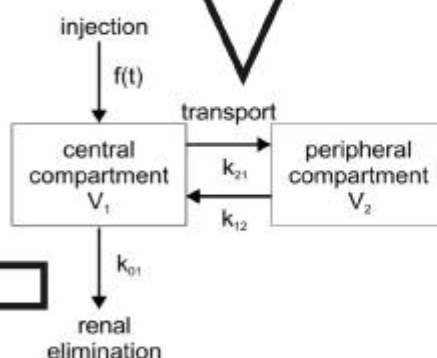# SIMULATION NEWS EUROPE

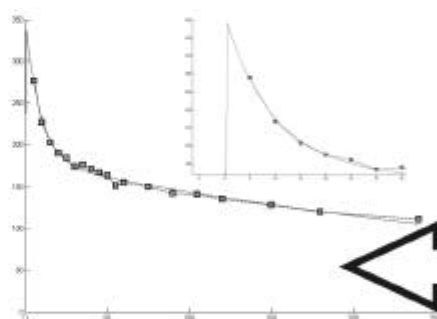## A European Forum on Development in Modeling and Simulation

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Right Kidney Sectioned in Several Planes

injection

$f(t)$

transport

| central compartment V_1 | peripheral compartment V_2 |

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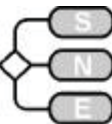
k_{12}

k_{01}

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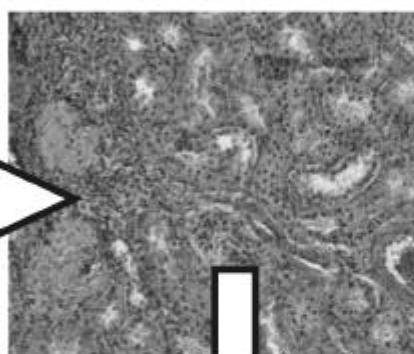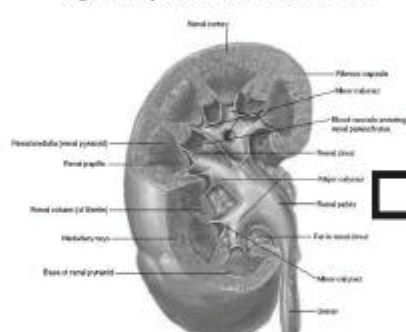
A EUROSIM Publication

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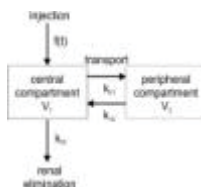
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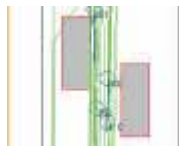
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for  k = 1 to n |
    Monte Carlo loop
  b = b0 + B * ran() |
  drun |  solve odes
```

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Editorial

Dear readers,

In the Editorial in the last issue we have started a discussion about an extended role of modelling and simulation. Based on observations, that modelling and simulation has become a widespread method, which is not only dealt with in simulation societies, we have stated a natural development: application societies deal with modelling and simulation, simulation societies open to computational engineering.

We have got a lot of responses, most of them agreeing with our view. It was argued, that on the one hand this development opens a new chance for a bigger potential in research and application of modelling and simulation, but on the other hand it may also lead to senseless competition – which is to be avoided.

SNE therefore will support this development in the sense of co-operation:

- by publishing technical notes and short notes on new methods and new applications - (in this issue e.g. differential inclusions),

- by introducing simulation activities from "application societies" and from projects (in this issue e.g. about a virtual simulation institute and a virtual action group on hybrid dynamics),

- comparing and evaluating in the ARGESIM comparisons not only features of simulators, but also - nowadays mainly - different modelling methods,

- searching and announcing conferences and events, where simulation societies and application societies can meet and benefit from each other (in this issue announcement of SIMPAT'2003, a trade fair with computer engineering tools combined with conferences), etc.

We are glad, that we can publish a new comparison in this issue, which also is an outcome of the broader view of modelling and simulation. Comparison C15 "Clearance Identification" is based on a model used in reality: identified model parameters represent the "Clearance", a measure for the clearance function of the kidney – instead of – inaccurate experimental data. Furthermore, the model in this comparison is used in web courses for physicians.

We hope, you enjoy this issue, and I thank all authors and members of editorial boards for their co-operation. This issue will be distributed end of November / begin of December; so we take the opportunity to wish you Merry Christmas and A happy New Year 2003. The next issue, **SNE** 37 will be published in May 2002.

Felix Breitenecker, editor-in-chief
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INTRO

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Aims & Scope

The journal **SNE - S**imulation **N**ews **E**urope – is intended i) to inform about new developments in modelling and simulation and ii) to report about news from European simulation societies and events from International Simulation Societies and Simulation Groups all over the world. SNE is the also the official membership journal of **EUROSIM** and **SCS Europe**.

SNE reports in the *News Section* about EUROSIM, EUROSIM societies, SCS Europe and about other International Simulation Societies and Simulation Groups. A calendar of simulation conferences, industry news, etc. concludes the *News Section*.

SNE's *Archive Section* publishes technical notes and short notes on general overviews or new developments, new software and hardware, new applications and methods. Furthermore **SNE** presents *Simulation Centres,* introduces *Simulationists* and reviews t recent books on modelling and simulation and related topics. **SNE**'s special series *Comparison of Modelling and Simulation Technique and Tools* (**ARGESIM Comparisons**) gives a comprehensive overview on developments in application and implementation.

Parts of **SNE** can be also found on the web. News from societies is published at EUROSIM's web server (www.eurosim.info). Contents, archive and an evaluation of the Comparisons are available at ARGESIM's website www.argesim.org/sne/.

All contributions are selected and may be edited. For news publication, please contact a member of SNE's News Editorial Board (p. XXVIII), for publication of technical notes, short notes, etc. please contact a member of SNE's General Editorial Board (p.53) or the Editor-in-Chief.

TECHNICAL NOTES

Alternative Mathematical Tools for Modelling and Simulation: Metric Space of Models, Uncertainty, Differential Inclusions and Semi-Discrete Events

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Augusto Rodin 498, 03910 Mexico City, Mexico

…. discusses alternative approaches for discrete and continuous modelling and simulation
…. defines a measure for the difference of models – based on Hausdorff metrics, giving examples for queuing systems and their parameters
…. Starts an revival of differential inclusions as modelling approach, sketching briefly also software
…. introduces semi-discrete events, which last longer than zero, so that no problems with concurrent events can occur

Abstract

This article has three parts. First, a metric structure is proposed in the set of dynamic system models. In this way we obtain a metric space of models with the corresponding induced topology. The distance function is based on the Hausdorff distance between sets of probability functions related to model outputs. This permits to calculate the distance between two models, to define convergent sequences of models and to handle the mappings from model parameter space to the model space. The second part treats about possible applications of differential inclusions in data uncertainty treatment. It is shown that the differential inclusions are natural tools in dynamic uncertainty problems. Finally, a generalization of discrete event modelling is proposed. The concept of semi-discrete events is introduced and illustrated with a simple example of a mass service model.

The Hausdorff Set-to-Set Distance

Both informal and formal description of dynamic system models have been well defined and widely used. For a formal model specification we have a wide game of tools, starting from ordinary differential equations (ODE models), bond graphs (Cellier, 1992), block diagrams, signal flow diagrams partial differential equations, birth-and death equations, differential inclusions (Raczynski, 1996) or object-oriented modelling paradigms (Cellier and Elmquist, 1993) and DEVS (Discrete Event Specification Formalism, (Zeigler, 1976, Barros, 1996, Chow 1996).

The statistical comparison of model behaviours proposed here does not refer to any particular specification formalism. It could be applied to any model, which has well defined output, deterministic or stochastic. However, the approach is designed rather for stochastic systems, and the comparison is carried out for the probability density functions of output variables and not for a particular model trajectories.

Some Definitions

Recall that a function $d(a,b)$ where a and b are two points of a set Y is *a distance between a and b* if and only if it satisfies the following conditions:

$$d(a,b)=d(b,a) \qquad (1)$$
$$d(a,b) \geq 0 \qquad (2)$$
$$d(a,c) \leq d(a,b) + d(b,c) \qquad (3)$$
$$d(a,b) = 0 \;\; \text{if and only if} \;\; a = b \qquad (4)$$

for all $a,b \in Y$. We say "a distance", because normally it is possible to define many different distance functions in the same set of points (set elements).

Since we do not specify what Y is, the points may represent geometrical points, functions, sets, probabilistic measures, DEVS models or any other abstract items. If a distance in Y exists, then the set Y becomes a metric space.

Looking for a distance between models we must use the concept of distance between sets. To define such distance, first recall that the *point-to-set distance* in a normed space is defined as

$$d(x,A) = liminf \{ \, | \, x - b \, | \, , b \in A \, \}$$

where x is a point and A is a set and $|*|$ is the norm.

The symbol *liminf* means "the maximal lower bound" of the argument (the same as the minimum for closed sets). The *r - neighbourhood of a set A* is defined as follows:

$$V(A,r) = \{ \, x: d(x,A) \leq r \}$$

The *Hausdorff distance between two sets A and B* is defined by (Kuratowski 1977, Raczynski 1996):

$$d^*(A,B) = liminf\{r : A \subset V(B,r), B \subset V(A,r), r \geq 0\}$$

In the above, *A, B* and *x* are defined in the same space *Y*. In other words, the distance *d*(A,B)* is the minimal value of *r*, such that *A* is included in the r-neighbourhood of *B* and vice versa.

It is well known that the function *d** satisfies the conditions (1), (2) and (3). As for condition (4), it is not always satisfied. Consequently, if we do not impose some additional conditions, *d** is not a distance, but rather a *semi-distance* in the given set of sets. Considering a set of *closed* sets, the function *d** satisfies condition (4) and becomes a well-defined distance.

Other definition that we will need is a distance between two functions of time. Consider the set *F* of all integrable functions $[0,T] \rightarrow R$ where *[0,T]* is the closed interval of real numbers between 0 and T. The distance we will use is defined as follows:

$$h(f,g) = \int_0^T (f(y)-g(y))^2 dy \qquad (5)$$

where $f,g \in F$. The function *h* is a distance if we treat every two functions as equal to each other if they are equal everywhere except a set of points of total measure zero.

Distance between Models

There are many ways to compare models. One can say that two models are similar if they have similar structure, use similar distributions of random numbers or reveal similar behaviour of the state variables or of the output variables. Note, however, that if one defines a **metric structure** in a set of models, this implies that a sequence of convergent models can be defined and the space of models becomes a **metric and topological** space, equipped with all properties of a topology. Since we want to compare models of different structures or models with variable structures, the model structure can hardly be used as a factor in the definition of a distance. Two models with very similar structure can behave in very different ways, and even small changes in the random variable generator inside a model can imply big changes in simulation results.

Other way to define the distance is to treat models as "black boxes" and suppose that the observer can only measure the initial conditions, and input and output variables. This approach will be used in the proposed distance definition.

We will restrict the distance definition to models with a finite or denumerable number of output signals. Let $P_k (M, C, I, t, j)$ be the **probability** that in the time-instant *t* the value of the output *k* is equal to *j*.

Here *M* is the model identifier, *C* denotes initial conditions and *I* stands for model inputs over the interval *[0,t)*. For example, $P_5 (M,C,I,t,34)$ could read "*the probability that queue no.5 has the length 34*". Let us concentrate on probabilities and not on particular outputs. Note that the functions $P_k (M, C, I, t, j)$ are usually **continuous** functions of time, even if the model states are discrete. This is well known from the birth-and-death equation, frequently used to describe queuing models and population growth. In our case we do not need this equation. The only fact needed here is that the functions $P_k(M,C,I,t,j)$ do exist. To define the distance between models, we first **define the experimental frames as the sets of all functions P_k.** In the following the final time of model trajectories is fixed and equal to *T*.

Definition 1.

The semi-distance *D* between two models *M* and *N* is defined as follows:

$$D(M,N) = d^*(A_M, A_N)$$

where A_L is the set of all functions $P_k (L, \bullet, \bullet, \bullet, \bullet)$, k = 1,2,3,.....

Note that in the above definition $P_{k,j}$ are functions of three variables, where *C* and *I* may belong to quite complicated spaces. **The function *D* is the Hausdorff distance between the sets of probability functions for output variables of the two models**. We use the term "semi-distance", because *D(M,N) = 0* does not imply that the models *M* and *N* are equal to each other. However, if we treat two models that have the same output probability functions as equal to each other, then the function *D* becomes a distance. Let us denote this supposition as the **Condition E**. Thus, upon the condition *E*, **the set of all models equipped with the distance *D* becomes a metric space of models**. In the following we suppose that the condition E is fulfilled.

Observe that in practical cases the set of observed output functions is always finite, for technical reasons (we suppose that the model is simulated using a real computer). Consequently, the sets for which the Hausdorff distance is calculated contain finite number of points (functions $P_{k,j}$). This means that the sets are closed and the function *d** is a distance and not a semi-distance.

Definition 2

The distance $D_C (M,N)$ is the distance *D(M,N)* with fixed initial condition *C*.

Definition 3

The distance $D_{C,I} (M,N)$ is the distance *D(M,N)* with fixed initial condition *C* and fixed input *I* over the interval *[0,T)*.

The last two definitions may be useful when it is difficult or impossible to calculate the distance *D*. For example, in the definition 3 the functions $P_k(L,\bullet,\bullet,\bullet,\bullet)$ are replaced by $P_k(L,C,I,\bullet,\bullet)$ with *C* and *I* fixed, and become functions of one real variable *t*. In this case the distance between functions can be calculated according to (5).

Definition 4

The distances *D*, D_C and $D_{C,I}$ are said to be **normalized** if the corresponding Hausdorff distance *d** is multiplied by the factor *1/(TK)* after being calculated. *T* is the final model simulation time and *K* is the number of probability functions used.

The above definitions do not refer to any particular model type or structure. They can be used to compare different models. In the following section all the distances will be normalized.

Examples

Consider the queuing model shown on figure 1. This is a PASION/QMG model of a service system (Raczynski 1990, consult also: www.mixcoac.upmx.mx/pasion/sumpas.htm).

Figure 1. A simple service model.

Note that for queuing models with outputs being the queue lengths, the set of all possible values of the output variables is finite (finite automata) or denumerable. So, in the following we use the notation $P_{k,j}(t)$ instead of $P_k(M,C,I,t,j)$ (*j* is an integer number, *M, C* and *I* are fixed).

Clients are generated in block 1, with exponential distribution of intervals between arrivals with mean 1. The generator stops after generating 80 clients. Block 2 is a queue, block 3 is the server and block 4 is a terminal point (exit). The server is supposed to change his mean time of service *A* depending on the number N of clients waiting actually in the queue, according to the following rule.

$$A = \begin{cases} 2(1\text{-}N/20) & for\,N < 20 \\ 0 & for\,N > 20 \end{cases}$$

First, compare two models:

Model 1 is characterized by the above parameters and has the queue of type FIFO (first-in-first-out). The experimental frame for this model includes the function $P_{1,j}$ for the length of the queue over the time interval [0,100].

Model 2 is equal to Model 1 but has the queue of type LIFO (last-in-first-out).

Since neither input flow nor service time depends on the attributes of the clients and the time spent by a client in the system is not an output function, it is clear that the observed results (according to the actual experimental frame) of both models have the same probability density functions. Figure 2 shows the density function for the length of the queue as function of time (this is a standard PASION output). Simulating the two models one also can confirm that the result is the same. This means that the distance between Model 1 and Model 2 is equal to zero, and the two models are equal to each other in the sense of the actual experimental frame.
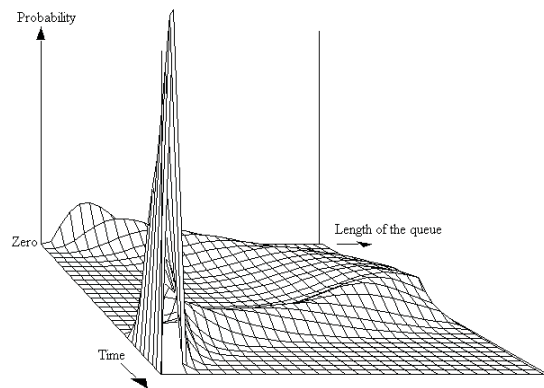
Figure 2. Probability density function for the model of fig.1.

Now, consider the following models.

Model 3. The parameters of Model 3 are the same as of Model 1, with FIFO queue. The experimental frame is different. Suppose that the simulationist wants to know when the average waiting time *E* (calculated at the moment, for all clients actually in the queue) is greater than 10 time units. The output function is modified, including only one logical variable *L*, being *true* if *E* is greater than 10, and *false* otherwise and the experimental frame includes the probability $P_{1,1}(t)$ that *L(t) is true.*

Model 4. Equal to Model 3 except the queue, which is of type LIFO.

The distance between Model 3 and Model 4 is greater than zero. Figure 3 shows the plot of the probability that *L(t)* is true, as function of time. This result was obtained running 180 repetitions of the simulation program, for Models 3 and 4. It is easy to calculate the distance between models in this case. The experimental frame includes only one function $P_{1,1}(t)$, and the sets A and B of fig. 1 reduce to one point each other.

TECHNICAL NOTES

The Hausdorff distance becomes the distance between two points in the space of functions. The distance can be calculated using formula (6), and the (normalized) result is D = 0.578. This means that the models are quite far from each other in our model space (see figure 3). Note that the maximal possible (normalized) distance between models is equal to 1.
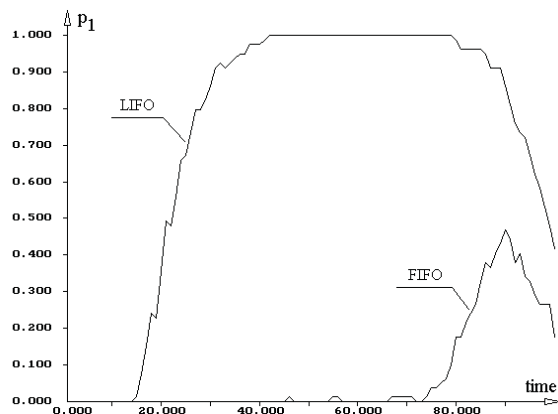
Fig. 3: Probability $P_1(t)$ as function of time – models 3 and 4

To see more properties of the distance *D* consider Model 1 again. Now, consider the following.

Model 5. This model is derived from Model 1 by adding other line of service, equal to that of Figure 1. The two lines run concurrently without any interactions between them. It may be somewhat surprising that **the distance between Model 1 and Model 5 is equal to zero.**

Indeed, the experimental frame of Model 1 includes only the queue length. The experimental frame of Model 5 includes two functions $P_{1,j}(t)$ and $P_{2,j}(t)$ (for the lengths of the two queues). Note that these probability functions are equal to each other. Calculating the distance between these models, we must calculate the Hausdorff distance between two sets: the set *A* that corresponds to Model 1 and contains the set *C1* of probability functions for all states of the queue (*j* = 0,1,2,...etc.), and the set *B* for Model 5, that contains two sets of functions *C2* and *C3,* for the two queues, respectively. But *C2=C3=C1.* This means that the resulting distance is zero.

One can ask how the distance between two apparently different models (with 4 and 8 blocks, respectively) can be equal to zero. Observe that expanding the Model 1 to Model 5 we did not add any relevant components, because the two service lines are identical. This makes the distance equal to zero.

Further research is needed in this field.

Dynamic Uncertainty and Differential Inclusions

The lack of reliable data in computer simulation is an important obstacle in many simulation projects. Models that are nice and valid from the academic point of view often result to be useless in practical applications, when the user cannot provide reliable data. In the past, a common way to treat this lack of exact data was to suppose some model parameters or input variables to be random ones. This results in a stochastic model, where every realization of the system trajectory is different, and the problem is rather to determine the probability density function in the system space for certain time-sections, the variance, confidence intervals etc.

Such stochastic analysis is interesting but not always possible. The common problem consists in the lack of data. Some parameters of the model have "uncertain" values, and the model user has no idea about their probabilistic behaviour.

More likely we are given an interval the uncertain parameter belongs to, instead of its probability distribution or sampled real data. Some external disturbances can fluctuate within certain intervals, and what we are asked to is to give the interval for some output variables. The stochastic simulations with randomized variables do not give such intervals. Moreover, frequently the user wants to know a possible extremal values rather than a probability to reach them (recall the law of Murphy !). The uncertainty treatment has nothing, or very little, to do with "Monte Carlo" or stochastic simulation. The intervals we are looking for are not confidence intervals or any other statistics.

There is no room here to mention a huge number of publications on uncertainty problems. See Bargiela and Hainsworth or Bargiela for an example of uncertainty management in water distribution systems, for example.

Mathematical Modelling Tool

Most simulationists who deal with continuous systems use, as a basic tool, ordinary or partial differential equations. My point is that ordinary differential (ODE) and partial differential equations as modelling tools are too primitive for many system models except, perhaps, simple mechanisms, circuits and very academic examples.

Let us consider a simple example of a second order system

$$d^2y/dt^2 + a\,dy/dt + y = b \qquad (6)$$

This is a simple ODE model. Introducing notation $x_1 = y$, $x_2 = dy/dt$ we obtain

$$dx_1/dt = x_2$$

$$dx_2/dt = b - ax_2 - x_1 \qquad (7)$$

In more general notation the state equation is

$$dx/dt = f(a,b,x) \qquad (8)$$

where x is a two-dimensional vector, t is the time and f is a vector-valued function.

Now suppose that the parameters a and b are uncertain and that the only information we have are the corresponding intervals where their values may belong, or a permissible irregular set on the plain where the point (a,b) must belong. Note that we know nothing about a possible probability distribution of these parameters and we do not treat them as random variables. Thus, the equation (8) takes the following form.

$$dx/dt \in F(x,t) \qquad (9)$$

where F is a set. What we obtained is a **differential inclusion (DI)**. The right-hand side of the equation (9) determines the set $F.$ However, this is merely a one of possible ways to represent the set. In this case it is parameterized by a and b.

The solution to a DI is the reachable set for the possible system trajectories that is exactly the solution to our uncertainty problem. In this very natural way we see that the uncertainty in dynamic system modelling leads to differential inclusions as a corresponding mathematical tool. Note that this tool is known for about 70 years and that there is wide literature available on the DIs theory and applications.

The first works have been published in 1931-32 by Marchaud and Zaremba. They used the terms "contingent" or "paratingent" equations. Later, in 1960-70, T. Wazewski and his collaborators published a series of works, referring to the DIs as orientor conditions and orientor fields. As always occurs with new theories, their works received sever criticism, mainly from some physicists who claimed that it is a stupid way of wasting time while dealing with so abstract an useless theories. Fortunately, the authors did not abandon the idea and developed the elemental theory of differential inclusions. In the decade 1930-40 such problems as the existence and properties of the solutions to the DIs have been resolved in the finite-dimensional space. After this, many works appear on DIs in more abstract, infinite-dimensional spaces.

Within few years after the first publications, the DIs resulted to be the basic tool in the optimal control theory. Recall that optimal trajectories of a dynamic system are those that lay on the boundary of the system reachable set.

In the works of Pontryagin, Markus and Lee, Bellman and many others, one of the fundamental problems are the properties of the reachable sets. Using the theory of Marchaud and Zaremba, T.Wazewski pointed out that in many optimal control problems the resulting control strategy is the so-called *bang-bang* control, generated by switching controllers.

Differential Inclusion Solver

A differential inclusion is a generalization of an ordinary differential equation. In fact, an ODE is a special case of a DI, where the right-hand F is a one-point set. One could expect that a solution algorithm for a DI might be obtained as some extension of a known algorithm for the ODEs. Unfortunately, this is not the case.

First of all, the solution to a DI is a set. Namely, it is a set in the time-sate space, where the graphs of all possible trajectories of a DI are included. Finding the boundary of such set (named *reachable set*, or *emission zone* as in the works of Zaremba and Wazewski) is not an easy task. I will not discuss here more theoretical details about the DIs. A more extended survey can be found in Raczynski, 1996.

One of the properties of the reachable sets is the fact that if a trajectory reaches a point on the boundary of the RS at the final time, then its entire graph must belong to the RS. This fact is well known and used in the optimal control theory. Observe that any trajectory that reaches a point on the boundary of the RS is optimal in some sense. Such trajectories can be calculated using several methods, the main one being the Maximum Principle of Pontryagin. This can be used to construct an algorithm for RS determination. If we can calculate a sufficient number of trajectories that scan the RS boundary, then we can see its shape. The trajectories should be uniformly distributed over the RS boundary. This can be done by some kind of random shooting over the RS boundary. Such shooting has nothing to do with a simple random shooting, when the trajectories are generated randomly inside the RS.

My first attempts to develop a DI solver were presented on the IFAC Symposium on Optimization Methods, Varna, 1974. This was a random shooting method, but not a simple shooting. That algorithm generated trajectories inside the RS, but the control variable was being modified to obtain a nearly uniform distribution of points inside the RS at the end of the simulated time interval. The DI solver presented in the Transactions on SCS in 1996 is much more effective.

In few words, the DI solver works as follows: The user provides the DI in the form of an equivalent control system.

To do it he/she must parameterize the right-hand size (the set F) using an m-dimensional auxiliary variable *u*. The DI solver determines the equations of so-called conjugated vector *p* and integrates a set of trajectories, each of them belonging to the boundary of the RS. Over each trajectory the Hamiltonian *H(x,p,u,t)* is maximized.

This procedure is similar to that used in dynamic optimization. In the optimal control problem the main difficulty consists in the boundary conditions for the state and conjugated vectors. For the state vector we have the initial condition defined, and for the conjugated vector only the final conditions (at the end of the trajectory) are known, given by the transversality conditions. This means that the optimal control algorithm must resolve the corresponding two-point-boundary value problem.

In the case of a DI we are in better situation. There is no object function and no transversality conditions. As the consequence, for the vector *p* we can define the final as well as the initial conditions. Anyway we obtain a trajectory which graph belongs to the RS boundary.

Defining initial conditions for p we integrate the trajectory only once, going forward. The only problem is how to generate these initial conditions in order to scan the RS boundary with uniform density. The algorithm is quite simple: the initial conditions for p are generated randomly, due to a density function that changes, covering with more density points that correspond to trajectories that fall into a low density places at the RS boundary. Trajectories that are very close to each other are not stored (storing only one from each eventual cluster). As the result we obtain a set of trajectories covering the RS boundary that can be observed in graphical form and processed.

Example

Consider a second order dynamic system where the acceleration as well as the damping coefficient is uncertain. An example of the corresponding DI in parameterized form can be as follows.

$$dx_1/dt = x_2, \quad dx_2/dt = u_1 - u_2 x_2 - x_1$$

where *-1 < u1 < 1* and *0.5 < u2 < 1.5* . Figure 4 shows the 3D image of the RS in coordinates x_1 (upwards), x_2 (to the right) and *t*.

On Figure 5 you can see a time-section of the RS for some fixed time. Observe the small cluster of trajectories at the origin of the coordinate system. These are trajectories (10000 in total) obtained by a simple random shooting, where both controls had been generated randomly within the limits defined above.

The other pixels (the RS contour) are the end points (400 in total) of the trajectories generated by the DI solver. **This demonstrates how useless the simple shooting method in DI solving is.**
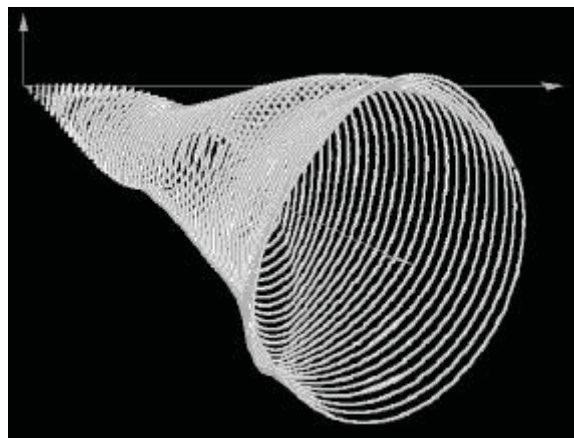
Figure 4. The solution to a differential inclusion.
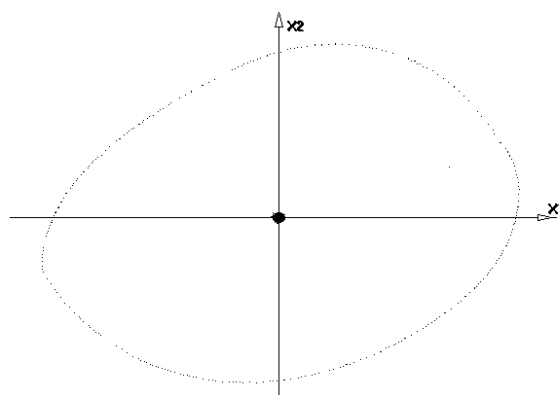
Figure 5. A time-section of a reachable set.
The contour is defined by 400 trajectories.
The central small cluster of pixels are the end points of
10000 trajectories generated by a simple random shooting.

Semi-Discrete Events

More than a half of the simulation software has been developed to simulate event that occur in a discrete time instants. Mostly the applications are mass service and manufacturing systems or any kind of models that involve queues, servers etc. There is a huge literature and well-developed theory in the field (see Zeigler 1976, Barros 1996, Chow 1996). The fundamental property of discrete events is the fact that they occur in one time instant. The duration of the event is equal to zero (in the model time).

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This permits to simulate many queuing and similar systems very fast. The main effort in developing the corresponding simulation software lays in the event queue and process interaction management inside the simulation package. However, we should take into account the validity of such "ideal" discrete event models. Note that in the reality discrete events does not exist. A client that leaves a queue and seizes a server needs some time to do it. A flip-flop in a computer changes its state during some time interval in a complicated transient process that is subject to random fluctuations.

Handling of simultaneous events is one of the problems that result from ideal discrete event approach. Consider a simple model in with clients must pass through two consecutive servers without buffers. Suppose that the clients arrive in time intervals equal to one time unit and the service time for each server is equal to one. A new client or that that leaves the first server and intents to seize the following one may not be allowed to do this, because the server is still occupied. In fact, the server will be free at the same model time instant, but the client event (seize the server) has already failed. Changing the order the simultaneous events are executed or other methods (the SELECT feature of the DEVS formalism) solve this conflict, but it results to be a non-trivial problem.

Let us see what happens in the real system. A new client or that leaving the first server looks at the state of the following server. Any client who cannot occupy a server is being lost and disappears from the model. If he observes that the server **is changing its state** at the moment, he will immediately seize the server and will not be lost. But this needs a small (maybe approaching zero) model time interval. This means that the event is executed in some non-zero model time. Note that the client will not wait in any queue. What I suggest here is not to add any invisible (GPSS-like) buffers before the servers.

The only difference between ideal discrete events and the semi-discrete events suggested here is to **define an event as an activity of a model object that is performed during some small time interval** instead of time interval with zero duration.

The above definition of a semi-discrete event (SDE) implies that the event must be something more than a simple sequence of logical or arithmetical operations.

Recall the event (or *activity*) definition of one of the first simulation languages CSL (Control and Simulation Language, used in late 50s of the last centenary). CSL activities were ideal discrete events, but had some well defined structure.

The activity has a conditional (normally time-related) part and the sequence of operations that were to be executed if the result of the conditional part was true. We propose to apply this rule to semi-discrete events.

In other words, a semi-discrete event has finite non-zero duration HE. It means that during HE the event may be active. Within HE the event permanently evaluates the conditional part and if it results in TRUE, the event executes its operation part and terminates the activity. If the conditional part remains FALSE during HE, the operational part is not executed (the event fails).

One can say that in the previous example the result is the same as if we add a buffer before each server. However, in our model no buffers exist and the model is conceptually different. A new model parameter must be defined (a global one or event-related), namely the SDE duration HE. This interval should be small.

Note that if HE=0 we get an ideal discrete-event model and if HE is equal to model final time we get a model with GPSS-like buffers. In practice, HE must be small, related to what the user decides to be the event "time resolution".

Note that the "activity intensity" of events needs not be "rectangular" as shown in the figure 6. The event intensity function can have any shape, telling how frequently the event is checking its conditional part at the moment.
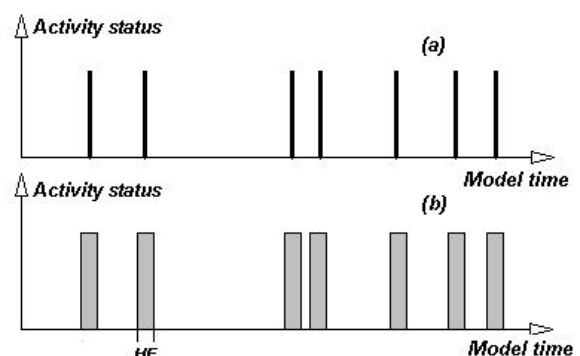

Figure 6. Activity status of discrete events (a) and semi-discrete events (b).

Obviously such change from ideal discrete to semi discrete event model implies certain price we must pay. The real-time execution will be considerably slower. This depends on the size of the HE interval and of the "activity intensity" of events inside HE.

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The "activity intensity" determines how frequently an event will check its conditional part before executing the operational part. Multiprocessing may considerably accelerate the simulation.

We will not discuss here any implementation-related issues, leaving them to future research. Anyway, new hardware and software developments should follow and obey conceptual work and not vice-versa. Some simple examples have been implemented using the PASION language. Here is a fragment of the output from a model discussed in the previous example (two consecutive servers).

