS.

Conference Activities SCS

Western Multiconference on Computer Simulation, La Jolla, USA, January 17-20, 1993

This conference will feature the 1993 International Conference on Bond Graph Modelling, Simulation in Health Sciences, Conference on Simulation in Engineering Education, Business Management and MIS, Object-Oriented Simulation and the 1993 Workshop on Modelling, Analysis and Simulation of Computer and Telecommunications Systems.

For further information please contact: SCS, P.O.Box 17900, CA 92177, San Diego, USA. Tel: +1.619.277.3888, Fax: +1.619.277.3930.

SMC '93, Simulation Multiconference, Arlington, Virginia, March 29 - April 1, 1993

This conference will feature the 26th Annual Simulation Symposium, 2nd Annual Conference on Military and Government Simulation, International Emergency Management and Engineering Conference, Visualization, Validation and Verification of Computer Simulation.

For further information please contact: SCS, P.O.Box 17900, CA 92177, San Diego, USA. Tel: +1.619.277.3888, Fax: +1.619.277.3930.

ESM 93, European Simulation Multiconference, Lyon, France, June 7-9,1993

Venue: The 1993 European Simulation Multiconference will this year take place in Lyon, an old Gallo Roman city, renowned for its delicious food, right in the middle of Beaujolais country. The official headquarters and venue for the 1992 ESM will be L'Ecole Normale Superieure de Lyon. This high-tech school with its innovative architecture will certainly provide the conference participants an event to remember.

Scientific Program: The 1993 European Simulation Multiconference will bring together six individual conferences. We invite papers for presentation at the conference and for publication in the Conference Proceedings on the following subjects: Simulation Methodology and Practice, Simulation in Economics, Simulation in Aerospace, Simulation in Transport and Traffic, Simulation in Environmental Systems and Global Climate Modelling, Simulation in Parallel and Distributed Processing.

Deadlines and Requirements: Extended abstracts, of long papers and poster sessions (two pages typewritten without drawings and tables) are due to arrive in TRIPLICATE at the SCS International, European Simulation Office before **December 1st, 1992.** Camera ready copies of accepted papers: **April 1st, 1993.**

For further information please contact: The Society for Computer Simulation International, European Simulation Office , c/o Philippe Geril, University of Ghent, Coupure Links 653, B-9000 Ghent, Belgium, Tel/Fax: +32.91.234941, E-Mail: SCSI@BIOMATH.RUG.AC.BE

ITEC 1993, Concurrent Engineering, Wembley, United Kingdom, May 4-6, 1993

The 1993 ITEC conference features for the first time a category of papers within the field of Concurrent Engineering, organized by SCS (The Society for Computer Simulation). Concurrent Engineering tries to enhance the engineering and manufacturing process by altering the mainly linear processes, eliminating feedback and introducing concurrency. This speeds up the time to delivery drastically. Evidently, computer support for such an effort is crucial. In particular, where large corporations are concerned, many face the problem that their experts are scattered accross the globe and it is very expensive to have them transferred to one location to have them perform some cooperative brainstorming. Because it transpired that, especially these so-called "skunk groups" deliver the best results, where product design is concerned, many large corporations and especially DOD have decided that these experts should be linked by a highspeed network, high performance workstations and video equipment, so that the global group can function as a "local" working unit. As many of the research projects now being done are based on simulation technology, SCS has taken it upon itself to promote this technology in Europe.

Concurrent Engineering has become one of the key technologies for the nineties in the US and promises to be a key element in manufacturing technology for the future, culminating in what is now known as the Virtual Enterprise/Factory project. The virtual factory being an international (electronic) network of manufacturers, flexible components manufacturers, distributors, etc.... By exchanging information, like product data, in the form of CAD/CAM PDI ("Product Data Interchange")-files, companies can be linked or unlinked depending on marketneeds. This enables them to react very quickly to market changes.

Further features of the track on Concurrent Engineering will be a panel discussion on the future of Concurrent Engineering in Europe, the workings of the SiE (Simulation in Europe) SIG special working group of the ESPRIT programme of the EEC.

TILE 93, Maastricht, The Netherlands, June 29-July 1st, 1993

The theme for the TILE 1993 Conference is : "Realism in Vision, Movement and Sound" The selection of papers is being made by an international panel of prominent members of the leisure, entertainment and manufacturing communities.

The 1992 Conference has 35 papers covering overviews of the industry; interactive entertainment; virtual reality; technology for museums and exhibitions; animatronics, and "telling the story"; simulation; sound and lasers; film, 3-D and HDTV; and ride and ticketing technology.

The 1993 conference will have new papers addressing these areas and other areas such as safety, maintenance and the financial returns from using advanced technology.

For further information please contact: Andrich International Ltd., 51 Market Place, Warminster, Wiltshire BA12 9AZ, United Kingdom, Tel: +44.985.846.181, Fax: +44.985.846.163

Summer Computer Simulation Conference' 93, Boston, Massachusetts, July 19-21, 1993

SCSC'93 will feature presentations of innovative work, state-of-the-art technology reviews, panel discussions, tutorials, and trade exhibits designed to provide comprehensive coverage of this rapidly evolving field.

For further information please contact: Dr. Joel M. Schoen, SCSC'93 Committee, The MITRE Corporation, 202 Burlington Road, Bedford, MA 01730-1420, USA. Tel: +1 617.271.2230, Fax: +1 617.271.5173, E-mail: jms@mitre.org

ESS 93, European Simulation Symposium, Delft, The Netherlands, October 25-28, 1993

For further information please contact: Philippe Geril, SCSI, European Simulation Office, University of Ghent, Coupure Links 653, B-9000 Ghent, Belgium, Tel/Fax: +32. 91.23.49.41, E-mail: scsi@biomath.rug.ac.be.