```
.........................
10.01056654  10   End service 1
10.01056654  10   try to enter serv 2
10.01058492  11   try to enter the first server
11.01030253      End service 1
11.01030253  11   try to enter serv 2
11.01040253  11   try to enter serv 2
11.01050253  11   try to enter serv 2
11.01056654      End service 2
11.01060253  11   try to enter serv 2
11.01234052  12   try to enter the first server
12.01060253      End service 2
12.01200983  12   End service 1
12.01200983  12   try to enter serv 2
12.01394743  13   try to enter the first server
13.01200983      End service 2
13.01429602      End service 1
13.01429602  13   try to enter serv 2
.......................
```

The first column shows the model time, and the second is the object identifier (except ·End service events). The time intervals between client arrivals were equal to one time unit. The fractional part of the model time is caused by the finite event activity duration. Note several intents to seize a server that is occupied in the moment, but released within a small model time interval. In the "normal" ideal discrete event simulation the client 11 will not be able to enter service and will be lost unless some extra conflict resolution mechanism is applied.

Conclusions

We should look for new modelling tools. The primitive ODE models and discrete events cannot be applied to everything. In fact, these tools have been used for decades without looking for any alternative approach to system modelling.

As for the metric model space it may help in some theoretical modelling problems, for example while comparing models with different structures or while establishing convergence conditions for a series of models. What I present here are only proposals. Further research is necessary in these fields.

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PASION home page:

www.raczynski.com/pn/pn.htm

Fast Monte Carlo Simulation of Noisy Dynamic Systems
on Small Digital Computers

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…. Introduces into Monte Carlo Simulation (MC Simulation) for continuous and discrete processes
…. discusses techniques for fast Monte Carlo Simulation by vectorisation
…. sketches the Windows- und Linux – based continuous simulation software DESIRE , especially wrt to stochastic features and MC simulation
…. describes the Parzen-Window Technique for estimating the density distribution of a continuous random variable

Abstract

We describe personal-computer programs for conventional repeated-run Monte Carlo simulation and for replicated-model ("vectorised") Monte Carlo. New software automatically replicates screen-entered differential-equation models and permits very fast estimation of statistics such as averages, distribution densities, and test statistics. We develop noise-sampling techniques that work correctly with both fixed- or variable-step digital integration and propose a new heuristic test of pseudorandom-noise quality.

Replicated-model Monte Carlo examples include a nonlinear control system and a classical random-walk study. The latter required double-precision, floating-point solution of up to 20,000 simultaneous ordinary differential equations. Inexpensive personal computers complete such tasks in tens of seconds.

1. Introduction

A **Monte Carlo study** investigates the behaviour of a noisy system by taking statistics on a large sample of repeated simulations. This requires much computation, but inexpensive digital computers are now fast enough to do respectable Monte Carlo studies of noisy dynamic systems, such as control systems or aerospace vehicles. This report discusses personal-computer or workstation programs for both conventional repeated-run and model-replication ("vectorised") Monte Carlo studies.

Section 2 introduces simulation programs that control fast compiled differential-equation-solving simulation runs with a powerful interpreted experiment-protocol script. Section 3 exhibits such scripts for repeated-run Monte Carlo studies.

We are specifically interested in simulating random-noise inputs in differential-equation systems (Sec. 4), and Secs. 5 and 6 carefully develop often-neglected precautions for sampling pseudorandom noise so that it cannot interfere with correct digital integration.

We next show that model-replication ("vectorised") Monte Carlo studies can as useful on small single-processor computers as they are on supercomputers. Section 7 describes new software for automatic simulation-model replication, and Section 8 illustrates improved statistics computations.

To present a Monte Carlo simulation with well-known theoretical results, Section 9 studies a classical random walk. Section 10 simulates a nonlinear control system with filtered-noise input. Sections 11 to 14 introduce the critical problem of pseudorandom-noise quality and discuss simulation speed and accuracy. Single-processor model replication permits a useful new heuristic check of noise-sample independence, since the noise streams fed to each model are completely scrambled by any change of the sample size.

2. Programs for Dynamic System Simulation. Experiment Control Scripts

Simulation is experimentation with models. The simulation programs discussed here exercise dynamic-system models by solving several first-order differential equations (*state equations*) of the form

$$dx/dt \ x = f(x, y, a, b, \dots) \qquad (1a)$$

together with a set of *defined-variable assignments*

$$y = f(x, c, d, \dots) \qquad (1b)$$

between $t = t0$ and $t = t_0 + T_{MAX}$, with programmed *initial values x(0)* that default to 0. The quantities *a, b, c, d, …* are *model parameters*. Recursive defined-variable assignments can be used to introduce difference equations (Sec. 6).

But practical computer simulation, say of aerospace vehicles, control systems, or biological systems, is never simply a matter of programming model differential equations.

In addition to *DYNAMIC program segments* listing the system differential equations and/or difference equations, every *simulation study* requires an *experiment protocol program* that tests solutions for different model configurations, parameter values and function settings.

The simplest experiment-protocol programs are simply successive typed *commands* like

```
………(set system parameters and initial
     conditions . . . . . . .)
  drun (make a differential-equation-solving
       simulation run)
  reset
  damping = 0.9  (change a parameter)
  drun
……………
```

which permits simple interactive modelling. Here **drun** calls a differential-equation-solving run, and **reset** resets differential-equation state variables to their initial values. The operator looks at the solution output after each simulation run and can then assign new parameter values in command mode. Command mode is also useful for debugging.[1] A serious simulation study, however, needs a *programmed experiment-protocol script*.

The interactive DESIRE/2000 simulation program runs under Microsoft Windows or Linux.[1] Programs are entered and edited in Editor Windows (Fig. 1). A parameter-setting experiment-protocol script is interpreted much like an advanced Basic dialect. Whenever the script encounters a **drun** statement, a fast runtime compiler compiles a DYNAMIC program segment and executes a differential-equation-solving simulation run from **t=t0** to **t=TMAX**. With compilation delays below 50 msec, DESIRE immediately displays solution plots on a function-key command. Repeated editing and simulation permits interactive modelling. Runs from multiple Editor Windows make it easy to compare models.

3. Experiment Protocol Scripts for Repeated-Run Monte Carlo Simulation

The DESIRE experiment-protocol language is a complete computer language in its own right. Scripts not only assign new parameter values for successive simulation runs. They can produce hard-copy output; can loop to repeat runs with new parameters; admit **if** statements, procedures, vectors, and matrices; and can even handle complex variables for complex-frequency plots.
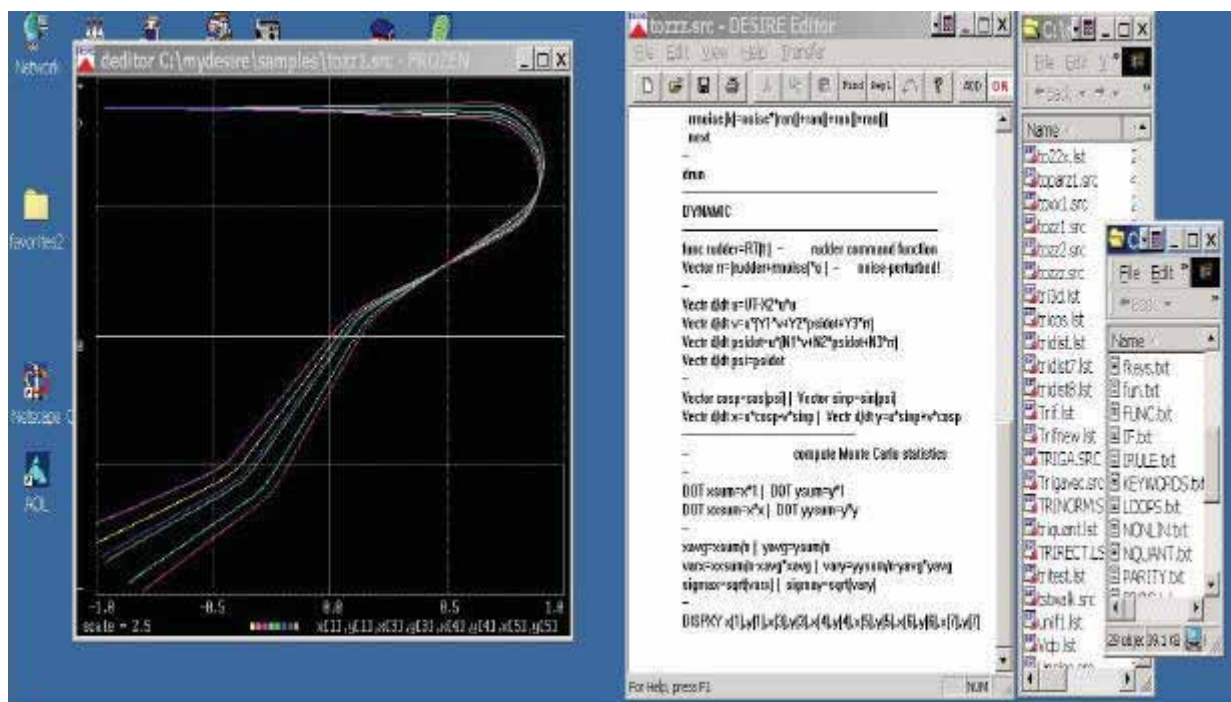
Figure 1: Personal-computer display for a DESIRE replicated-model Monte Carlo simulation of a defective torpedo.[2] The graphics window shows several of the 500 torpedo tracks obtained in a single simulation run. Programs are typed into an Editor Window, or dragged into the Editor Window from the File-manager Window on the right. Another file menu permits convenient display of user-written help screens

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As a case in point, a *repeated-run Monte Carlo simulation program* loops to exercise the same DYNAMIC program segment **n** times with new noise inputs. Here is a complete interpreted experiment-protocol program that accumulates statistics such as sample averages at the end (**t=t0+TMAX**) of each compiled simulation run:

```
…set fixed system parameters and initial
        conditions ………………
nxAvg= 0 | nxxAvg = 0 |  initialize statistics
                                computation
for  k = 1 to n        |  Monte Carlo loop
  b = b0 + B * ran()   |  set a new random
                          parameter (if any)
  x = x0 +  Q * ran()  |  and a new random initial
                            value (if any)
  drun  |  solve differential equations with
           noisy inputs
  nxAvg = nxAvg+x | nxxAvg = nxxAvg+x*x
  xAvg = nxAvg/n  | xxAvg = nxxAvg/n
  xVar = xxAvg - xAvg * xAvg |  accumulate
                                  statistics
  reset  |  reset initial values
  next   |  and loop back
```

The symbol **|** separates statements on the same line, and **ran()** is a library function that supplies a new noise sample with each call. The **for** loop produces the sample averages of x and x^2, and also the sample variance of x after n simulation runs. Loop statements are automatically indented in listings. Note that this technique lets you terminate the study as soon as a computed sample variance decreases to a predetermined value ("sequential" Monte Carlo).

One can also accumulate more advanced statistics, such as correlation and regression coefficients, statistics for classical t – test and $?^2$ -test, etc.. But for a fixed sample size n, elaborate statistics can be more efficiently computed after all n repeated runs are done. To this end, the experiment-protocol script declares **n**-dimensional arrays **X**, **Y**, . . . corresponding to every variable **x**, **y**, … involved in a statistics computation,

```
ARRAY   X[n], Y[n], . . .
```

and then saves the sample values **x(t0+TMAX)**, **y(t0+TMAX)**, at the end of each simulation run with

```
X[i] = x    |   Y[i] = y  |
```

After n repeated runs, the arrays **X**, **Y, ** … then contain complete end-of-run samples

```
(X[1], X[2],…, X[n]) (Y[1], Y[2],…Y[n]), …
```

of the corresponding random variables **x**, **y**, … .

Computing statistics as functions of these end-of-run sample values is much more efficient than run-by-run accumulation, especially since the DESIRE experiment-protocol script can call a second compiled DYNAMIC program segment to compute statistics with *compiled* rather than *interpreted* code. As a useful example, the Appendix shows a fast end-of-run program segment that estimates *probability density*.

4. Noisy Parameters vs. Dynamic Noise in Monte Carlo Simulation

Our example Monte Carlo script admits random-noise inputs both in the experiment protocol and in DYNAMIC program segments. A significant class of Monte Carlo studies (parameter-tolerance studies) does not involve dynamic noise inputs at all. One then needs new random parameter values and random initial values only once per simulation run.

We discuss such studies (which have important applications) in a companion paper [2] and turn to the more difficult problem of differential-equation and difference-equation models with dynamic noise inputs, i.e. random functions of time generated by periodic calls to a noise-generator routine.

5. Noise Inputs for Differential-Equation Models as Sampled Data. Simulated Noise and Digital Integration

Our noise-generator function **ran()** supplies double-precision floating-point numbers uniformly distributed between -1 and 1. Different functions of **ran()** readily produce different noise distributions. Note also that **A*(ran()+ran()+ran()+ran())** is roughly Gaussian with mean 0 and variance 4$\mathbf{A}^2$/3.

Dynamic-system simulation languages must accommodate models incorporating differential equations, difference equations, or both (e.g. sampled-data control systems). Pure difference-equation systems are easiest, because you can simply call new pseudo-random-noise samples at each solution point, or at a fraction of this rate. Dealing with differential equations is not as simple.

To get correct noise inputs, you cannot just call a noise-generator library function somewhere in the derivative assignments of a differential-equation solving program. The following points are often neglected because "it is only noise". But correct modelling requires noise with accurately known statistical properties. Specifically,

1. *Noise samples must occur periodically*, for the noise-sampling rate affects the frequency spectrum of the simulated noise.
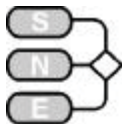
Simulation software can explicitly emulate sample-hold circuits, but there are better ways. In any case, *the necessarily discontinuous digital noise must not be allowed to compromise digital integration*:

1. Noise must not be sampled at every derivative call of a multi-call digital integration routine.
2. For proper integration, noise steps must occur exactly at the start of some of the - possibly variable - integration steps.

It follows that the integration steps - whether variable or fixed - must be synchronized with the noise-sampling, whose frequency is determined by the required noise spectrum. It turns out that most simulation software serendipitously already provides a periodic sampling process with just the required properties, namely the built-in simulation-output sampling at the so-called communication points.[1]

Fixed-step integration rules must use integration steps equal to an integral fraction of the communication interval. Properly designed variable-step integration routines automatically adjust so that integration steps never overstep a communication point.[1]

Noise samples are, in truth, sampled-data variables. *We must treat noise samples exactly like digital-controller state variables in models of sampled-data control systems*. Such models combine sampled-data difference equations with differential equations representing analog subsystems, and we again recommend sampling rates based on the simulation-output sampling rate. That keeps the digital integration of our simulated analog variables honest.

6. Sampled-Data Programming in Differential-Equation Models

The DESIRE simulation language lets you specify the number **NN** of communication points between (and including) **t=t0** and **T=t0+TMAX**. Then any assignment, say **noise=A*ran(),** subsequent to an **OUT** statement at the end of a DYNAMIC program segment executes *only at communication points*.

The value of **noise**, therefore, will not change until *t* reaches the next communication point. Such **OUT** blocks were originally provided to speed manipulation of simulation data meant only for output.

The sampled-data sequence generated by **noise =A*ran()** is now nicely synchronized with our integration routine. We can then use the resulting samples in a differential-equation model, say a simulated analog filter used to shape the noise spectrum. Here is a complete small DYNAMIC program segment:

```
d/dt p = - w * p + noise
--
OUT
noise = A * ran()
```

noise is a discontinuous sampled-data variable, but the integrator output **p** represents a continuous variable, which can be used and integrated safely at every derivative call.

Unlike equation-sorting simulation languages like Aegis/ACSL or DARE, DESIRE is a procedural language, i.e., all assignments execute in turn. Note that our DYNAMIC program segment assigns the value **A * ran()** to the sampled-data variable *after* **noise** is used in the differential equation. DESIRE would, therefore, return an undefined variable error (sort error) if the experiment-protocol program (which necessarily precedes all DYNAMIC program segments) did not program an *initial-value assignment* like **noise=A*ran(),** or simply **noise=0**. Indeed, **noise** is a *difference-equation state variable* which needs an initial value, exactly like a state variable in a simulated digital controller![1]

Whether we simulate random noise or digital controllers, sampled-data assignments following the **OUT** statement are synchronized with the integration routine used for the differential equations. If the desired noise-sampling rate is too fast for simulation-output sampling, we can set a system variable **MM** that will cause simulation-output sampling at $1/\text{MM}^{th}$ of the noise-sampling communication rate determined by **NN**. A block of sampled-data assignments can also be sampled at $1/\text{m}^{th}$ of the communication rate by preceding the block with a **SAMPLE m** statement.

7. Replicated-Model Monte Carlo

Rather than repeat Monte Carlo runs of a given model *n* times, one can exercise *n* replicas of the model, with individual random-noise inputs, in a single simulation run. This speeds computation by avoiding the repetition-loop overhead and also simplifies statistics computation. Model replication in different program threads and/or multiple processors ("vectorised Monte Carlo") is often used on supercomputer Monte Carlo studies.[3] We now describe an efficient single-processor version that, as an added bonus, also helps to check the quality of our pseudorandom noise.

DESIRE/2000's new vector compiler[4] makes model replication *automatic*. To replicate the differential-equation model of Eq. (1) *n* times, the experiment-protocol script declares *n*-dimensional arrays (vectors) for each state variable **x** and each variable **y** with

```
STATE x[n], …| ARRAY y[n], noise[n], .
```

In the DYNAMIC program segment, derivative and defined-variable assignments (1) are then simply replaced by corresponding vector assignments

```
Vector d/dt x = f(x,y,a,b,…,alpha,…)    (2a)
Vector y = f(x,c,d,…beta,…)             (2b)
```

DESIRE now automatically compiles each vector assignment (2) into *n* assignments:

```
d/dt x[i] = f(x[i],y[i],a[i],b[i],…,alpha,…)
                        (i = 1, 2, …,  n)     (3a)
y[i] = g(x[i],c[i],d[i],…,beta,…)
                        (i = 1, 2, …,  n)     (3b)
```

In this way, the DYNAMIC program segment models *n replicated models*. Note that the parameters **alpha**, **beta**, … are the same for all *n* models.

8. Replicated-Model Monte Carlo: Simplified Statistics Computation

Our DYNAMIC program segments employ fast compiled **DOT** (inner-product) operations [4] to compute and plot statistics like **xAvg** and **xxAvg** as functions of *t* at each output-sampling point:

```
DOT nxAvg = x * 1  | DOT nxxAvg = x * x
xAvg = nxAvg/n | xxAvg = nxxAvg/n
xVar = xxAvg - xAvg * xAvg
```

DESIRE automatically compiles this into

```
nxAvg =  Σ x[k]   |   nxxAvg = Σ x[k] * x[k]
xAvg = nxAvg/n   |   xxAvg = nxxAvg/n
xVar = xxAvg - xAvg * xAvg
```

No conformable vectors are rejected with an error message. Compiled **DOT** assignments generate very efficient code *without any summation-loop overhead* and can also evaluate quadratic forms and sums of inner products.[4] To save computing time, we program all statistics computations after the **OUT** statement already used to sample the noise.

The fast (compiled) DYNAMIC-segment code can also evaluate much more elaborate statistics, such as classical test statistics, at each point in time, so that sophisticated sequential Monte Carlo studies are possible.

The experiment-protocol script can still call a separate DYNAMIC program segment for end-of-run statistics computations and plotting; the Appendix shows a useful example.

9. Example: Replicated-Model Simulation of a Random Walk

An integrator with noise input **a*ran()** produces random walks *x(t)*. This simple example is interesting because the expected values of statistics are easily derived from probability theory.

The integrator input is constant during successive sampling intervals of length

```
COMINT = TMAX/(NN - 1)
```

Our integrator output *x(t)* is simply the sum of **t/COMINT** statistically independent random variables **v** each uniformly distributed between –**a*COMINT** and **a*COMINT**, so we have

```
E{v} = 0     E{v2} = (a COMINT)2 /3
E{x(t)} = 0
Var{x(t)} = E{x2(t)} = truVar =
  (t/COMINT) E{v2} = (a2 t/3) COMINT
```

With increasing *t*, the probability distribution of **x** is asymptotically normal with mean 0 and variance **truVar**.

The *experiment protocol script for our random walk study* declares arrays for the integrator output **X** and for the noise samples **noise**:

```
n = 5000 | STATE x[n] | ARRAY noise[n]
```

The starting time **t0** and the initial values of the differential-equation state variables **x[i]** simply default to 0, but the experiment protocol script must assign initial values to each random sample **noise[i]** to be used at **t=0**:

```
for i=1 to n | noise[i]=a*ran() | next
```

The following complete *DYNAMIC program segment* then replicates *n* random walks and computes the sample mean, mean square, and variance of **x** at each point of time:

```
Vectr d/dt x = noise
--
OUT
Vector noise = a * ran()
--
DOT nxAvg = x * 1 | DOT nxxAvg = x * x
xAvgx = nxAvg/n    | xxAvg = nxxAvg/n
xVar = xxAvg - xAvg * xAvg
```

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Note that different fixed- or variable-step integration rules all work. But with the integrator input constant between sampling points, simple Euler integration is as good as any.

Figure 2 and Sec. 13 show results and compare them to theoretical expected values. At the end of the simulation run ($t = T_{MAX}$), the model outputs **x[1]**, **x[2]**,…, **x[n]** are all available, so the experiment-protocol script can feed them directly to a second DYNAMIC program segment which quickly estimates and plots a Parzen-window estimate of the probability density of **x** at the end of the run. (Appendix).
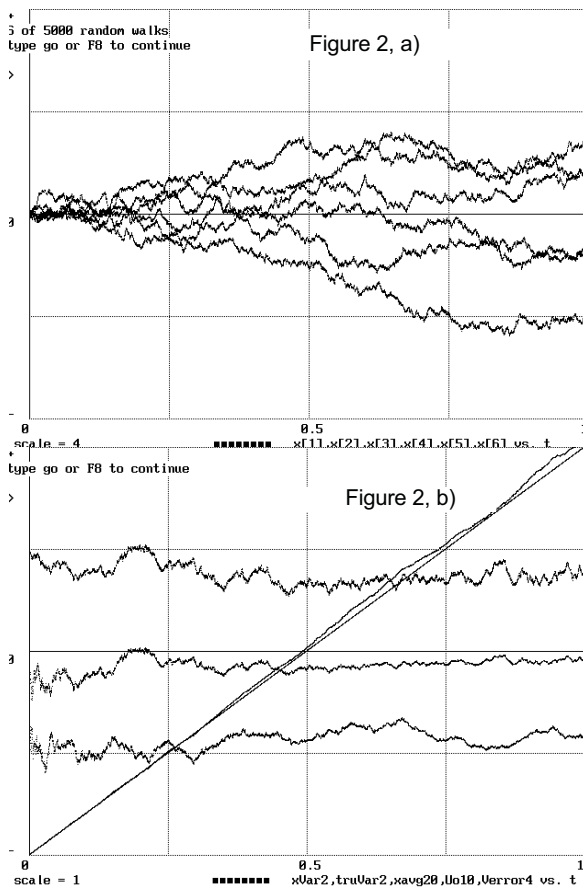
Figure 2, a)

Figure 2, b)

Figure 2: 6 of n = 5000 random walks (*a*), and (*b*) scaled stripchart plots showing time histories of the Monte Carlo sample variance **xVar**, of the true variance **truVar**, and of the test statistics **U** and **Verror**. The original DESIRE display was in color; the small black squares are color keys.

10. Example: Nonlinear Control System with Noise Input

As a more complicated example, consider a model for a nonlinear electrical servomechanism,

```
d/dt p = - w * p + noise  |
  -- two-section low-pass noise filter
d/dt u = - w * u + p --
--
e = x - u |  --   servo error
voltage = - k * e - r * xdot  |
  --  motor voltage
d/dt v = - B * v + voltage  |
  --  motor-field buildup
torque = maxtrq * tanh(g2 * v/maxtrq) |
  --  saturation-limited motor torque
--
d/dt x = xdot   |   -- dynamics
Vectr d/dt xdot = torque - R * xdot  |
```

For large signals, motor-torque saturation, modelled with the **tanh()** function, makes the dynamics so nonlinear that we cannot compute the mean-square error with one of the differential-equation schemes described in Refs. 5 and 6, so Monte Carlo is the only game in town.

The *experiment-protocol script* must declare arrays for the differential-equation state variables **p,u,v,x,xdot**, for the sampled-data state variable **noise**, and for the defined variables **e, torque**,

```
STATE p[n],u[n],v[n],x[n],xdot[n]
ARRAY  noise[n],e[n], torque[n]
```

The parameters **w,k,r,B, maxtorq,R,a** are the same for all *n* models and need no arrays. The initial values of **p,u,v,x,xdot** default to 0. The experiment protocol again assigns initial noise samples with the loop.

```
for i=1 to n | noise[i]=a*ran() | next
```

The DYNAMIC program segment replicating our model *n* times simply prefaces model equations with **Vectr** or **Vector** (figure 3 shows the results):

```
Vectr d/dt p = - w * p + noise |
  --   two-section low-pass noise filter
Vectr d/dt u = - w * u + p
Vector e = x - u |  --     servo error
Vector voltage = - k * e - r * xdot  |
  --           motor voltage
  Vectr d/dt v = - B * v + voltage  |
    motor-field buildup
```

```
Vector torque=maxtrq*tanh(g2*v/maxtrq)
--   saturation-limited torque
--
Vectr d/dt x = xdot
Vectr d/dt xdo t = torque - R * xdot
--   dynamics
--   sample at communication points
  OUT
  Vector noise = a * ran() | sampled noise
--
DOT neAvg = e * 1
DOT neeAvg = e * e  | -- compute statistics
eAvg = neAvg/n      |   eeAvg =neeAvg/n
eVar = eeAvg - eAvg * eAvg
```

11. Pseudorandom-Noise Problems and Model Replication

In a our Monte Carlo programs, `ran()` is derived from a C-library function that supplies pseudorandom numbers repeating after about 4 billion samples. For debugging purposes, a `SEED` statement in the experiment-protocol script can restart the noise generator with a fixed seed whenever required.

Such noise samples are known to be uncorrelated; but they cannot possibly be statistically independent. Improved pseudorandom-noise generators have periods as long as 2^{90}.

One commonly *assumes* statistical independence and checks results against experience, and also against results obtained with different noise generators. Such heuristic methods have worked well when the number of noise samples is small compared to the period length – say when only system parameters or initial state-variable values are noisy.

But Monte Carlo with dynamic, time-varying broadband noise can require *enormous* numbers of noise samples.

In a random-walk experiment with `TMAX=1` and `NN=10001`, we have 10000 samples per time unit. This amounts to a noise bandwidth of the order of 1 KHz in simulated time.

Each simulation run requires `NN-1`=10000 noise samples for each random-walk model. In principle, our simulated integrator output `x` for `t=TMAX` depends on the joint probability distribution of *all* these noise samples.

Next, for `n=1000` Monte Carlo runs we need a total of `n*(NN - 1)= 10000000` noise samples. This is an appreciable fraction of the noise-generator period. Even if we reduce `NN` to 1001 and `n` to 500 we still need up to `n*(NN-1)=500000` noise samples.; and our program involves only a single noise function!

All checks of pseudorandom-noise quality in practical dynamic system simulations are heuristic. But our model-replication technique adds a new simple test to the usual substitution of different noise generators. *Since each replicated model is fed its noise in turn, any change in the number n of replicated models will completely scramble the noise sequence fed to each model.* Agreement of Monte Carlo results with different values of `n`, therefore, constitutes a plausible heuristic test of the noise quality.

12. Computing Speeds

Figures 2 and 3 show typical simulation time-history plots. We used an inexpensive ($1000) 1-GHz Athlon personal computer with only 128 Mb of DDR memory. Newer personal computers are about twice as fast. The following computing times are for DESIRE running under Windows 2000.


```
0                                5                          10
scale = 1            ■■■■■■■■  X,U,eAvg200,tto10,eeAvgx1K vs. t
```
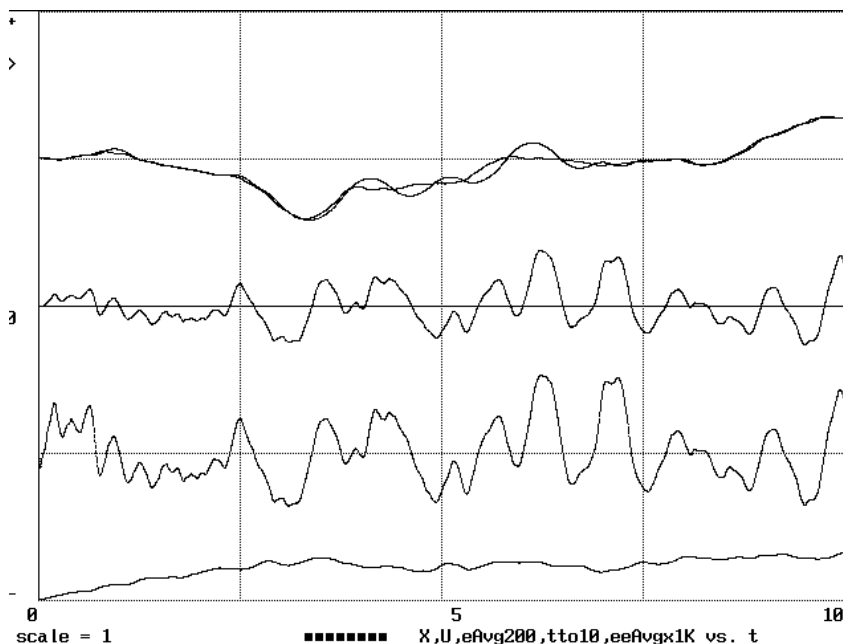
Figure 3: Scaled stripchart plots of the control-system input **u** and output **x** for one sample, and of the statistics **eAvg**, **eeAvg**, and **tt** for **n** = 1000.

The Linux version of DESIRE, written entirely in C for portability, is about half as fast as the Windows version, which compiles optimized machine code.

Measured computing times for *10000-step random-walk study*, using Euler integration and including calculation of mean value and mean square, were:

	Repeated-Run Study	Repeated-Model Study
n = 1000	67sec	0.75 sec
n = 2000	134 sec	1.5 sec
n = 3000	335 sec	6.4 sec

Parzen-window estimation and plotting of one probability-density (Appendix) required 0.72 sec for **n** = 1000, and 1.3 sec for **n** = 2000.

For very small models like our random walk and simple trajectory simple models in physics, replicated-model Monte Carlo is dramatically faster than repeated-run Monte Carlo because the repetition-loop overhead is relatively significant. The speed advantage of model replication is not as large for engineering simulations with larger models. For a fair speed comparison, we timed our engineering simulations without any statistics computation other than data collection, assuming that end-or-run statistics would be computed separately for both repeated-run and replicated model studies.

The control-system study discussed in Sec. 10, with statistics computations, using 2nd-order Runge-Kutta integration and **n** = 1000, **NN** = 5000, required *51.5 sec with repeated runs and 26.0 sec with model replication.*

Monte Carlo simulations involving only noisy parameters or initial conditions run much faster since, without the sampled-data noise, variable-step integration can use much larger steps. Monte Carlo simulation, without statistics computations, of a noisy-parameter 6th order torpedo model (Fig. 1)[2] with variable-step 4th-order Runge-Kutta integration and **n** = 500 took only *14.2 sec with repeated runs and 7.8 sec with model replication.*

13. Accuracy of Monte Carlo Results. Test Statistics

Statistical results for repeated and model-replication Monte Carlo were essentially identical. All DESIRE calculations use double-precision floating-point format (64 bits or about 15 decimal places), so that roundoff errors are no problem in our examples.

The random-walk example permits exact checks against the theoretical expected values listed in Sec. 9. We plotted and printed the sample mean and variance, and also the test statistics

```
U = xAvg * sqrt(n/Var{x(t)})
Verror = (xVar/Var{x(t)}) - 1
```

as functions of **t** (Fig. 2). **U** is the ratio of **xavg** and its expected standard deviation, and **Verror** is the fractional error in **xVar**. When **t** is sufficiently large to make **x** approximately Gaussian, **U** is approximately normal with mean 0 and variance 1, and **n*(Verror+1)** is approximately distributed like χ^2 with **n−1** degrees of freedom.

The random-walk sample variance **xVar** was within 4 percent of its theoretical expected value for **n=5000**, and within 10 per cent for **n=1000**. The end-of-run value of **|U|** was below 0.7 for **n=5000**, but as large as 1.6 for **n=1000**.

For **n=5000**, the probability-density estimate calculated in the Appendix was within 5 percent of its expected value except in the tails of the distribution (Fig. 4), where the variance of any probability-density estimate is necessarily large because relatively very few sample values fall into the tails. The probability-density result is interesting, for it is known from both theory and experiments [9] that bad pseudorandom-noise generators can produce entirely wrong (even bimodal) random-walk probability densities.

Monte Carlo statistics obtained for our control-system model (Fig.3) and for the larger torpedo model [2] looked reasonable on the basis of engineering experience, but only the expected zero value of **xAvg** for the control system is known from theory. We computed the test statistic

```
tt = eAvg * sqrt((n - 1)/eVar)
```

which is approximately distributed like Student's t with **n−1** degrees of freedom.

Conclusion and Discussion

DESIRE Monte Carlo studies on inexpensive personal computers are fast enough to permit very convenient interactive program changes, including runs with different test statistics and graphic displays.

Pseudorandom-noise validation is a vital necessity for all Monte Carlo studies. We were originally apprehensive about using the relatively primitive linear congruential noise generators **rand** and **drand48** furnished with Windows and Linux.

But in our limited number of examples, *Monte Carlo results showed no noticeable changes on interchanging* **rand** *and* **drand48**, *nor by re-scrambling the noise in replicated-model studies*. Much better noise-generator routines with massively longer periods have been reported in the literature.[10, 11]

The advantages of replicated-model ("vectorised") Monte Carlo - improved computing speed and easy statistics computation - were as evident in our personal-computer work as they have been for supercomputers. A new heuristic noise-validation test is an added bonus on small single-processor machines. Replicated models, though, require more computer memory than repeated-run Monte Carlo.

DESIRE admits up to 150,000 defined variables, plus up to 20,000 differential-equation state variables for fixed-and variable step Runge-Kutta integration rules, enough for 500 40th-order models, or 1000 20th-order models. Our variable-order Gear and Adams integration rules, however, are limited to 400 state variables, and therefore usually require repeated-run Monte Carlo. Studies of large models can employ a combination Monte Carlo technique that repeats replicated-model runs.

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Appendix: Parzen-Window Probability Density Estimation

Given a sample array **(x[1],x[2],…,x[n])** for a continuous random variable **x**, one can estimate its probability-density function **p(xx)** as the sample average of the *Parzen-window function* [10]

```
f = exp[-(x-xx)^2/2h^2]/[h*sqrt(2p)]
```

The Parzen window is a bump-shaped function centered on **xx = x** and weights the sample values **x[i]** according to their distance from the desired **xx**-value. The parameter **h** determines the bump width. Small values of **h** emphasize samples **x[i]** close to **xx**; this improves the resolution but increases the estimate variance. We chose **h** by trial and error and usually decrease **h** when we increase the sample size **n**. The estimate is asymptotically unbiased and consistent if **h** ? 0 and **nh** ? ∞ as **n** ? ∞.[10]

To compute the probability-density estimate, our experiment-protocol script sets **n, h**, and

```
alpha = 1/(2 * h * h)
beta = 1 /(h * n * sqrt(2 * PI))
```

The experiment protocol then calls a new compiled DYNAMIC program segment labelled **PARZEN** with

```
irule 0 |  --   no integration
TMAX = scale |    NN = 2000
MM = 1  | --   new display
t = 0
drun PARZEN
```

where **scale** is the display scale, i.e. the largest desired display excursion, and defaults to 1.

The new DYNAMIC program segment uses its built-in simulation-time variable **t** to sweep the argument **xx** of the probability-density estimate **F** from **-scale** to **scale**:

```
label PARZEN
xx = 2 * t - TMAX  | -- display sweep
--  compute n samples of the Parzen-window
  function divided by n
Vector f = beta * exp(alpha*(xx-x)*(x-xx))
DOT F = f * 1 |
--  and sum to average them
```

Note that the factor 1/**n** needed for averaging is already included in our parameter **beta**.

As **t** increases from **t=0** to **t=TMAX**, the program computes **xx** and **F** for **NN** values of **t**. **xx** goes from **xx=-scale** to **xx=scale**, and we can plot the probability-density estimate **F** as a function of its proper argument **xx**.

Figure 4 shows results obtained at the end of the random-walk study, with the correct Gaussian probability density plotted for comparison purposes.

This short program is a good example of a fast compiled end-of-run statistics computation. Computing times and accuracy are discussed and are listed in Secs. 12 and 13.

we used 1e+007 noise samples

scale = 4   ▪▪▪▪▪▪▪▪ xx,FF,Y,error5
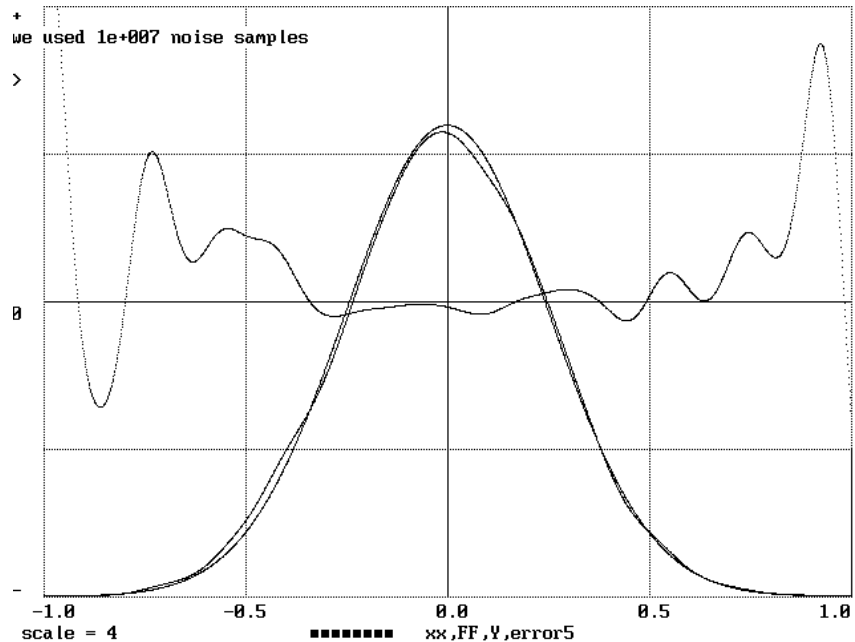
Figure 4: Display of a Parzen-window probability-density estimate for the random-walk study with **n** = 5000 and **h** = 0.06. The expected Gaussian curve and the relative error of the Monte Carlo estimate are also shown. The program works with both repeated-run and replicated-model Monte Carlo.

iSiM ESL

European Simulation Language

Built for the European Space Agency, **ESL** is a graphical environment for dynamic system modelling in all fields of industry, science and technology.

Version 8.0, available for Windows NT and Sun Solaris 2 platforms, provides the following features:

- robust simulation of large non-linear systems
- multi-window graphical block diagram editor
- interactive control of simulation execution
- accurate treatment of discontinuities
- option to generate C++ and FORTRAN code
- distributed processing facility
- embedded simulation facility
- application specific toolbox capability
- option to mix *ESL* code and graphical submodels
- generation of COM/Active-X components
- extensive library of submodels
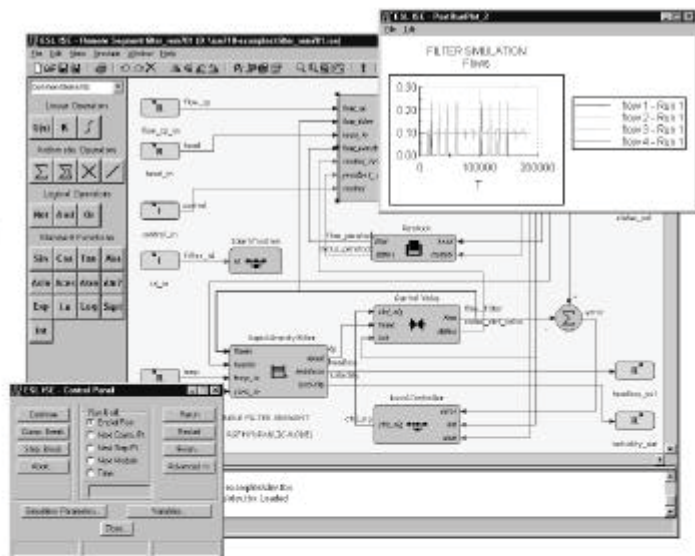
Some Applications
- on-board software validation for XMM telescope satellite
- gas turbine compressor simulation
- off-shore gas rig training simulator
- water treatment simulation

ESL - for accurate and robust simulation
"A simulation engine that runs forever" - ESTEC

For further information contact Bryan Trafford at ISIM International Simulation Limited
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isim@cogsys.com   www.cogsys.com

SHORT NOTES

Increasing Safety of Tunnels

Walter Esberger

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> *…. gives insight into tunnel safety problems*
>
> *…. sketches discrete event modelling of evacuation procedures (individual and global)*
>
> *…. presents a simulation environment with GUIs: scenario editor, visualisation etc.*
>
> *sketches briefly applications*

With increasing of fast traffic connections more and longer tunnels have to be built, which are regarded as large technical achievement. This opens not only new market perspectives, but brings also new dangers for the users of this infrastructure. To give an example a ICE high-speed rail connection between Cologne and Frankfurt/Main was build, including 30 tunnels, partly several kilometres long, allowing a train speed of up to 300 km/h.

Well known to experts is the high danger potential of such tunnels. Already a small fire in a train can easily lead to an inferno with hundreds of victims. Nearly the same can be said about road tunnels although the number of victims is expected to be smaller.

Several European train companies are trying to prepare for this growing thread with evacuation test events. However the results are shocking in most cases. Due to the high personnel and financial expenses of such test series simulation technique offers a great potential to obtain more security. Similar simulation techniques are already used successfully in other sensitive ranges as sports stadium or construction of large buildings.

Thus experts of the Austrian Institut for sport facilities construction (ÖISS) used simulation successfully to analyse the dangerous building situation of the Bergiselstadions, where during a big event many people were injured or even killed. Threads could be eliminated so that this situation can never happen again.

The following text describes a simulation tool that was especially designed to evaluate risk potentials of tunnels or similar buildings and can be used during planning of new buildings, adaption of existing buildings or even in safety related education. In was used to evaluate road- and rail tunnel scenarios.

Simulation model

For the evaluated types of buildings, many parameters were identified that may have influence on each other. From this very complex resulting matrix, the most important parameters were used to build the simulation model.

The following parameters were taken into account in the final simulation application:

Model of person

- visibility range, disabilities
- blockade, latency
- behaviour of person groups
- speed of movement, body parameters

Model of scenario

- orientation guides, length, width
- type of area/tunnel, ventilation
- safe areas, visibility conditions, floor type

Model of accident

- location of accident, blockades
- spreading of fire, spreading of smoke

The simulation model is based on discrete events. After initialisation each person tries to escape to a safe location. When reached by the fire or deadly smoke it is no longer scheduled for movement (fig.1). Every person is treated autonomous and has its own properties. Accoring to this the behaviour of each person is different compared to the others.
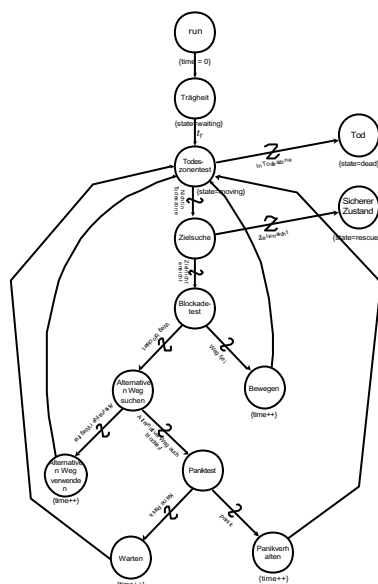
Figure 1: event graph model

SHORT NOTES

Simulation tool

The simulation tool was created using an object oriented software development tool on the windows platform. The main simulation model is based on an event graph model (Figure 1) that was optimized during implementation. As a high level object oriented software it is very flexible and can be used in many areas of application. Classes were defined for the environment, the persons, blockades and others. One of the most complex parts of the model was the definition of the persons behaviour.

Other simulation systems showed that results were not close enough to the reality when too much simplification was applied to the model. The same can be said about most traditional techniques used in state of the art real time computer games. As a result of this the implementation uses high efficient geometric algorithms. This and the object oriented implementation ensures best simulation results and a near real time visualization of the scenario.

Visualization

The final simulation result is the movement behaviour for the modelled scenario. It can be visualized in many ways including display of the moving paths (figure 2) or the evacuation time curve (figure 3).

The movement path visualisation can be used to identify bottlenecks or areas without proper light conditions. Also the need for visual guides can be evaluated. The example shows movement pathes and persons in a road tunnel.
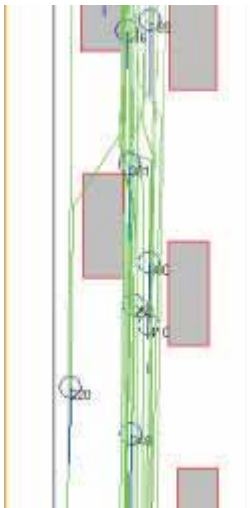
Another visualisation of the simulation results is the evacuation curve. It can be used to compare different scenarios with each other, the impact of parameter variation or to measure if the evacuation time for the given scenario can be achieved according to national law (Figure).

Figure 2:
movement path
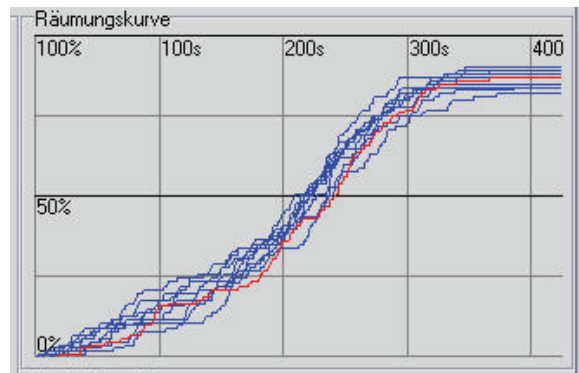
Figure 3: evacuation time graph

Scenario editor

The current version of the software uses source code to describe the simulation scenario. It is compiled into the application and therefore no additional modelling front end is used. For future versions a powerful front end is under development so the simulation tool can be used by non programmers. The prototype shows a crowded area (figure 4) and some parameters.
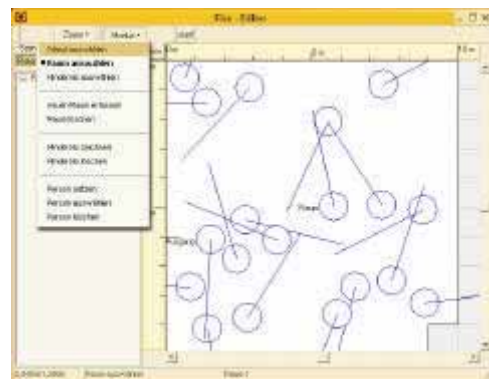
Figure 1: GUI frontend of prototype

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The PASION Simulation System

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…. introduces PASION, a simulation system for continuous, discrete and hybrid processes

…. sketches modelling and simulation of server lines with the queuing simulation module QMGW.

…. Shows different approaches to continuous modelling and simulation by PASION CSS and the graphical modelling environments BSGW (bond graphs) and FLOWD (block diagrams), etc.

PASION Overview

PASION stands for PAScal simulatION. It is an object-oriented, Pascal-related simulation language. The language has a clear process/event structure and is equipped with appropriate environment.

PASION translator generates Pascal source code that can be run using a Pascal compiler (this new version generates code compatible with the Borland's Delphi 4,5,6 or 7). The following features make PASION a very complete and versatile simulation tool.

- Efficient scheduling and *event queue management*.

- *Inheritance mechanism*, that permits to add new properties to old processes without intervening the source code of processes declared earlier.

- *State events*. Discrete and continuous objects can run concurrently. The state events can be activated by continuous objects as well as by logical conditions changed according to state of the model.

- The library of **PASION** *predefined processes* contains various frequently used processes, e.g. a rigid body dynamics, and several helpful processes that handle graphics and show simulation results.

- Program generator for *ODE (Ordinary differential equations)* models **DIFEQ**.

- Program generator for queuing models **(QMGW**). This module includes graphical editor for queuing schemes, program and report generators.

- Program generator for continuous processes **FLOWD** described by *signal flow diagrams or block schemes*.

- *Bond Graph editor and analyzer* **BONDW**. This module includes a Bond graph editor and a program generator that creates source Pascal and PASION code for a given Bond graph model.

- **Frequency response.** Each of the continuous simulation modules (bond graphs, signal flow and ODE) provides transient as well as frequency response in the form of the Bode diagrams and the Nyquist plot.

- **PASION Animator.** Includes a Scenario and Icon Editor that permits to create 3D scenarios for animated simulation. The user creates the scenario and defines the possible routes for model components and the component icons. Simple calls to animation procedures from the source program makes the icons move according to the simulated component activities.

- **VARAN**: *Post Mortem analyzer for stochastic (discrete and continuous) models*. Shows variance, confidence intervals etc. *as functions of time*, particularly useful for the statistical analysis of transient processes.

- **Complex System Simulator (CSS)** - new versatile PASION module. Very useful for combined systems, permits model coupling. Sub-models of different types (queuing, continuous, etc.) run concurrently in the same simulation program. Needs no or very little programming. Generates PASION source code.

Object-oriented simulation offers great flexibility in model building. While coding directly in PASION language you can create complex models described in terms of processes and events, create the process instances (objects) and activate them.

Figure 1 shows a simple model of breaking the rack, where each ball is a model object and moves according to its own rules, receiving external forces from other objects, friction and the table limits. Figure 2 shows the full structure of the PASION simulation system.
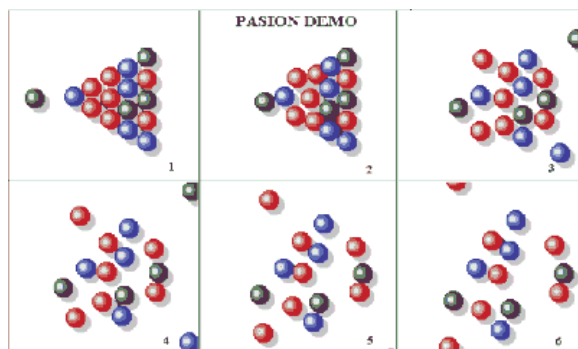
Fig. 1: PASION Animation: break of the rock
– moving holes and collisions
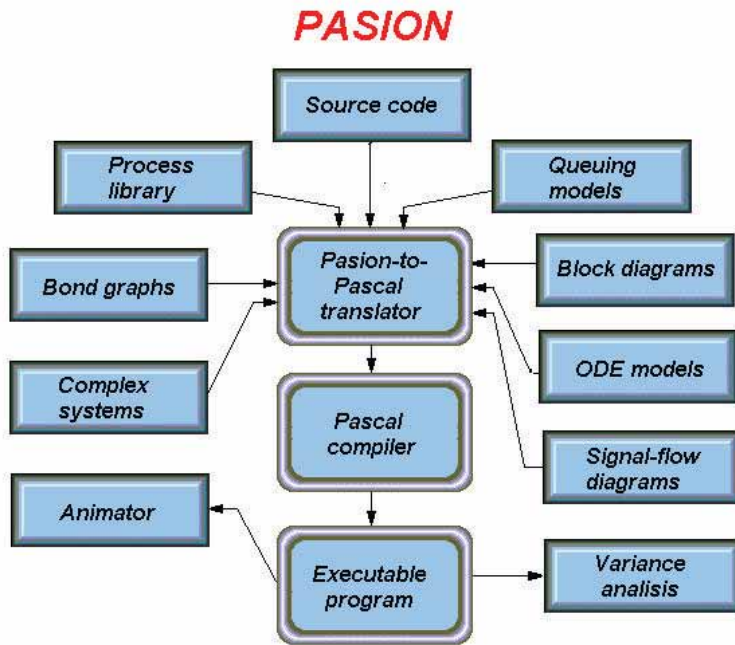
Figure 2: Structure of the PASION simulation system

Queuing Model Generator QMGW

QMGW is a part of the PASION simulation system. It is a program generator for queuing models. The output from QMGW can be:

- A complete PASION program that can be run using the PASION-to-PASCAL translator PatW and a Pascal compiler.
- A PASION process. It can be used as a submodel while creating a complex model (see **CSS** PASION module).
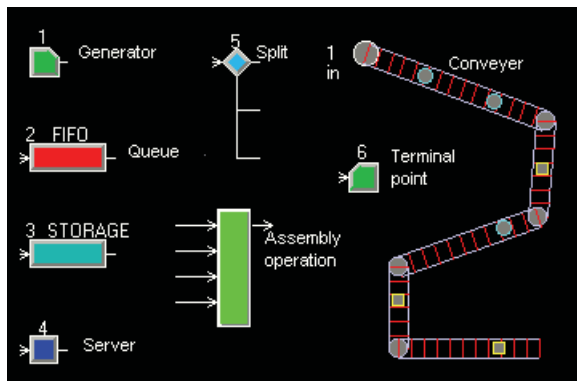
Figure 3: Modelling Blocks of QMGW

The user can simulate queuing models without programming. The model structure is created on the screen by means of graphic icons, and analyzed by QMGW. Then, the user is asked to give the parameters for the model blocks and the corresponding PASION program is generated.

For more complicated models the user can provide his own Pascal procedures for service time distributions, priorities etc. PASION programmers can work on the resulting PASION code, making necessary changes or adding other processes to the model.

The main QMGW modelling blocks are: input flow (entity generator), queue, server, assembly operation, flow split, storage, conveyor and terminating block (figure 3). Figure 4 shows a classical parallel single server line build up of these blocks.
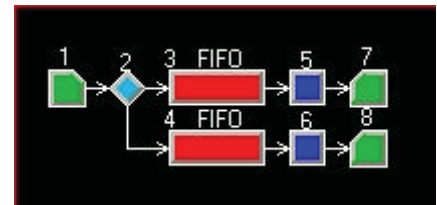
Figure 4: QMGW model of parallel single server line

Graphical result presentation. The queues appear on the screen as moving bars. The state of the servers and other blocks is shown during the simulation. The actual implementation of QMGW permits models with up to 800 blocks.

Various statistics are calculated as a result of a QMGW run. The standard GPSS-like statistics appear after each run. The program can repeat the simulation storing the model trajectories. This set of trajectories can be analyzed using mechanisms of the PASION environment.

The variance, confidence intervals etc. can be given as functions of model time, showing useful statistics of transient processes (figure 5). See also the PASION **DEMO** for examples of simulation runs, animation and graphical result displays.

QMGW works with the PASION **Animator**. The items can move over 3D user-defined scenarios. This makes the simulation more spectacular.

SHORT NOTES

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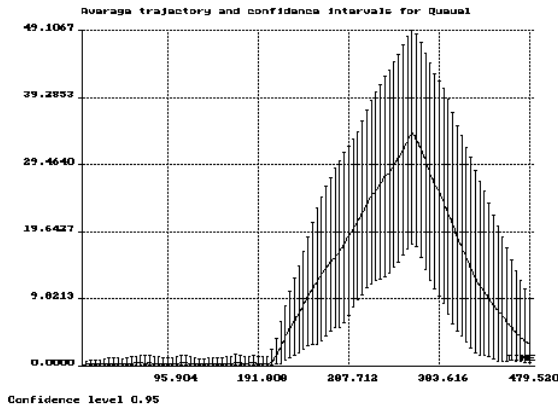
Figure 5: Example of a standard PASION output (VARAN utility). The plot shows the average length of a QMGW queue and the confidence intervals. Horizontal axis is the model time; vertical axis is the queue length.

CSSS - Complex Dynamic Systems Simulator -

Combined continuous - discrete models

This module of the PASION simulation system permits to simulate complex dynamic systems without or with very little programming. We say that a dynamic system is complex, if it has multiple components, which reveal different dynamic properties. This may occur, for example, when all system components are continuous with concentrated parameters, but the model includes very fast and very slow parts. Other example is a system where discrete parts interact with continuous sub-models of different speed and different kind, for example an electronic circuit that contains integrated circuits as well as electro-mechanical parts such as relays and motors. Other example is a model that has a discrete part (e.g. queuing) and a continuous process that interact between them. In other words, the model complexity has little to do with the model size.

The main concepts of CSS are objects (sub-models) and model coupling. To define a component of a model, the user defines the component type and the number of instances (objects) to be generated according to the model type. The objects appear on the screen as blocks. For each block the user defines its inputs, outputs and parameters, if any. The inputs and outputs are shown on the model scheme inside the blocks. They can be connected to each other with links, using the mouse. Then, the model can be stored, updated, coupled into a new model type or converted into a PASION program and run.

The model coupling is carried out according to the DEVS (Discrete Event Specification) coupling concepts. This feature is useful while creating complex models

The sub model types supported by CDSS are defined by the PASION process declarations. In particular, these can be provided in any of the following forms:

- **Differential Equations (ODE Models)** - model described by a set of ordinary differential equations.
  ODE models can be programmed by the user directly in PASION or created by the Signal Flow Diagram module (FLOWD) - model described by a Signal Flow Diagram (Signal flow diagrams or block diagrams), BODW module (models given in the form of bond graphs), or by the DIFEQ module, which requires only the set of ordinary differential equations.
 Note that the FLOWD tool can also handle any model given in the form of a **transfer function**, being a FLOWD block or link (if the signal flow diagrams are used).
- **Queuing models** - generated by the QMGW queuing model generator.
- **Coupled CSS** models, created in a previous CSS sessions.
- And finally**, any** other **process type**, coded by the user.

CSS can retrieve sub-models from the Model Library. This library is a file that contains a series of PASION processes.

Simple useful processes as the first and second order inertial processes, **an integrator, sample-and-hold, PID controller, function generator** and others are provided in the library. The user can create and add his own processes to the library.