Ph. Geril

Elections of European SCS Fellows, Vice-Presidents and Directors

As a result of a new set of bylaws, the SCS Board of Directors approved the new membership grade of FELLOW to recognize the most senior and technically renowned members of the Society for Computer Simulation International (SCS). Fellows are required to have been Senior members for at least five years, to be nominated by a Society member, to have had outstanding and acknowledged achievements in the simulation field, and to be evaluated by at least six members who are Life, Fellow or Senior members. A number of 11 members were elected by the SCS Board of Directors during its annual meeting, July 30 in Reno, Nevada, USA to be the first group of Fellows of SCS and privileged to list "F.S.C.S." after their names. Two of them are Europeans: Dr. Eugene J.H. Kerckhoffs (University of Delft, The Netherlands) and Prof. Ghislain C. Vansteenkiste (University of Ghent, Belgium).

In the same above-mentioned annual meeting of the SCS Board Dr. Eugene Kerckhoffs was elected to be the new Vice-President (VP) Europe for a period of two years. He replaces the retiring VP Prof. Ghislain Vansteenkiste, who has kept office for nine years. The new VP Europe has appointed three Associate VPs: Prof. Axel Lehmann (Munich, Germany), for Academic Affairs, Rainer Rimane (Erlangen, Germany) for Conferences and Finances, and Dr. Heinz Weigl (Vienna, Austria) for Industries.

In the SCS Board of Directors 1992/1993 a number of 7 European directors have been elected. Five of them are on behalf of the European Simulation Council (EuSC): Prof. Axel Lehmann (Germany), Prof. Istvan Molnar (Hungary), Rainer Rimane (Germany), Prof. Ghislain Vansteenkiste (Belgium), and Dr. Richard Zobel (UK). There are two directors-at-large: Dr. Jürgen Halin (Switzerland) and Dr. Heinz Weigl (Austria).

E.J.H. Kerckhoffs

IMACS

1. MATHMOD VIENNA

1. MATHMOD VIENNA

1. MATHMOD VIENNA

1. MATHMOD VIENNA

February 2-4, 1994
Technical University Vienna, Austria

Scope: All aspects of mathematical modelling of all types of systems, including systems which are * dynamic or static * deterministic or stochastic * continuous or discrete * lumped parameter or distributed parameter * linear or nonlinear * or of any other nature

Consequently, a wide variety of formal models will be discussed and the term "mathematical model" will include classical models such as differential or difference equations, Markov processes, ARMA models as well as more recent approaches such as Bond Graphs or Petri nets.

The scope of the topics to be discussed will include modelling theory * general aspects of modelling incl. modelling methodologies * modelling for/by simulation * qualitative modelling and associate learning networks in modelling * methodologies for model validation * guidelines for setting up models (checklist) * model simplification and order reduction including software for model reduction * automation of modelling and software supporting modelling * applications in engineering, natural sciences, biotechnology, biology, medicine, sociology, econometrics, etc. * relations between model type and problem solution (pre-determination of solution by modelling approach) * education in modelling

Deadlines: Submission of Abstracts: **May 1, 1993**, Notification of Authors: **September 1, 1993**, Full Paper due: **November 1, 1993**

All correspondence should be adressed to: Univ.Prof. Dr. Inge Troch, Technische Universitaet Wien, Wiedner Hauptstrasse 8-10, A-1040 Wien.

Laboratory for Ecological Modelling at the Rudjer Boskovic Institute, Zagreb, Croatia

The laboratory has been involved with simulation of ecological systems such as lakes, coastal seas and rivers.

In addition to constructing specific models of ecosystems or their parts, the laboratory has constructed three software packages:

- VOLUME - a package to calculate volume of irregular small cells that cannot be removed from the solution (phytoplankton, bacteria, zooplankton etc.).
- AS - simulation of dispersion of pollutants through air from accidents for real time applications.
- RECON - for finding the optimal management plan for pollutant concentration in lakes and coastal sea.

RECON is by far the largest package. Composed of more than forty modules, the package is able to reconstruct the current field in a water body even when a few data exist. This is done by using inverse modelling methods for partial differential equations. The obtained current field is equivalent to the solution of linearized Navier-Stokes equations where forces are afine functions of current measurements. When the current field has been successfully reconstructed the package reconstructs the concentration field of any conservative or nonconservative substance (for example a pollutant) released to a water body. The procedure is successful even if intensity of some sources are not known in which case they are estimated by the package. The criteria for estimation is the minimization of square error between measurements and the solution to a transport equation. The package also estimates the extinction rate of the substance from the water column due to uptake by biota, sedimentation, evaporation etc. By the time the two reconstructions are successfully performed, the package has constructed and validated models with appropriate boundary conditions and hence it is ready for predictions of various management plans which may involve decreasing intensity, relocating or merging sources.

The modules contain methods for:

- recognition of a various types of data that might exist about the water body (measurements of currents, locations of rivers, measurements of concentration, locations of sources and their intensity if known);
- checking mutual consistency of data;
- interactive building of models and boundary conditions;
- estimating parameters for the models (solving inverse problems);
- estimating (reconstructing) the existing current field;
- an ability to experiment with the existing data for the purpose of verification or additional monitoring;
- estimations for the transport equation with various types of boundary conditions; Estimation of the concentration field;
- calculation of a complete mass balance of any conservative or nonconservative substance in the coastal sea;
- calculation of future concentration fields following various environmental management plans.

It took several scientists 10 years to develop the package: to implement existing methods, to develop mew methods, to build in the artificial intelligence needed to solve real world problems and to make it extremely simple to use.

The software includes known and a series of novel, highly optimized numerical routines to solve direct and inverse problems, to converse with the user and to give results in a clear and intuitive fashion.

The package is suited for:

- small and large firms concerned with environmental management, environmental impact assessment, selection of the optimum environmental management plans.
- universities concerned with teaching future environmental engineers in departments such as ecology, environmental engineering, geography, limnology and marine sciences.
- research laboratories concerned with calculation of mass balance of substances in coastal seas; discovery of sources of various substances and as a platform for a series for additional research.

The software represents the unique and a comprehensive package. In the decade to come it will bridge the gap between talking about an optimal management plan and being able to inspect and act on it.

Governments, private firms and universities are invited to acquire it for scientists, environmental engineers and students. Short courses on how to use it effectively could easily be organized.

This package represents our contribution toward a wiser management of aquatic environment.