After defining a complex model, the corresponding PASION program is generated, translated to Pascal, compiled and run. All types of standard PASION result presentation and analysis can be carried out, including the dynamic variance analysis.

PASION ANIMATOR
Animation for queuing models in 3D scenarios

This module includes a Scenario Editor and Animator. The user defines a set of small icons that represent the model entities, a three-dimensional scenario and a set of routes for the entity movements. Then a simple set of procedure calls make the icons move within the scenario.

Scenario Editor. This tool permits to create 3D scenarios. It is a drawing object-oriented tool. The scenario is composed using a set of simple geometrical figures. The entity routes are defined on the scenario. The program also determines the route visibility. The scenario can be seen from different angles (see fig. 6 for an example.

Figure 6: PASION animation layout, driven by the queuing simulation module QMGW.

Using Paintbrush or similar tool you can create your own set of small icons (those are *.BMP and not *ICO files).

Some icons like MAN, WOMAN, CAR, PLAIN etc. are already defined and provided on the PASION disks. The ANIMATOR displays the scenario and puts and moves the icons over the scenario, according to the PASION source code.

PASION ANIMATOR can work with the QMGW (Queuing Model Generator) module. QMGW generates automatically the source code with animation instructions. The user only defines the scenario and the entity routes for his QMGW queuing model, and the ANIMATOR makes the rest automatically.

ODE Models editor DIFEQ

PASION offers code generators for models described by block diagrams, signal flow graphs and bond graphs. This means that most of the continuous models need no programming and even no mathematics provided by the user.

Creation of model equations as well as code generation is done automatically. However, sometimes the user prefers to use his own equations to describe the model dynamics. The DIFEQ module can help in creating the PASION code for **ODE (Ordinary Differential Equations)** models.

The input to DIFEQ is given by four sets of specification data: additional process attributes and Pascal declarations, auxiliary operations (performed each time before the right-hand sides of model equations are evaluated), model equations (given by the right-hand side expressions) and output operations.

DIFEQ can invoke, from its main menu, the other continuous simulation PASION modules, like FLOWD (Signal Flow/Block diagrams) and BONDW (Bond graphs). DIFEQ generates PASION code that can run in the following simulation modes:

- Simple simulation run - generates a complete PASION program that provides the plots of selected output variables as functions of time
- Varying parameter - a series of trajectories is integrated, where a selected parameter is changed in given interval. The results are shown as 2D and 3D plots.
- Preparing files for VARAN. While running in this mode, the target simulation program repeats the simulation several times. The corresponding trajectories are stored on disk, for further statistical analysis. This mode is used for stochastic models. As the result, various statistics, like variance, confidence intervals etc. are shown as **functions of time.**
- Process only - encapsulate parameters. This creates a PASION process declaration, which is "self-sufficient". This means it has the parameters and initial conditions encapsulated in the code. Such process only needs to be created and activated to run. It is useful as a possible sub model for the CSS Complex System Simulator.
- Simple process only. A PASION process (not program) describing the model dynamics is created.

It should be noted that the PASION modules **FLOWD** and **BONDW** generate equation files that are processed by DIFEQ in the same way as the user-provided equations are. This means that *these modules can generate programs that can run in any of the above DIFEQ simulation modes.*

Bond Graph Simulator BGSW

BGSW is a part of the PASION simulation system. The main features of the BGSW program are:

- Bond Graph Editor. The model is created on the screen using a menu-driven easy-to-use graphical editor (see figure 7).
- No causalities are needed. BGS can verify the user causalities or impose its own causalities on the user model.

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- Non-linear dependencies can be used describing source nodes or special user-defined non-linear graphs.
- BGSW generates a set of differential equations for a given model. The equations appear on the screen. If accepted by the user, these equations are used to automatically generate the corresponding PASION code.
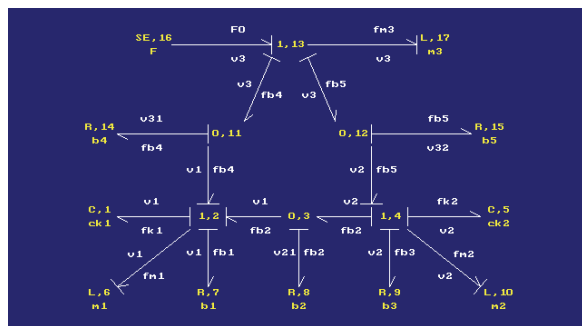
Figure 7: Example of a bond graph model with PASION BSGW

Stochastic systems can be analyzed using mechanisms of the PASION environment. After storing a set of system trajectories, the variance, confidence intervals etc. can be given as functions of model time, showing useful statistics of transient processes (analysis done by the VARAN utility).

BGSW generates model equations and invokes the DIFEQ module that does the rest of the job. Consult the **DIFEQ** program summary for possible simulation modes executed by the target program.

Signal Flow Diagrams - FLOWD

FLOWD is a part of the PASION simulation system. It accepts models given in the form of signal flow graphs or Block diagrams.

The output from FLOWD is a *.EQU file that contains the set of differential equations that describe the model dynamics. The equations are generated automatically with all necessary auxiliary declarations and operations.

The *.EQU file can be processed by the DIFEQ module of the PASION system, then translated to PASCAL (using the PATW PASION-to- PASCAL translator), compiled by the Delphi compiler and run. If you enter DIFEQ module first and run FLOWD from it, then all these operations are executed automatically. See the DIFEQ manual or help for more detail concerning the processing of the differential equations and running the executable simulation program.
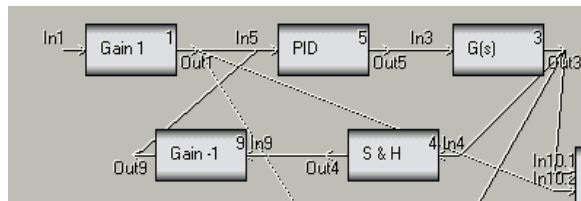
Figure 8: A fragment of a FLOWD block diagram example

The main features of FLOWD are:

- Signal Flow Graph and Block Diagram Editor. The model is created on the screen using a menu-driven easy-to-use graphical editor for signal flow diagrams or block diagrams.
- Link or block types may be as follows: linear static, non-linear static, dynamic, sample-and-hold, delay, PID controller and a submodel (superlink). See figure 8 for an example.
- Input signals may be defined by the user as Pascal functions, or taken from the FLOWD menu of input signals.
- FLOWD generates a set of differential equations for a given model. These equations are used to generate the corresponding PASION process declaration or a complete PASION program.

Stochastic systems can be analyzed using mechanisms of the PASION environment. After storing a set of system trajectories, the variance, confidence intervals etc. can be given as functions of model time, showing useful statistics of transient processes. FLOWD generates model equations and invokes the DIFEQ module that does the rest of the job.

More information can be found at the PASION web page: www.raczynski.com/pn/pn.htm

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JBSF - Java Block Simulation Framework

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…. introduces simulation with JBSF, a JAVA-based object oriented block simulation framework.
…. describes JBSF's role and phase concept, its architecture and the main building blocks.
…. provides a walk through a complete simulation phase cycle.

Introduction

The JBSF (Java Block Simulation Framework) is an event-based free-ware block simulation environment. It provides the possibility to develop simulations, composed of so-called simulation objects. These objects act as real system substitutes, performing the behaviour of the modelled system in their state machines. Different simulation objects can be added to a simulation and afterwards, they can be connected together in a flexible manner at run time. This guarantees the maximum possible modularity. A clear defined role and phase concept and intuitive as well as self-explaining framework interfaces provide a simple simulation creation. Finally, the usage of the Java technology 0 enables a platform independent usage as well as an application over the Internet as applets.

The remainder of the document is organized as follows. The next section explains the role and phase concept of JBSF. It defines the three different developer roles and outlines the four simulation phases. Section 3 provides a closer description of the architecture of the simulation framework and describes its single elements. Section 4 walks through the four simulation phases in detail. Sequence diagrams shall enable an easier understanding of the ongoing interactions. The document ends with a summary and an outlook to the next steps of the JBSF development.

Role and Phase Concept

JBSF separates the process of the development of the simulation environment, the process of the development of the simulation objects and the process of the simulation. Therefore, different persons can perform all these tasks.

- Simulation object developer: the person, who implements simulation objects.
- Simulation developer: the person, who defines all important aspects of the simulation like the objects involved, the way they are connected together or the simulation object properties used for simulation object initialisation.

- He/she is totally free in choosing a proper modelling concept. A commonly used possibility might be a modelling with event graphs 0 0.
- Simulation framework developer: The person, who implemented the simulation Framework.
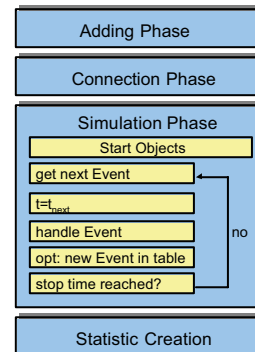
Figure 1: JBSF phase concept

The JBSF relies on a clear structured phase concept, strongly influenced by its event-based nature. Figure 1 gives an overview to this concept. The different phases can be described as follows:

- Adding phase: process, in which the simulation developer adds objects to the simulation. Here, object properties can be assigned to each simulation object in a generic way.
- Connecting phase: process, in which the simulation developer connects simulation objects together. The connect commands are verified by the simulation framework and in case of success the connection is stored. All object outputs and inputs have to be connected before this phase ends.
- Simulation phase: process, in which at first each simulation object is enabled to come into an initial state and to put some future events into the so called event table of the simulation framework. When all objects are called in this way, the first event in the event table is processed. Hereby, the, in this entry designated, simulation object is invoked to process the event. Maybe, it stores new events in the event table. In this way, the event table is walked through until the simulation stop time is reached.
- Statistic creation phase: process, in which each simulation object gets the possibility to make statistics persistent in a simulation object programmer defined way for further analyses. Statistic is used here as a common term for each kind of information, generated by the simulation objects during the simulation.

Section 4 provides a more detailed description of the different phases.

Architecture of the JBSF

In this section the general architecture of the JBSF is described. It shall provide an understanding of the involved components, their relations and interconnections and the software package organization.

Figure 2 shows the overall architecture of the JBSF simulation environment. The single elements can be described as follows:

- SIMMAN: interface definition, useable for the simulation developer from the main routine of the simulation. The methods, offered in this interface, enable to add simulation objects, to connect simulation objects, to add simulation object properties, to start the simulation and to set the log level of the simulation.
- SIMFrame: interface definition, useable for the simulation object implementations. The methods, offered in this interface, enable the simulation objects to perform their event behaviour.
- SIMMANAGER: implements the SIMMAN and the SIMFrame interface. It is the most important part of the simulation environment and the contact point of simulation developer, simulation object developer and simulation framework developer.
- Event table: data structure used to store all the events. It is necessary on the one hand, to have the possibility to walk sequentially through the table. On the other hand insertion and removing should also work very efficiently. Therefore a TreeMap (see jdk 1.3.1) 0 0is used.
- Event table manager: entity that maintains the event table. It adds and removes events to and from the table and observes the simulation stop time.
- Object table: repository to store simulation objects, added by the simulation programmer in the main routine. The object table maintains simulation object ID's and all connections between simulation objects.
- Object table manager: entity that maintains the simulation object table. It adds objects to the table and it maintains connection matrices for checking errors on connection. Moreover, it performs tasks like inviting all simulation objects to the simulation phase calling their start method or inviting all simulation objects the statistics creation phase.

- Simulation object: a simulation component, developed by the simulation object developer, which behaves like the real system component in all, for the simulation relevant aspects. It has to be derived from an abstract java class named SIMObj. This class already implements the, for the interworking with other simulation environment components required functionalities like simulation object interconnection or initialisation. Other functionalities like the simulation object reaction on specific events, the start phase of the simulation or the way statistics are made persistent have to be implemented by the simulation object developer.
- Simulation object input port: facility of each simulation object acting as receiver, either for packets existing in the real system as well or only for simulation information exchange packets. It provides functionality for interconnection to output ports as well as a First In First Out (FIFO) buffer for incoming packets and the possibility for the owning simulation object to set a notification trigger, requesting an information on packet arrival. Each port has to be connected exactly to one other port.
- Simulation object output port: facility of each simulation object acting as sender, either for packets existing in the real system as well as for simulation information exchange packets. It provides functionality for interconnection to the corresponding input port as well as the possibility to transfer the packet to this input port of the receiver simulation object. Each port has to be connected exactly to one other port.
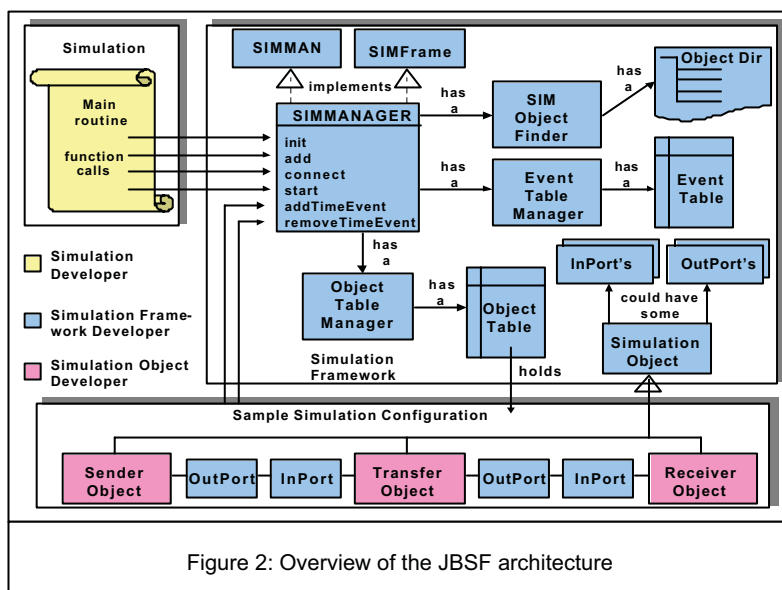

Figure 2: Overview of the JBSF architecture

- SIMObjectFinder: maintains an object directory, containing all available simulation objects.
- Simulation framework: consist of the SIMMANAGER, implementing SIMFrame and SIMMAN interfaces, the Event Table with its corresponding table manager, the object table with its corresponding table manager and all other functionality, the simulation object developer or the simulation developer can use to perform the requested behaviour.

Phase Scenarios

As mentioned in section2, the simulation is a sequence of different phases. These phases are described in the following sections using sequence diagrams for a better understanding of ongoing interactions between the involved simulation framework components.

Adding phase

In the adding phase the simulation programmer can add each simulation object existing in the object directory.

As can be seen in Figure 3, he calls SIMMANAGER's add method with the name of the simulation object and optionally, if the simulation object requires, a simulation object properties object.

Furthermore, the numbers of input ports and output ports have to be provided. The simulation object is found, instantiated and stored in the object table by the object table manager.

At initialisation time of the simulation object, the in-ports and the out-ports are created and initialised as well. Furthermore, at this point of time, the properties are delivered.
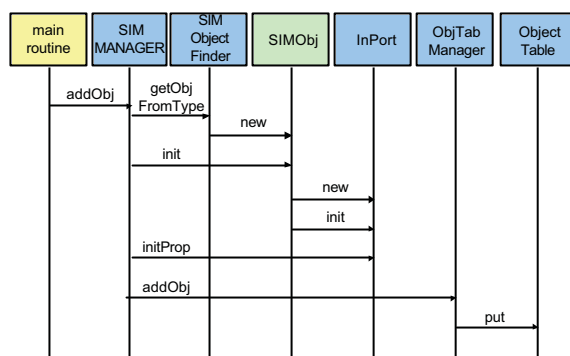
Figure 3: Adding phase of a simulation

Connection phase

In the connection phase the simulation programmer has the possibility to connect simulation object output ports with simulation object input ports. This is provided by SIMMAN's connect method, implemented by the SIMMANAGER.

The connect functionality is performed mostly by the object table manager, which at first gets the corresponding entries for the simulation objects and is therefore able to prove in their connection matrix, whether such a connection is possible or not.

If yes, the connection matrix is adopted, and the simulation objects are linked together calling the connect method of the sender simulation object. This function call is passed through its out-port to the receiver simulation object and its in-port.