Prof. T. Legovic, Laboratory for Ecological Modelling at the Rudjer Boskovic Institute, POB 1016, 41001 Zagreb, Croatia.

Workshop "Modeling and Simulation in the Environmental Area"

The regional group of the Society of Informatic (Gesellschaft für Informatik e.V., GI) of Rostock/Wismar and the working group of modeling/simulation of the department of informatic at the University of Rostock have invited to a workshop from June 25th to 26th, 1992. Subject of this workshop was "Modeling and Simulation in the Environmental Area". It was held at the University of Rostock, Germany, Department of Informatic. About fifty specialists have discussed problems of the environmental modeling, simulation, and of all questions associated with these working fields.

The objective of this meeting was: to provide a comprehensive overview of currently environmental problems and the progress achieved in their numerical simulation; to create a basis for an intensive discussion and an exchange of ideas of the specialists.

The scientific organization was realized by Prof. Rolf Grützner from the University of Rostock. The main topics were: architecture and functionality of simulation systems: techniques of modeling and simulation (qualitative simulation, heuristical modeling, and the use of expert systems co-operating with simulation systems); application of modeling and simulation in the environmental protection and in the ecosystem research (e.g. modeling of the Baltic Sea, computational water resources, water purification plants, dying of the forests, ecosystems, wind models); simulation systems, environmental information systems and their coupling.

Invited papers were held by Prof. B. Schmidt, University of Passau, "5th Generation of Simulation Systems" and by Prof. B. Page and Dipl. Inform. H. Häuslein, University of Hamburg, "Software Support of Modeling and Simulation in the Environmental Area".

An interesting paper was represented by Prof. Schiewer, a biologist of the University of Rostock, who reported about demands on modeling and simulation looking as biologist or ecologist to these problem solving tools.

All papers were published in a booklet - the proceedings of the workshop - and delivered to all participants at the beginning of the workshop.

In addition to the Workshop there was a meeting of the Working Group 5 "Tools for Modeling and Simulation in Environmental Applications" of the GI Special Group 4.6. "Informatic in the Environment Protection". This meeting was on June 24th, 1992, in Rostock. Special requirements were discussed, which must be fullfilled by the modeling and simulation tools used in the environmental field.

All aims of the workshop and the meeting are realized in a warm atmosphere. A second workshop is planned for 1993 with the same topics.

Prof. Dr. habil. Rolf Grützner, working group Modelling/Simulation, Dept. of Informatic, University of Rostock, PSF. 999, 0-2500 Rostock, Germany

Foundation of the European GPSS-User-Group

GPSS and GPSS like systems belong to the most commonly used simulation systems in the U.S.A. But they are not widespread in Europe and in Germany especially. At some European Universities and Colleges GPSS simulation systems were and are being used to teach simulation. Simulation models based on GPSS are used for many applications.

However an organization for communicating between the users, and contacting developers and vendors of these systems does not exist. To organize those meetings regularly and to reach a larger audience, we want to found a GPSS-User-Group Europe. The search is on for all developers and users of GPSS and GPSS like simulation systems (e.g. GPSS/H, GPSS/PC, SIMDIS, GPSS-FORTRAN etc.). The GPSS-User-Group is not connected with other simulation organizations. We want to address all interested parties.

The goals of the user group are:

- to inform users about new developments in the field of simulation and animation using GPSS
- to exchange experiences of methods of building simulation models with GPSS
- to organize tutorials to introduce the usage of GPSS
- to distribute information materials
- to work out and spread teaching materials

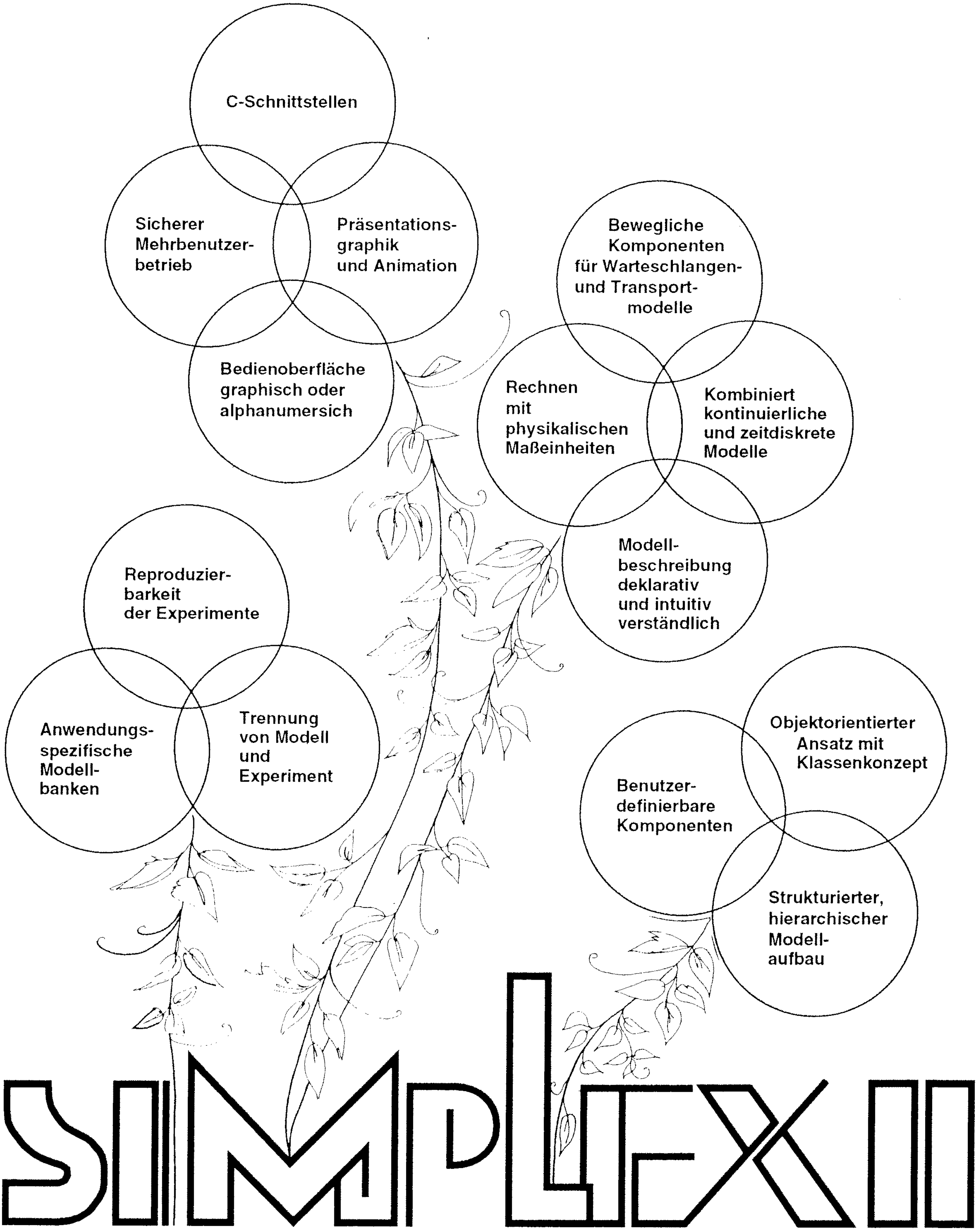
The first meeting will take place on the 11th/12th of March, 1993 in Magdeburg. The following speakers are invited: Felix Breitenecker, Technical University Vienna, Springer W. Cox, Minuteman Software Corp. (vendor of GPSS/PC), James O. Henrikson, Wolverine Software Corp. (vendor of GPSS/H), Peter Lorenz, Technical University Magdeburg, Thomas J. Schriber, University of Michigan, Ingolf Ståhl, Stockholm School of Economics.