Simulation phase

As can be seen in Figure 4, the simulation phase begins with the start command of the SIMMANAGER, called by the main routine of the simulation.

The SIMMANAGER forwards the call to the object table manager, which calls the start method of each involved simulation object.
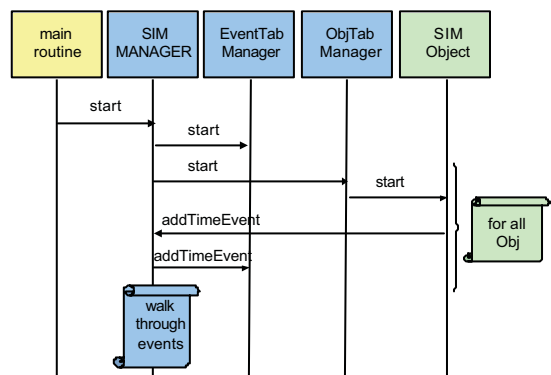
Figure 4: Simulation phase of a simulation

That gives them the possibility to get initial state as well as to add time events to the event table, calling the addTimeEvent method of the SIMMANAGER.

The event could be designated to the calling simulation object or to any other object in the simulation. The event is stored in a data structure called tree map, maintained by the event table manager.

The tree map provides both, a sequential walk-through as well as fast search and insertion.

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Simulation iteration

The simulation iteration consists of getting the next event from the event table using the event table manager and to call the handle event method of the designated simulation object, where some simulation object specific behavior is performed.

In many cases, the simulation object will add another event to the event table, calling addTimeEvent of the SIMMANAGER (see Figure 5).
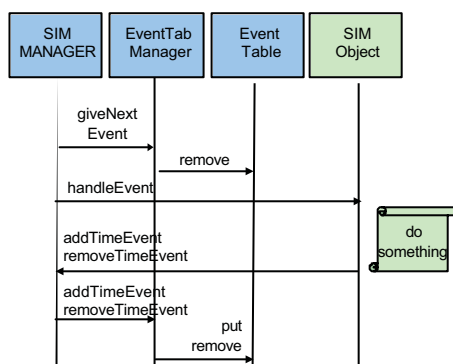
Figure 5: Simulation iteration plus adding new event

Statistic creation

At the end of the simulation, the SIMMANAGER forces the object table manager to call the createStatistic method of each involved simulation object.

This enables the simulation object developer to store the statistic, created by this simulation object, in a simulation object dependent way. See Figure 6 for the corresponding sequence diagram.
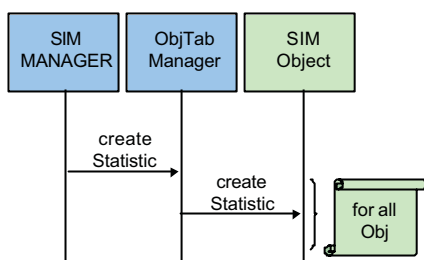
Figure 6: Statistic creation phase of a simulation

Summary and outlook

We have seen a flexible and modular block simulation environment, applicable for event-based simulations. The Java technology enables a platform independent usage as well as an application over the Internet.

The simulation framework itself bases on both, well-defined role and phase concepts. Therefore, it clearly distinguishes the roles simulation developer, simulation object developer and simulation environment developer. Furthermore, simulations are performed in an intuitive phase sequence.

The framework offers two interfaces, one for the development of simulations and the other for the interaction with simulation objects. Both are easy to understand and self-explaining. The environment uses special java classes for event and object tables to provide maximum on performance.

Further steps in the development of the JBSF environment are the implementation of a proper graphical user interface for a faster and easier simulation creation and the development of libraries for typical application cases.

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Automatic Generation of Dynamic Models in Mathcad® illustrated with a Hydraulic Servo Valve

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…. sketches modelling, simulation and analysis of a hydraulic servo valve.
…. makes use of Mathcad and Vissim for this purpose.
…. Introduces into Mathcad toolboxes for identification and modelling in hydraulics.

Summary

Taking a hydraulic servo valve as an example this paper explains how dynamic models may be generated automatically from measured data. The resulting model description consists of a set of differential equations including all parameters. This model may be used for further analysis directly in Mathcad® or in VisSim™ as one simulation component for overall system simulations (e.g. vehicle dynamics, hydraulic power unit dynamics, etc). For finding/calculating the models it's crucial to gain the solution easily and as fast as possible. Therefore, some major requirements are key: (a) no need for programming, (b) no need to know about the theoretical background underlying the modeling task and (c) documentation may not consume extra time.

All these requirements are fulfilled by Mathcad because of its worksheet based environment being identical to the development document and providing a lot of engineering functionality without any need for programming.

0. Modelling of Dynamic Systems

Dynamic models allow getting deeper insight into the behavior of dynamic systems. They are prerequisite for detailed system analysis and simulations in order to avoid building many prototypes and testing. The benefits are manifold; some of them are industry specific, some application specific.

In any case they include: increasing product quality, providing advanced functionality, reducing time to market and gaining competitive advantages.

The paper presented here focuses on hydraulic systems. They may be considered as typical examples engineers are facing during their work in industry. It will turn out that transfering the automatic modeling procedure based on measurements to other application areas is easy to manage.

1. Typical Hydraulic System Setup for Position Controlled Cylinder Drives

Hydraulic components and systems are widely used in industry for various purposes. One typical setup for position controlled cylinder drives is shown in Figure 1.
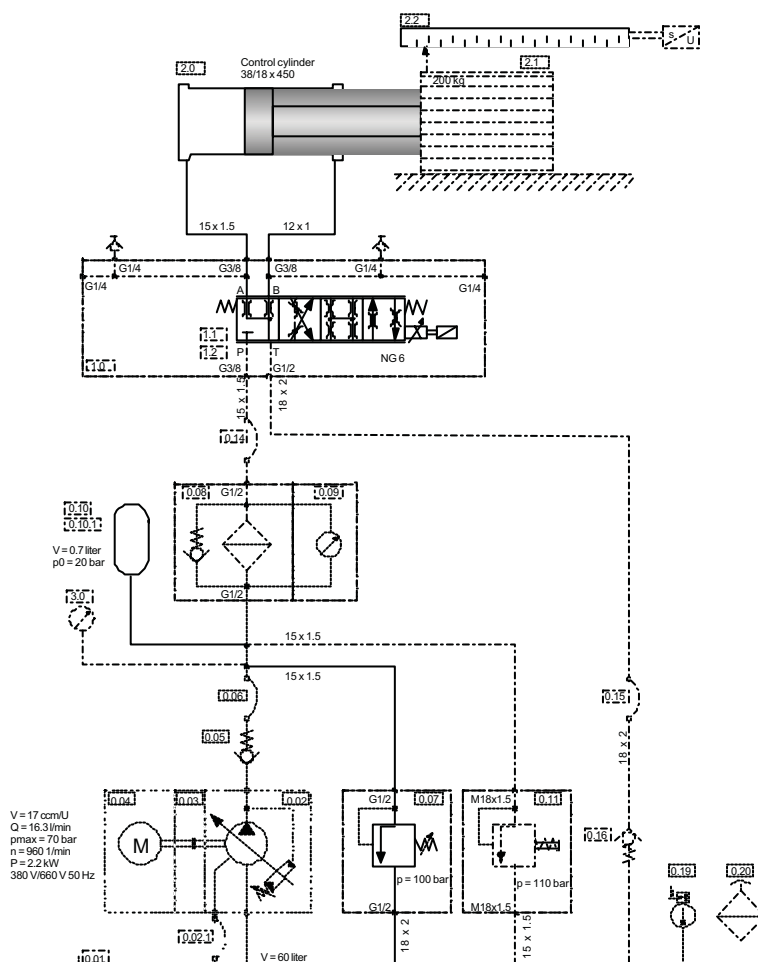

Figure 1: Hydraulic circuit diagram for a position controlled cylinder drive

SHORT NOTES

In position controlled cylinder drives, servo valves constitute key components as they control the oil flow to and from the main cyclinder. The positioning precision/quality is highly dependent on how the servo valve gets commanded to open and close the oil flow. In order to gain high quality, dynamic models are needed which describe the servo valve behavior sufficiently. Consecutive analyses and simulations have to be carried out to derive the appropriate control strategies. However as space is limited here, this paper only describes the steps on how to get the dynamic behavior from measured servo valve data.

1.1 Servo Valve Despcription

The servo valve model describes the resistance behavior and switching time response of a 4/3 servo valve (resistance bridge) assuming a 2nd order dynamic behavior of the spool movement. This valve has four control edges. The model description is based on the Δp-Q characteristic and the y-Q characteristic of the control edge.
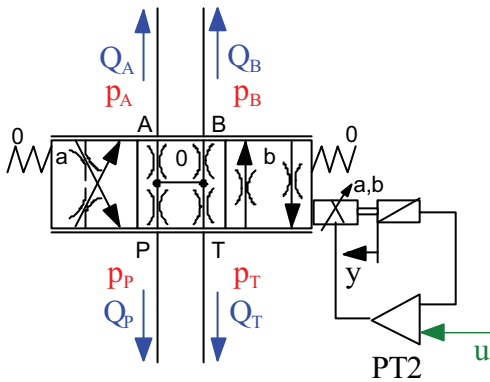
Figure 2: Model for the spool movement

The dynamical behaviour applies to the spool movement (figure 2) in dependence on the input signal (figure 3):

$$T_2 \frac{d^2 y}{dt^2} + 2DT_2 \frac{dy}{dt} + y = \frac{y_{max}}{u_{max}} u$$

The spool path is limited according to

$$y_{gr\,min} \leq y \leq y_{gr\,max}$$

$$y_{max} = \max\left(\left|y_{gr\,min}\right|, \left|y_{gr\,max}\right|\right)$$

The open/close speed of the spool is limited to:

$$-\frac{y_{max}}{T_{close}} \leq \frac{dy}{dt} \leq \frac{y_{max}}{T_{open}}$$
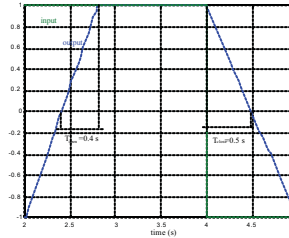
Fig. 3a: Large range signal dynamics; Response time: T_{open}=0.4 s, T_{close}=0.5 s, T2=0.02 s, D=0.4
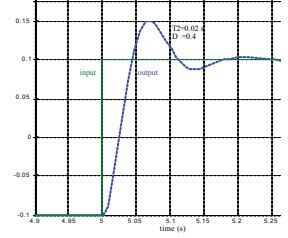
Fig. 3b: Small range signal dynamics: Response time: T_{open}=0 s, T_{close}=0 s, T2=0.02 s, D=0.4

The following equations apply to the resistance description of the control edges:

$$\Delta p_{PA} = p_P - p_A \qquad Q_{PA} = f_{PA}(y) \cdot f_{PA}(\Delta p_{PA})$$

$$\Delta p_{PB} = p_P - p_B \qquad Q_{PB} = f_{PB}(y) \cdot f_{PB}(\Delta p_{PB})$$

$$\Delta p_{AT} = p_A - p_T \qquad Q_{AT} = f_{AT}(y) \cdot f_{AT}(\Delta p_{AT})$$

$$\Delta p_{BT} = p_B - p_T \qquad Q_{BT} = f_{BT}(y) \cdot f_{BT}(\Delta p_{BT})$$

Different computation methods are needed depending on the parameter input. Details may be found in literature.

1.2 Servo Valve Measurements

Measurements are taken from a servo valve being used in an industrial environment having a hydraulic system setup like the one shown in Fig 1. While the whole hydraulic system is working, the input voltage at servo valve and the position output are captured and saved in a file (see Figure 4: servovalve.dat) to make this data available for further processing.

Measurement noise as can be seen in Figure 4 is quite common. Noisy signals usually challenge traditional modeling algorithms or make it even impossible to get high quality models. On the other hand, noise reduction means are considered costly and therefore industry tries to avoid these additional efforts. When using IDCON for this task together with Mathcad, these problems are overcome and the desired model may be gained easily. This is due to the powerful and advanced modeling algorithms provided by IDCON which can work even with strong noisy signals.

The modelling steps are described in the following.

2. Automatic Modeling in Mathcad Using IDCON Classic

The following Figures 4 - 7 show the Mathcad worksheet for IDCON Classic. This worksheet includes all GUIs needed to calculate the desired model description and represents the documentation at the same time.
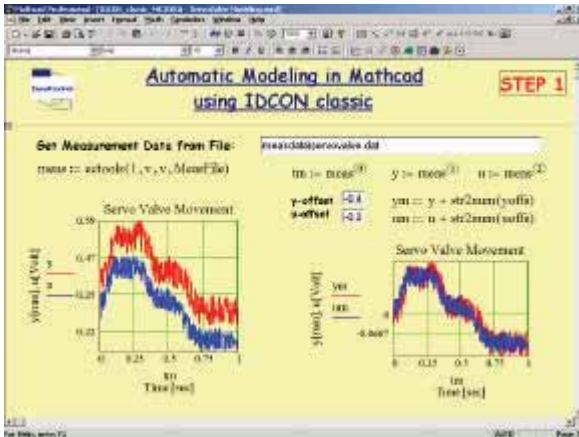
Figure 4: First step in the automatic modeling process

Figure 5: Steps 2 and 3 in the automatic
modelling process

Further analysis steps may follow now within Mathcad or in other tools. If the overall system simulation shall be considered as well, VisSim may be used for these purposes.

The next chapter gives an idea on how to put the model just generated by IDCON Classic into VisSim and do some verification simulation runs as an initial step before building the full hydraulic simulation model.

3. Simulating Overall System Dynamics with VisSim

VisSim is a *Windows-based* program for the modelling and simulation of complex dynamic systems. It combines an intuitive drag-and-drop block diagram interface with a powerful mathematical engine:

- The visual block diagram interface offers a simple method for constructing, modifying and maintaining complex system models.
- The mathematical engine provides fast and accurate solutions for linear, nonlinear, continuous time, discrete time, time varying and hybrid system designs.

These are key features needed for hydraulic simulation applications.

As already mentioned the first step in hydraulic system design involves the creation of a plant model (see Fig 1). VisSim enables engineers to build plant models, from a first principles perspective, by simply selecting and connecting predefined function blocks. VisSim supports hierarchical design and allows users to create custom blocks in C, FORTRAN or Pascal.
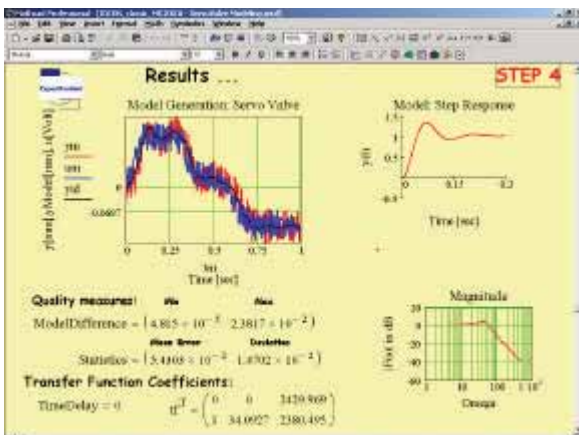
Figure 6: First step in the automatic modelling process – model is available now
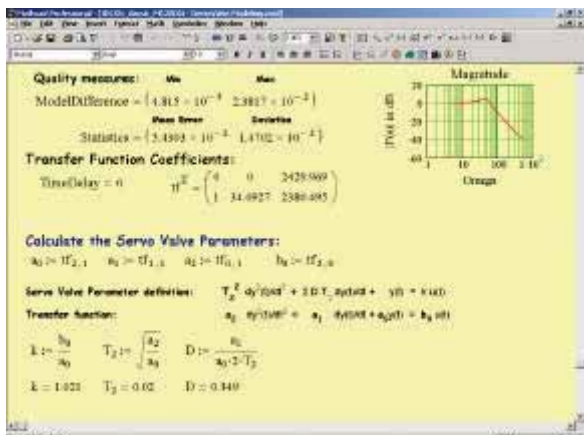
Figure 7: Final step in the automatic modelling process – calculate the servo valve characteristics
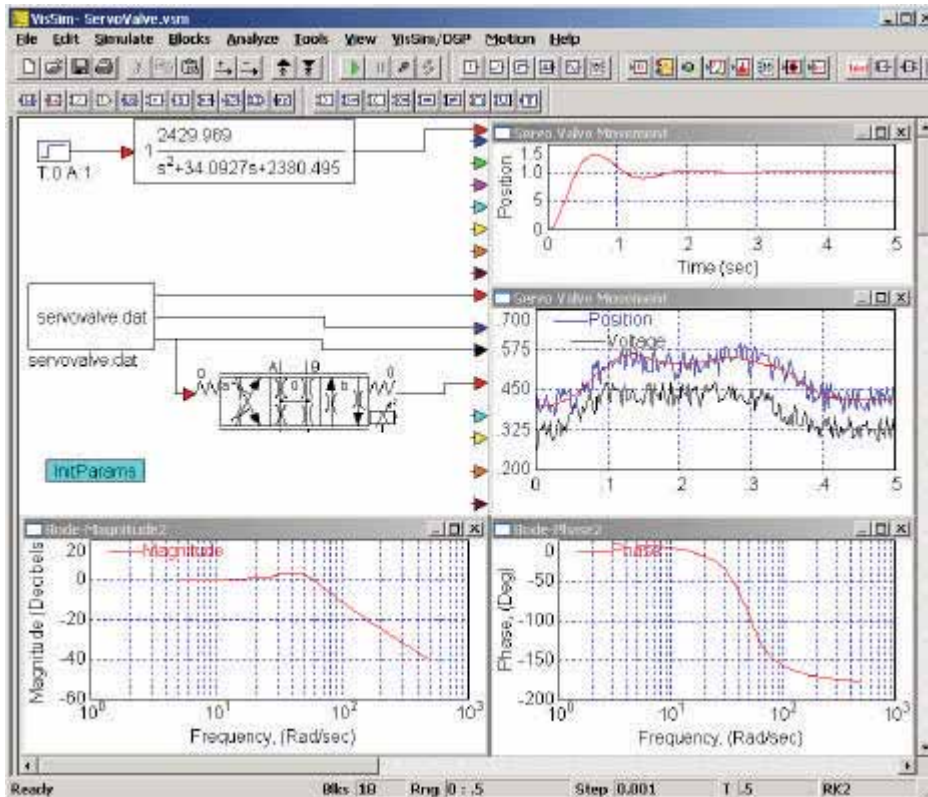
Figure 7:
Final step in the automatic modelling process –
calculate the servo valve characteristics

Once designed, the plant model is simulated to compare the plant model outputs to desired behavior. In VisSim, this is immediately visualized with plots, strip charts and other visualization blocks. In consecutive steps, the overall plant model can then be refined until the model accurately reflects the desired behavior (conforms to the actual plant or to specifications of the plant model). However, for the sake of space these steps are not shown in this paper.

After selecting the simulation parameters – for example start/end times and step size – the simulation run may be carried out. Fig 8 shows the results. Three categories of analyses are visualized at the same time:

1. Step resonse being identical to the modeling result depicted in Figure 6
2. Comparison of measured noisy signals of the servo valve and simulation results
3. Bode Diagram to analyze the servo valve's frequency response behavior with respect to magnitude and phase.

Conclusions

Software for generating dynamic models is gaining more and more importance.

In real industrial environments it's essential to build leading-edge and competitive products without necessarily knowing all theoretical details lying underneath the software packages used. IDCON Classic for Mathcad combines ease-of-use of a complex automatic modeling technology with all advantages and capabilites Mathcad provides. Using VisSim as an integrated part for complete system simulation magnifies the efficiency to gain deep insight into the system's dynamic behavior and derive development improvements from the analysis and simulation results.

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Hybrid Systems:
Glossary, Features, Software

www.robotic.dlr.de/control/cacsd/hds/

.... introduces the work of the Virtual Action Group on Hybrid Dynamic Systems
.... offers a glossary on terms of hybrid system simulation and modelling
.... Summarises necessary features of hybrid simulation software
.... presents a list of software tools for simulation, verification and specification of hybrid systems

The **Virtual Action Group on Hybrid Dynamic Systems** is running a website, which intends to provide a convenient entry point into the world of combined continuous/discrete modelling and analysis.

In the following some contents of this site are summarised: a hybrid systems glossary, necessary software features for simulation of hybrid systems, and a list of hybrid systems software

Hybrid Systems Glossary

This page contains terms as used in hybrid systems literature and their definition. If you have any additions, changes or comments, please send an email to pieter_j_mosterman@mathworks.com

automata

hybrid automata	Automata that may contain differential equations in the discrete states.
I/O automata	Automata where connections between sub-systems define input/output relations.
Linear hybrid automata	Automata where the continuous components can change only linearly, and all terms used must be linear.
Rectangular automata	An automata with each continuous variable, x, being part of a differential inclusion, i.e., satisfying a differential equation of the form $a < dx/dt < b$, where a and b are rational constants.
Timed automata	Automata that may contain clocks in the discrete states. The value of a clock may be reset as part of a state transition action.

Bond graphs

hybrid bond graphs	Bond graphs that contain junctions that act as *ideal switches* and that are controlled by local finite state machines.

Switched bond graphs	Bond graphs extended with an *ideal switch* element.
chattering	Repeated switching between two modes of continuous operation.
clock	A continuous variable that changes with a constant rate.
complementarity models	Models with a differential equation part and switching conditions of the form $x>=0, y>=0, x*y=0$. For example, used in multi-body dynamics to model contact constraints (either normal force, $N>=0$ and separation, $d=0$, or $N=0$ and $d>=0$).

event

state event	An event that is detected.
step event	An event that occurs at a completed numerical integration step.
time event	An event that has a time of occurrence that can be predicted.

event iteration	The processing of a sequence of consecutive discrete events.

hybrid

modelling	The modelling of a physical system by means of a hybrid formalism.
simulation	Behaviour generation of a hybrid system.
system	A model specified by a hybrid formalism.

ideal switch	Element with two constituent equations (in *complementarity* form), $x>=0, y>=0, x*y=0$, and *variable causality*.
impulse space	Space in which discontinuous changes in continuous state variables occur.
instantaneous equation	Equation that determines the posteriori value of a continuous variable at a discontinuity.
jump space	See *impulse space*.

SHORT NOTES

limit cycle	Behaviour that cycles through a sequence of modes in continuous time.
mode	A system configuration of continuous operation.
mythical mode	A mode that is entered with variable values that cause an immediate further mode transition.
Petri nets	
batch nets	Extend *hybrid Petri nets* with a new kind of batch places and batch transitions.
DAE-Petri nets	Focuses on the interaction between a Petri net model and a continuous model which is a set of Differential Algebraic Equations (DAE). It can be seen as an extension of *hybrid automata*.
differential Petri nets	Introduces the differential place (whose marking may also be negative) and the differential transition and can integrate all kinds of discrete Petri nets.
first-order hybrid Petri nets	Consist of continuous places holding fluid, discrete places containing a non-negative integer number of tokens, and either discrete or continuous transitions. The continuous flows have constant rates and the fluid content of each continuous place varies linearly with time.
fluid stochastic Petri nets	Extend stochastic Petri nets by introducing places with continuous tokens and arcs with fluid flow so as to handle stochastic fluid flow systems. No continuous transitions are present in this model.
high-level hybrid nets	Nets characterized by the use of structured individual tokens.
hybrid flow nets	Consist of a continuous flow net interacting with a Petri net according to a control interaction, i.e., the Petri net controls the continuous flow net and *vice versa*.
hybrid Petri nets	Consist of a "continuous part" (continuous places and transitions) and a "discrete part" (discrete places and transitions).