The meeting will deal with New Developments and Application Fields (March 11th) and Problems and Methods Using GPSS for Simulation (March 12th). The fee for the meeting is DM 150.-. On the days preceeding the first meeting, two tutorials will be offered to introduce newcomers in simulation to GPSS (fees for tutorials are DM 120.- each; both tutorials DM 200.-):

March 9	Tutorial: Introduction to GPSS
March 10	Tutorial: Advanced GPSS Programming and Proof Animation

Registration before January 15th, 1993:

Thomas Behlau
Department of Computer Simulation and Graphics
Technical University Magdeburg
P.O. Box 4120, D-O- Magdeburg, Germany
Tel: +49-(0)391 55922868, Fax.: +49-(0)391 55
E-Mail: BEHLAU@DMDTU11.bitnet



Das universelle Simulationssystem der neuen Generation auf UNIX System V

Modellaufbau: Schnell und doch individuell !

Hierarchische Modelle bauen ...

Ausgangspunkt für die Modellerstellung ist stets eine **Modellbank**.

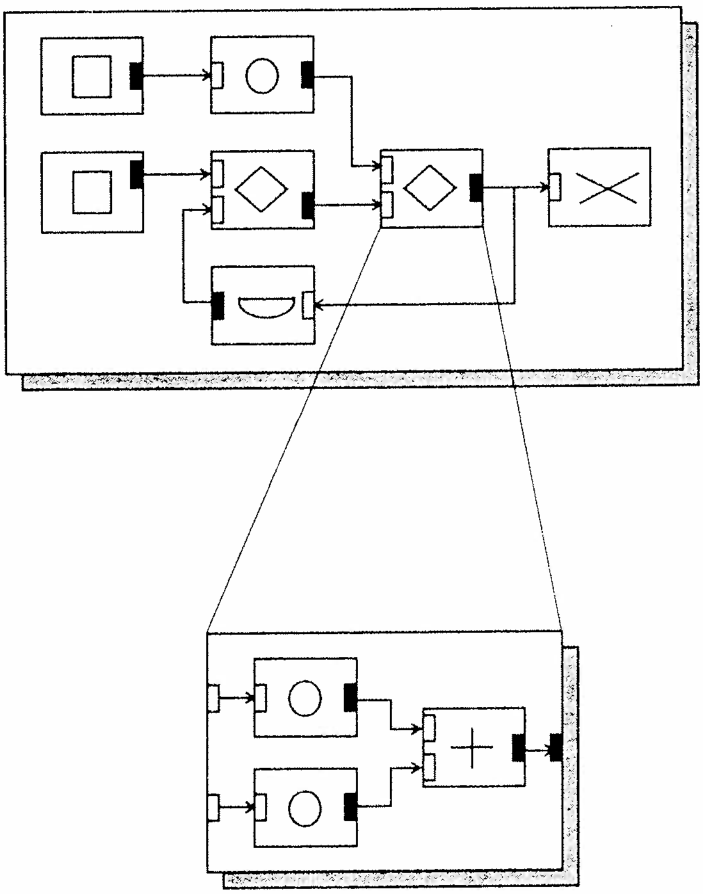
In ihr sind Teilmodelle, sogenannte Modellkomponenten, aus einem speziellen Anwendungsbereich abgelegt.

Die Modellierung komplexer Systeme unterstützt folgende Konzepte:

• **Hierarchische Modellierung:** Vorhandene Komponenten werden zu einer neuen Struktur mit beliebig vielen Hierarchiestufen verknüpft. Auf diese Weise entsteht eine neue Komponente, die in der Modellbank abgelegt wird und selbst wieder in andere Komponenten eingebaut werden kann.
• **Klassenkonzept:** Eine in der Modellbank hinterlegte Komponente steht für eine gesamte Modellklasse. Sie kann folglich in mehreren Ausprägungen in höhere Komponenten eingebaut sein.

• **Versionenkonzept:** Für jede Modellkomponente können mehrere Versionen angelegt sein, beispielsweise eine Version zur Grob- und eine zur Feinmodellierung. Die Versionen können im Gesamtmodell sehr leicht ausgetauscht werden.

Zum Modelltest kann jede Komponente der Modellbank zu einem unabhängig von der Umgebung lauffähigen Modell werden.



... und modifizieren

Der Anwender ist beim Modellaufbau nicht allein auf vorgegebene Bausteine angewiesen:

Durch **Modifikation** bestehender oder die Entwicklung **neuer Komponenten** lassen sich weitere, benutzerspezifische Bausteine in die Modellbank einfügen.

Auf diese Weise wird die Erstellung individueller, an den Spezialfall angepaßter Modelle möglich.

Die Formulierung des Systemverhaltens in einer Modellbeschreibungssprache erlaubt dies auf einfache Art.

Dynamik beschreiben ...

Die Modellbeschreibung im Simulationssystem SIMPLEX II erfolgt in einer eigens entwickelten Modellbeschreibungssprache: **SIMPLEX MDL (Model Description Language)**

Entwurfsziel war eine **anwendungsnahe Formulierung** des Systemverhaltens in intuitiv verständlicher Form.

Als Ergebnis liegt heute eine **deklarative Spezifikationssprache** vor. Sie erlaubt einen modularen und hierarchischen Modellaufbau in deutlicher Anlehnung an die Vorgehensweise in der Systemtheorie.

Der Sprachumfang umfaßt insbesondere:

- **Differentialgleichungen** zur Beschreibung von kontinuierlichen Vorgängen
- **Ereignisse** zur Beschreibung von diskreten Vorgängen
- **Algebraische Gleichungen** zur Beschreibung von statischen Zusammenhängen
- **Locations** mit **Mobilen Komponenten** zur Beschreibung von Warteschlangen- und Transportsystemen

Alle Sprachkonstrukte lassen sich zu kombinierten Modellen beliebig zusammenfügen.

Die Modellbeschreibung wird in einer für alle Modellklassen einheitlichen Form abgearbeitet.

Experimentieren nach Herzenslust !

Modell und Experiment

Vollkommen unabhängig vom Modellaufbau zeigt sich die Experimentierumgebung von SIMPLEX II.

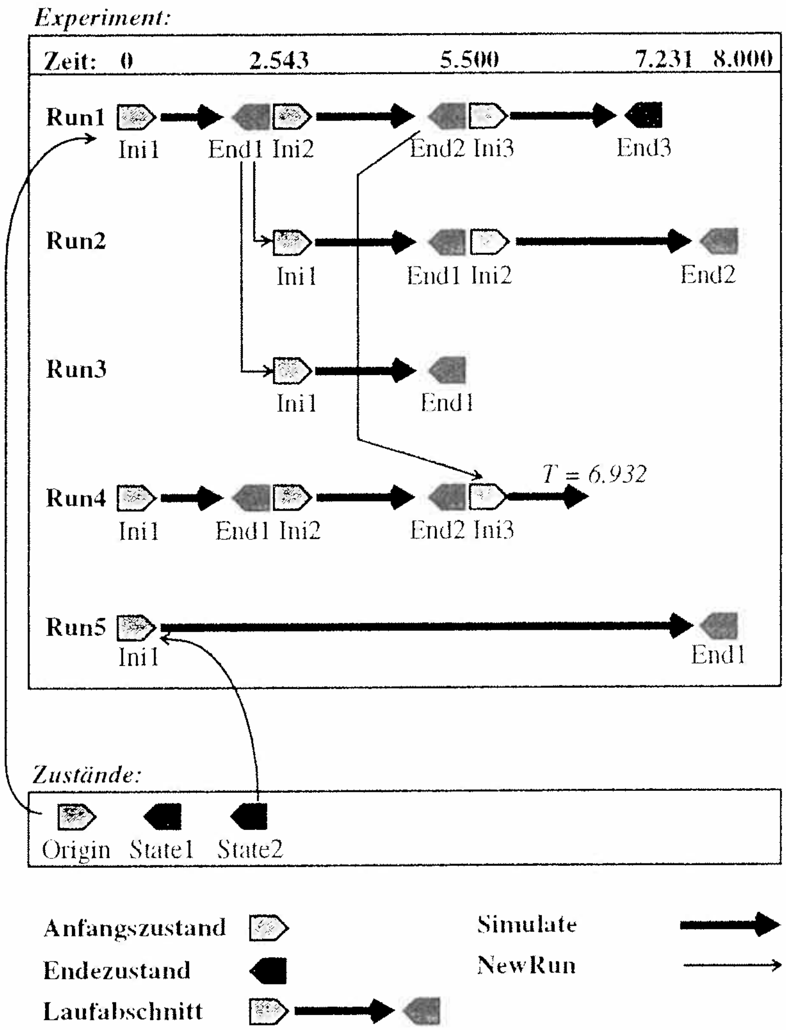
Während des Experimentierens steht dem Anwender das ablauffähige Modell zur Verfügung.

Zur Vorbereitung eines Laufes besteht lesender und schreibender Zugriff auf

- den ***Anfangszustand*** des Modells,
- die ***Steuerparameter*** des Simulators (z.B. Integrationsschrittweite, Integrationsverfahren, Fehlerabschätzung),
- die Definition von ***Aufzeichnungsverfahren***.

Nach der Durchführung des Laufes können die Simulationsergebnisse sowie der Endezustand des Modells dargestellt und analysiert werden.

Durch die Trennung von Experiment und Modell können alle diese Eingriffe während der Experimentierphase ohne ein erneutes Übersetzen und Binden des Modells vorgenommen werden.



Experimentieren ...

Die Experimentierumgebung bietet wertvolle Unterstützung bei der Durchführung einer Simulationsstudie, indem sie

- **Zugriffe auf Modellgrößen ermöglicht:**
In allen Endezuständen von Laufabschnitten besteht lesender, in allen Anfangszuständen lesender und schreibender Zugriff auf die Modellgrössen.

- **Ergebnisse sichert:**
Wichtige Modellzustände und Läufe eines Experimentes können unter Angabe eines Namens gesichert werden.

- **Reproduzierbarkeit gewährleistet:**
Die Modellbankverwaltung sorgt dafür, daß für jedes Experiment der Quelltext der dazugehörigen Modellkomponenten erhalten bleibt.

Dazu gliedert die Verwaltung ein **Experiment** in mehrere Modelläufe.

Ein **Lauf** wiederum setzt sich aus Laufabschnitten zusammen.

Diese sind jeweils durch ihren **Anfangs-** und **Endezustand** charakterisiert.

Verzweigungen der Laufstruktur unterstützen das Austesten von alternativen Parameterbelegungen im Modell.

Bestehende Läufe können jederzeit fortgesetzt werden. Neue Läufe können von beliebigen, bestehenden Zuständen aus begonnen werden.

Werte aufzeichnen ...

Vollständig: Abtastung des Funktionsverlaufes mit fester Schrittweite. Zusätzliche Aufzeichnung von Sprung- und Knickstellen.

Abtasten: Abtastung des Funktionsverlaufes mit fester Schrittweite. Sprung- und Knickstellen werden nicht berücksichtigt.

Komprimieren: Am Ende eines Abtastintervalls werden Mittelwert, Minimum und Maximum des Werteverlaufes in diesem Intervall aufgezeichnet.

Verteilung von Zeitreihen: Berechnet wird für jedes Intervall des Wertebereiches, wie lange sich der Funktionsverlauf in diesem Intervall aufgehalten hat.

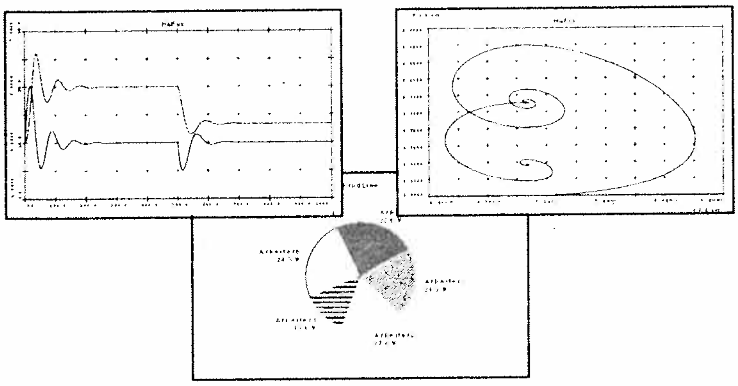
Häufigkeitstabelle durch ereignisgesteuerte Aufzeichnung.

Daten sehen - Modell verstehen !

Ergebnisse präsentieren ...

Zur Darstellung der Simulationsergebnisse stehen die üblichen Verfahren der Businessgraphik zur Verfügung. Es sind dies:

- Funktionsverläufe
- Tortendiagramme
- Wertetabelle
- Zustandsraumdarstellung
- Histogramme
- Gantt-Diagramme



... und animieren

Der Anwender erstellt sich zunächst ein Animationslayout. Dabei unterstützt ihn ein spezieller Layout-Editor. Im Animationslayout positioniert er Animationsobjekte. Anschließend ordnet er jedem Animationsobjekt den Werteverlauf einer Modellgröße zu.

Das System verfügt bereits über vordefinierte Animationsobjekte wie:

- Pulsierende Säulen (2D, 3D)
- Gleitende Kurven und Bänder
- Tachonadel
- Digitalanzeige
- Warteschlange

Neben diesen Objekten kann der Anwender mittels eines Objekt-Editors eigene Animationsobjekte einbringen.

Schulung und Beratung:

- Regelmäßig stattfindende Einführungsseminare und Tutorien
- Qualifizierte Schulungskurse
- Individuelle Beratung
- Unterstützung bei der Lösung spezieller Simulationsprobleme
- Wartung

Vorhandene Modellbanken:

Basierend auf Erfahrungen aus zahlreichen durchgeführten Simulationsstudien stehen für viele Anwendungsgebiete bereits fertige Modellbanken mit Standardkomponenten zur Verfügung.

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Beratung und Vertrieb:
Breilmann + Partner GmbH
Otto-Hahn-Straße 8
W - 6070 Langen

Telefon (06103) 77 64
Telefax (06103) 7 19 62

This section is intended to inform readers about new simulation products and activities from companies related to simulation. Companies are invited to send contributions (10 to 20 lines) to be published here to the editors of EUROSIM - Simulation News Europe.

ProModel Distributor in France

Production Modeling Corporation of Europe in England, the European Distributors of the ProModel Simulation System, have recently an agreement with RAMSES (part of Groupe Sodiseme) to market ProModel, the top-selling simulation system in France.

RAMSES are already established as a major supplier of systems for the manufacturing industry and will be responsible for direct sales of ProModel in France, together with the provision of customer support and training services from their offices in Dargoire near Lyon. The simplicity of ProModel and speed at which models can be built have impressed the French company and were key factors in RAMSES decision to market ProModel.

Some of the world's top companies who have already benefited from ProModel include Boeing, General Electric, Ford, IBM, Hewlett-Packard, Sony, DuPont, Amoco, Westinghouse, Goodyear, and Caterpillar.

ProModel is also available for Educational use at substantial discounts to the normal commercial prices and is becoming widely used in Universities and Polytechnics who specialise in Manufacturing courses.

Companies interested in becoming ProModel distributors or who wish to find out more about ProModel should contact Production Modeling Corporation of Europe, Barclays Venture Centre, University of Warwick Science Park, Sir William Lyons Road, Coventry CV4 7EZ, England, Tel: +44-(0)203 693485, Fax: +44-(0)203 410156.

Business System Modelling with SIMPROCESS

Many companies are concerned about the cost and efficiency of their administration and management functions. SIMPROCESS is a simulation tool which allows the analyst to graphically describe the business organisation and predict throughput, manpower utilisation, and other performance measures. This allows the impact of new organisation structures, new procedures, or the introduction of new technology - such as EDI - to be pretested using the simulation.

The main benefit of SIMPROCESS is that the most appropriate solution to a business organisation problem can be identified and validated **before** its introduction thus improving the quality of management decision making.

For further information please contact CACI Products Company in Maastricht on +31 43 670200 or in Camberley (UK) on +44 276 671671. Evaluation copies of the software are available.

1993 WINTER SIMULATION CONFERENCE

DECEMBER 12-15, 1993
THE LOS ANGELES BILTMORE HOTEL
LOS ANGELES, CALIFORNIA

ANNOUNCEMENT AND FINAL CALL FOR PAPERS

The 1993 Winter Simulation Conference will feature introductory tutorials on the fundamentals of system simulation, state-of-the-art reviews of current practice and research, contributed papers on applications and methodologies for simulation, panel discussions on current issues, and exhibits by software and hardware vendors. We encourage papers for submissions in the following categories (or tracks):

WSC'93
Winter Simulation Conference

■ Introductory Tutorials, Advanced Tutorials, and State-of-the-Art Reviews
Expository presentations on current or emerging simulation practice. Introductory Tutorials are designed for newcomers to the field of simulation. State-of- the-Art Reviews provide practitioners and researchers with an overview of recent fundamental advances in the field.

■ Software and Modelware Tutorials
Expository presentations on simulation software products as well as software and hardware systems for specification, development, documentation, management, animation, and presentation of simulation models.

■ Modeling Methodology
Discrete and combined discrete-continuous simulation; concepts and techniques for general systems modeling; model specification and development; support environments; animation; knowledge-based simulation; object-oriented simulation; parallel and distributed simulation; artificial intelligence; software engineering; verification; validation, and testing.

■ Analysis Methodology
Modeling, fitting, and generating stochastic input processes; start-up techniques; experimental design; metamodels; output analysis; optimization; sensitivity analysis; ranking and selection procedures; variance reduction techniques.

■ Manufacturing Applications
Facilities planning; flexible systems; materials handling; production and inventory control; on-line control; computer-integrated manufacturing; robotics; warehousing and distribution.

■ General Applications
Agriculture; computer and communication systems; energy systems; environment; government (e.g., policy planning and regulation); military systems; service systems (e.g., health care and financial institutions); transportation systems; aerospace systems.

We will consider submissions in other areas. All submissions will be reviewed. Accepted papers will be published in the conference *Proceedings*, which will be copyrighted and widely disseminated. All talks and tutorials must be accompanied by an acceptable *Proceedings* paper. All published papers must be at least three and at most ten *Proceedings* pages. Software and modelware tutorials may not exceed five *Proceedings* pages.

DEADLINES AND REQUIREMENTS
Send all submissions to the Program Chair (address below). Include a title and identify the corresponding author; for each coauthor or panel participant, include: full name, affiliation, complete address, telephone number, FAX number (if available), and electronic mail address (if available).

■ March 1, 1993 – Submit one- to three-page proposals to present tutorials or state-of-the-art reviews, to organize and chair regular paper sessions, or to organize and chair panel sessions.

■ April 5, 1993 – Submit four copies of contributed papers not previously published or presented. Each submission must be a full-length paper, including an abstract and a list of key words indicated one of the main categories (tracks) listed above. Submission implies that an author will attend the WSC'93 to present the paper, and all clearances required for publication of the paper will be obtained by August 1, 1993.

■ June 1, 1993 – Contributors will receive notification of paper acceptance and an Author's Kit including Instructions for Preparing Manuscripts.

■ August 2, 1993 – Authors provide camera-ready manuscript copy (meeting the length requirements specified above) to the *Proceedings* Editor. Electronic submission of papers will be allowed for the LaTeX files meeting the criteria specified in the Instructions for Preparing Manuscripts.

■ November 1, 1993 – Ph.D.-Student Colloquium Submissions. TIMS/College on Simulation invites Ph.D. students nearing completion of the dissertation to present 15-minute research summaries on Sunday night, December 12, 1993. Submit abstracts to: Sheldon Jacobson, Dept. of Operations Research, Weatherhead School of Management, Case Western Reserve University, Cleveland, OH 44106, tel: (216) 368-4778;
e-mail: jacobson@pyrite.som.cwru.edu.

FOR FURTHER INFORMATION CONTACT:
■ Program – William E. Biles, WSC'93 Program Chair, Department of Industrial Engineering, University of Louisville, KY 40292,
tel: (502) 588-6342; FAX: (502) 588-5633;
e-mail: webilc01@ulkyvm.

■ General – Edward C. Russell, Russell Software Technology, 1735 Stewart St. Santa Monica, CA 90404, tel: (310) 453-2927
FAX: (310) 829-6760

SPONSORING SOCIETIES:
ASA, ACM/SIGSIM, IEEE/CS, IEEE/SMCS, IIE, NIST, ORSA, TIMS/CS, and SCS

Calendar of Events

January 1993

17-20 **1993 International Conference on Bond Graph Modeling** (ICBGM'93). La Jolla, CA, USA.
Contact: F.E. Cellier, Dept. of Electr. and Computer Engr., University of Arizona, Tucson, Arizona 85721. Tel: +1-602-621 6192, Fax: +1-602-621 8076, E-mail: Cellier@ECE.arizona.edu

February 1993

10-11 **Conference on *"Simulation und Fabrikbetrieb"*** by ASIM WG *"Simulation in der Fertigungstechnik"*. Aachen, Germany
Contact: Prof. A. Kuhn, Fraunhofer-Institut, IML, Emil-Figge-Straße 75, W - 4600 Dortmund 50, Tel: +49-(0)231 7549 130, Fax: +49-(0)231 7549 211.

15-16 **"1. Fachtagung Bioinformatik Bonn"** by GI-FG 4.0.2 (Informatik in den Biowissenschaften) and Institut für Informatik (Universität Bonn). Bonn, Germany
Contact: Dr. Ralf Hofestädt, Uni Koblenz-Landau, Fachbereich Informatik, Rheinau 3-4, D-5400 Koblenz, E-mail: hofestae@infko.uni-koblenz.de.

22-26 **EUROCAST '93, Third International Workshop on Computer Aided Systems Theory**. Las Palmas, Gran Canaria, Spain.
Contact: Prof. Roberto Moreno-Diaz, Universidad de Las Palmas de Gran Canaria, Dept. de Informatica y Sistemas, Campus de Tafira, A. 322, E - 35017 Las Palmas, Gran Caaria, Spain, Tel: +34 28 458754, Fax: +34 28 351756

March 1993

8-9 10th ASIM workshop ***"Simulation technischer Systeme"***. Erlangen, Germany.
Contact: Prof. G. Kampe , FHT Esslingen, Flandernstraße 101, W-7300 Esslingen. Tel: +49-(0)711/394-258 or 266

15-17 **4. Symposium *"Simulation als betriebliche Entscheidungshilfe"*** by ASIM working group *"Simulation in der Betriebswirtschaft"*. Braunlage, Germany
Contact: B. Hollenbach, Georg-August-Universität Göttingen, Inst. f. Wirtschaftsinformatik, Platz der Göttinger Sieben 7, Tel: +49-(0)551/394440, Fax: +49-(0)551/399679.

25 ASIM workshop ***"Simulation von Verkehrssystemen"***, Karlsruhe, Germany
Contact: Karl-Heinz Münch, Siemens AG, Bereich VT2 CIR, Ackerstraße 22, W-3300 Braunschweig, Tel: +49-(0)531-226-2225, Fax: +49-(0)531-226-4305.

29-April 1
SMC'93, Simulation Multiconference, Arlington, Virginia, USA.
Contact: SCS, P.O. Box 17900, CA 92177, San Diego, USA. Tel: +1.619.277.3888, Fax: +1.619.277.3930.

April 1993

5-7 **Tooldiag '93**, International Conference on Fault Diagnosis. Toulouse, France
Contact: Secretariat Tooldiag '93, CERT-DERA, 2, avenue Edouard Belin, BP 4025, F - 31055 Toulouse CEDEX

22-23 ASIM Workshop ***"Simulation und Optimierung"***. Karlsruhe, Germany.
Contact: H. Szczerbicka, Universität Karlsruhe, Institut für Rechnerentwurf und Fehlertoleranz, Postfach 6980, D - 7500 Karlsruhe, Tel: +49-(0)721 608 4258.

May 1993

4-6 **European Simulation Conference '93**, Maastricht, The Netherlands
Contact: S. Mukherjee, CACI Products Division, Suite 11, Coliseum Business Centre, Watchmoor Park, Riverside Way, Camberley, Surrey GU15 3YL, Tel: +44 276 671671, Fax: +44 276 670677

7-9 **ITEC 93**, Concurrent Engineering. Wembley, U.K.
Contact: SCS International, c/o Philippe Geril, The European Simulation Office, Coupure Links 653, B - 9000 Ghent, Belgium. Tel/Fax: +32-91-234941, E-Mail: scsi@biomath.rug.ac.be

June 1993

1-4 **5th Symposium on Modelling and Simulation of Systems MOSIS '93**. Olomouc, Czechoslovakia
Contact: Jan Stefan, Chairman of MOSIS 93, Technical University of Ostrava, Department of Computer Science, tr. 17. listopadu, CS-708 33 Ostrava, CSFR

7-9 **ESM 93. European Simulation Multiconference**. Lyon, France
Contact: SCS International, c/o Philippe Geril, The European Simulation Office, Coupure Links 653, B - 9000 Ghent, Belgium. Tel/Fax: +32-91-234941, E-Mail: scsi@biomath.rug.ac.be

9-11 **35th SIMS Conference**. Kongsberg, Norway.
Contact: Torleif Iversen, SINTEF Automation Control, N-7034 Trondheim, Norway, Tel.: +47-7594474, Fax : +47-7594399, Email: torleif@itk.unit.no

15-18 **15th International Conference "Information Technology Interfaces" ITI '93**. Pula, Croatia
Contact: Branka Radic, University Computing Centre, Engelsova bb, 41000 Zagreb, Croatia, Tel: +38 41 510 099, Fax: +38 41 518 451,E-Mail: branka.radic@uni-zg.ac.mail.yu

29 - July 1
TILE 93 "Realism in Vision, Movement and Sound". Maastricht, The Netherlands.
Contact: Andrich International Ltd., 51 Market Place, Warminster, Wiltshire BA12 9AZ, United Kingdom, Tel: +44.985.846.181, Fax: +44.985.846.163

July 1993

19-21 **Summer Computer Simulation Conference '93**. Boston, USA.
Contact: Dr. Joel M. Schoen, SCSC'93 Committee, The MITRE Corporation, 202 Burlington Road, Bedford, MA 01730-1420, USA. Tel: +1 617.271.2230, Fax: +1 617.271.5173, E-mail: jms@mitre.org

September 1993

13-15 **United Kingdom Simulation Society Conference UKSS 93**. Lake District, U.K.
Contact: Dr. R. Zobel, Dept. of Computer Science, University of Manchester, Oxford Road, Manchester M13 9P1, U.K., Tel: +44 61 275 6189, Fax: +44 61 275 6236.

28-30 **ASIM 93. 8. Symposium Simulationstechnik**. Berlin, Germany.
Contact: R-P. Schäfer, GMD-First, Rudower Chaussee 5, O-1199 Berlin, Tel: +49-(0)30 6704 2867, Fax: +49-(0)30 6704 5610.

29-October 1
Performance 93. Roma, Italy.
Contact: Dr. Bruno Ciciani, Dipartimento Ingegneria Elettronica, Universita di Roma "Tor Vergata", Via Ricerca Scientifica, I-00133 Roma, Italy, Tel: +39-(0)6 72594477/78, Fax: +39-(0)6 2020519, Email: PERF93@irmias.bitnet

October 1993

25-28 **ESS 93. European Simulation Symposium**. Delft, The Netherlands.
Contact: SCS International, c/o Philippe Geril, The European Simulation Office, Coupure Links 653, B - 9000 Ghent, Belgium. Tel/Fax: +32-91-234941, E-Mail: scsi@biomath.rug.ac.b

December 1993

12-15 **1993 Winter Simulation Conference**. Los Angeles, USA:
Contact: Edward C. Russell, Russell Software Technology, 1735 Stewart St., Santa Monica, CA 90404, Tel: +1 310 453 2927, Fax: +1 310 829 6760.

February 1994

2-4 **1. MATHMOD VIENNA**. Vienna, Austria.
Contact: Prof. I. Troch, Technische Universität Wien, Wiedner Hauptstr. 8-10, A-1040 Wien.