pinnacle	A point in behaviour evolution that is achieved in a mode that is only active at a point in time.
variable causality	Variables that dynamically change their character. For example, the variables of an *ideal switch* may change from input to output and *vice versa*.

Zenoness	Characterizes system behaviour that can reach and exceed any point in time. Non-Zeno behaviour may converge to a limit point, e.g., by advancing time over an interval of half the size of the previous interval. In Zeno's Paradox Achilles fails to catch a tortoise because every time he reaches its position, the tortoise has moved some as well.

Necessary Software Features

To validate the quality of the modelling and simulation environment that is developed, a number of hybrid simulation features have been identified that need to be addressed.

Simulation of continuous systems requires a number of model processing steps before the numerical integration can be started. Therefore, simulation of continuous systems requires the following steps to be taken:

1. *sorting:* Identify and sort the set of equations.
2. *solving:* Manipulate the system of equations (e.g., Pantelides' algorithm) to achieve an acceptable index.
3. *initial state calculation:* Calculate the initial value of the variables.
4. *numerical integration:* Solve the DAEs in time.

Simulation of hybrid system models needs to facilitate these and a number of other phenomena that may occur during run-time. Following comparison discusses each of these phenomena and presents an overview of state of the art simulation packages with regards to their simulation features.

Critical to hybrid systems is the interaction between continuous and discrete model parts. This is achieved by having the continuous model part generate *events* and the discrete part change real variables and boolean variables that indicate the *mode* of operation.

time events: In case of sampled data systems, events are generated at predetermined times which can be treated efficiently.

state events: If events occur because of system variables crossing threshold values, the time of their occurrence is not known. In this situation,

- the event needs to be *detected*, and
- its time of occurrence needs to be *located*.

simulation model: When the mode changes, the system of equations that describes model behaviour may change.

- Blocks of sorted and solved equation may simply appear (e.g., a vehicle entering a highway) or disappear (e.g., a tank that becomes empty contains no more fluid and no corresponding states) and, therefore, can be dynamically added/removed.
- In some cases equations can be replaced by others, which may require the system of equations to be sorted again.
- In other cases, algebraic constraints between state variables may become active and the system of equations needs to be solved again, i.e., the variables that are chosen as state variables may change. For example, when two capacitors are connected in parallel the independent variable values are collapsed into one new one.

reinitialization: In other cases, the system of equations may remain the same, but there is a discontinuous change in state variable values.

- This change may be explicitly specified by the user by a new initial state equation (e.g., bouncing ball).
- The system of equations may have to be integrated to derive physically consistent initial values for a new mode. This ensures conservation of the thermodynamic extensity holds.

event iteration: When one event occurs, the new system variable values may be such that an immediate further event is triggered, which requires event iteration. Two type of event iteration can be distinguished:

- the state vector is invariant across the entire iteration (e.g., a freewheeling diode)
- the state vector is updated after each iteration step (e.g., a sequence of colliding bodies)

Chattering: After event iteration terminates, continuous integration resumes but advancing behaviour over a very small time interval may again trigger mode changes. If these mode changes move the system back to its original mode and the same happens, the system starts to *chatter* between two modes. In case root finding is applied to find the exact mode switch time, continuous integration repeatedly applies its smallest time step and simulation becomes slow. An equivalence relation can solve this problem.

Dirac pulses: When discontinuous changes in continuous variables occur at discrete events, Dirac pulses may emerge. A Dirac pulse occurs at a point in time and has an infinite magnitude and given area. If these are numerically approximated their value may be affected by non-Dirac type variables. To ensure numerically precise treatment, Dirac pulses should be distinguished from non-Dirac signals and evaluation can be based on their areas.

		Chi	ABACUSS	BaSiP	DOORS	Dymola	gPROMS	HyBrSim	Omola	SHIFT	SIMULINK	Smile	20sim
DAE based		x	x		x	x	x	x	x		x	x	x
time events		x	x		x	x	x		x		x	x	x
state events	detection	x	x	x	x	x	x	x	x	x	x	x	x
	location	x	x	x	x	x	x	x	x		x	x	x
simulation model	add/remove	x	x	x	x	x	x	x	x	x	x	x	
	sorting	x	x		x	x	x	x	x			x	
	solving							x					
reinitialization	explicit	x	x		x	x	x	x	x	x	x	x	x
	integrate							x					
event iteration	invariant							x					
	update	x	x	x	x	x	x	x	x	x		x	
chattering													
Dirac pulses								x					

Hybrid System Software

The software classification is based on the primary focus of a package. For example, the Chi design system is listed as a specification package, but a simulation engine is also available.

Repositories

Mathtools is a technical computing portal for all scientific and engineering needs. The portal is free and contains over 20,000 useful links to technical computing programmers, covering MATLAB, Java, Excel, C/C+, FORTRAN and others.

Simulation

ABACUSS (Advanced Batch And Continuous Unsteady-State Simulator), developed for chemical engineering systems, supports hybrid models, model inheritance, hierarchical model decomposition. It facilitates guaranteed state event location, batch process simulation, solution of high-index differential algebraic equations, dynamic and steady-state optimization, and dynamic sensitivity and uncertainty analysis.

DAEPACK is a software library for general numerical calculations. It is divided into two major libraries: symbolic analysis and transformation and numerical calculation. The symbolic analysis and transformation library consists of components for analyzing general Fortran-90 models and automatically generating the information required when using modern numerical algorithms, e.g., (i) sparsity pattern generation, (ii) discontinuity locking, and (iii) automatic differentiation.

AnyLogic is a professional virtual prototyping environment. It enables you to rapidly build a simulation model of the system under development and its environment, including physical objects and human users. The modelling technology is based on UML-RT, Java, and algebraic-differential equations. AnyLogic offers a range of domain-specific libraries.

BaSiP is developed for simulation of recipe-driven production in complex multi-purpose batch plants.

DOORS allows setup of a prototype for a distributed real-time simulator, which supports design of mechatronic systems from modelling to hardware-in-the-loop testing.

Dymola provides a powerful object oriented modelling and simulation environment for education and the professional engineer.

gPROMS represents the state-of-the-art in process modelling, simulation and optimisation technology.

HYBRSIM is an implementation of a *hybrid bond graph* modelling and simulation tool. It embodies a set of physical principles that govern discontinuous changes in physical system models.

Model Vision 3.0 is an object-oriented environment for the design of large dynamic systems that features:
(i) Supporting B-Charts (UML-compatible statecharts integrated with differential equations) to specify hybrid behaviour,
(ii) Numerical methods from ODEPACK and Hairer-Norsett-Wanner collection,
(iii) Supports matrix and vector data types,
(iv) Includes standard device class libraries and enables the user to create his own,
(v) Animation libraries and wizards for rapid creation of animated sketches,
(vi) Generates complete portable Win32 and Java executable models supporting automation.

OmSim is an environment for modelling and simulation based on Omola. Omola is an object-oriented language for modelling of continuous time and discrete event dynamical systems.

SHIFT is a programming language for describing dynamic networks of hybrid automata. Such systems consist of components which can be created, interconnected and destroyed as the system evolves. Components exhibit hybrid behaviour, consisting of continuous-time phases separated by discrete-event transitions.

Smile is a simulation tool for energy systems. A ZimOO (an object-oriented specification language for hybrid systems in which continuous aspects are modelled by differential equations) specification of a simulation model serves as the basis for implementing the model in the simulation language Smile.

20-SIM ("Twente Sim") is a modelling and simulation program that runs under Microsoft Windows and Sun-Unix.

With 20-sim you can simulate the behaviour of dynamic systems, such as electrical, mechanical and hydraulic systems or any combination of these systems.

Verification

HyTech is an automatic tool for the analysis of embedded systems. HyTech computes the condition under which a linear hybrid system satisfies a temporal requirement. Hybrid systems are specified as collections of automata with discrete and continuous components, and temporal requirements are verified by symbolic model checking. If the verification fails, then HyTech generates a diagnostic error trace.

KRONOS is a tool developed with the aim to verify complex real-time systems. Components of real-time systems are modelled by timed automata and the correctness requirements are expressed in the real-time temporal logic TCTL. KRONOS checks whether a timed automaton satisfies a TCTL-formula.

MOBY comprises a graphical editor for (i) PLC-Automata, a formal description technique for real-time systems, (ii) SDL-Specifications, and (iii) Object Z-Specifications. These specifications can be used for model checking (based on timed automata) and (graphical) simulation (based on high level Petri nets).

Spin is a widely distributed software package that supports the formal verification of distributed systems. The software was developed at Bell Labs in the formal methods and verification group.

STeP, the Stanford Temporal Prover, is being developed by the REACT research group to support the verification of reactive, real-time and hybrid systems based on their temporal specification. STeP is not restricted to finite-state systems, but combines model checking with deductive methods to allow the verification such systems as parameterized (N-component) circuit designs, parameterized (N-process) programs, and programs with infinite data domains.

UPPAAL is a tool suite for validation and verification of real-time system modelled as networks of timed automata extended with data variables. The tools have WYSIWYG interfaces and features: graphical editing, graphical symbolic simulation and symbolic verification.

Verdict is the name of a software tool for formal verification of discrete controls for continuous processes, e. g. in continuous batch processes. Formal verification is a tool, which a mathematical prove, that a given control influences in any situation a certain technical process, so that the process obeys any a-priori given behaviour.

visualSTATE is a suite of tools, that supports you all the way through the software development process in an iterative and interactive specification process. You rapidly create a virtual prototype of an outline of your product that can be evaluated and validated against the specification.
visualSTATE automatically generates code for your target system and the Tester tools and techniques include interactive simulation, real-link for in-target testing and complete dynamic formal verification.

Specification

The Chi design system is a concurrent programming language based on the (Timed) CSP formalism. The Chi language can be used to express models of industrial systems. A model expressed in Chi is simulated using the Chi simulator.

The Compositional Modelling Language (CML) is a general declarative modelling language for specifying the symbolic and mathematical properties of the structure and behaviour of physical systems.
It intendeds to facilitate the construction and accumulation of sharable models of core engineering domains.

The Hybrid CC language is a compositional modelling language for physical systems. It started with Concurrent Constraint programming languages, which provide the fine grained concurrency desirable for compositionality.
They are very expressive, being built on top of arbitrary constraint systems, and are declarative. Each program is a logical formula, facilitating reasoning about the models.

HySC has been developed for the construction and analysis of safety-critical embedded hybrid systems. Additionally, it combines several tools like HyTech, FDR, MATLAB, Gnuplot, Graphviz and VVT-RT which are used at different stages of the system development queue: system specification and verification, further the animation and implementation of the system and finally the system test.

Virtual Action Group on Hybrid Dynamic Systems
www.robotic.dlr.de/control/cacsd/hds/

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Renal Clearance – Modelling and Identification

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…. sketches compartmental modelling for metabolic processes
…. Shows identification for a clearance process done by kidneys with experimental data in compartment model
…. suggest model clearance parameter as test value for clearance function (instead of pure experimental value given by data).
…. is basis for ARGESIM Comparison C15 – Clearance Identification (SNE 35/36, Nov. 2002)

The object of this study is to demonstrate a computer-based system identification of the constants of two-compartment models from experimental marker concentration profiles.

The data basis for this purpose are kinetic experiments using markers fulfilling some postulates, such as those of exclusive elimination by glomerular filtration and distribution in extra-cellular space without storage or metabolization in the tissues.

The following pictures show the object under investigation, the kidney (Figure 1 – Figure 3).
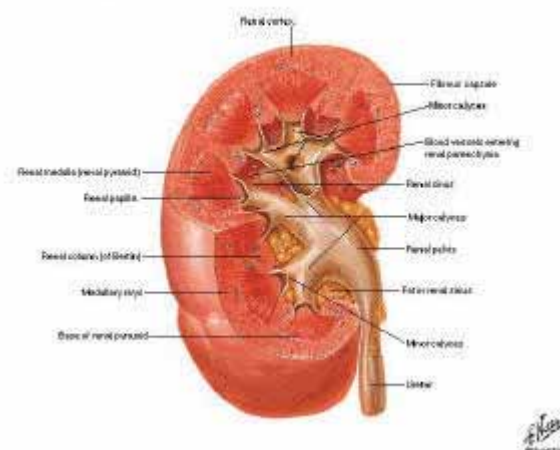
Fig. 1 Kidney section in several planes, modelled

A generalized solution of the dynamic problem comprising both single-injection and constant-infusion experiments is developed.

Fig. 2 Kidney section, real
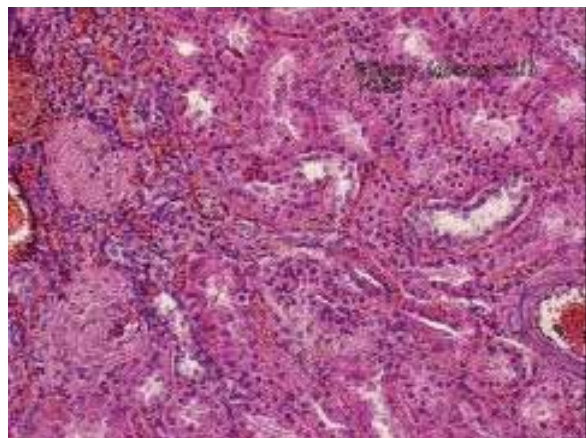
Fig. 3 Kidney, internal structure

In the model assumed as underlying the organismic marker distribution and elimination processes the extracellular space is considered to be composed of two functionally separated spaces, a well perfused central volume and a less perfused peripheral compartment. The marker kinetics as represented by the temporal courses of the marker amounts in the two compartments is the result of the infusion strategy, the exchange transports between the two compartments, and finally the renal elimination process (1,2,3).

The model can be formulated by a set of two simultaneous differential equations describing the rates of change of the marker amounts in the two respective compartments:

$$dx_1/dt = f(t) - (k_{01} + k_{21}) x_1 + k_{12}x_2 \qquad (1)$$

$$dx_2/dt = k_{21}x_1 - k_{12}x_2 \qquad (2)$$
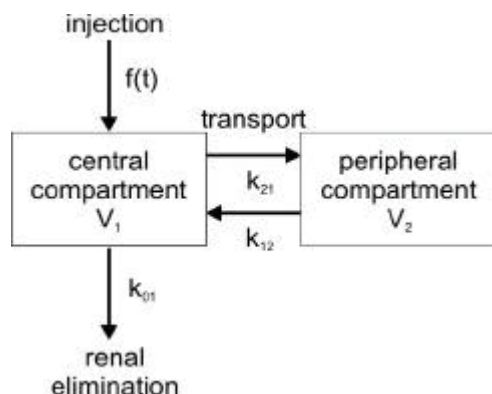
Fig. 4 Compartment model, formula (1) and (2)

Equations (1) and (2) can be stated verbally in the following way: Firstly, the rate of change of the marker amount in the central compartment, dx_1/dt, is determined by the input strategy chosen, the loss of marker from the central to the peripheral compartment, its gain by the central from the peripheral volume, and its elimination through the renal excretion mechanism. Secondly, the rate of change of the marker amount in the peripheral space, dx_2/dt, is due to gain from and loss to the central pool. These transport processes are assumed to be proportional to the marker amounts momentarily contained in the respective distribution volumes. The input function of an experiment consisting of a bolus injection followed by constant infusion is given by Equations (3) and (4☺

$f(t)=D/\tau,$ if $0 \leq t < \tau$ (3)

$f(t)=\rho,$ if $\tau \leq t < T_c$ (4)

The initial marker amounts are given by

$x_1(0) = c_1(0) V_1 = x_{10}$ (5)

$x_2(0)=c_2(0)V_2 = c_2(0)V_1(k_{21}/k_{12}) = x_{20}$ (6)

The fitting of the solution of the model defined by relations 1 to 6 to the experimental plasma concentration data measured over a sufficiently long time horizon can be done by a method for the search of the minimum of a criterion of the sort:

$E= \sum (c_1(t_i) - c_{exp}(t_i))^2,$ $(i = 1...n)$ (7)

The identification of the model is most efficiently done with the Levenberg-Marquardt algorithm (4-7) allowing one to estimate the optimal values of the independent system parameters k_{01}, k_{21}, k_{12}, and V_1 as well as of dependent parameters such as V_2, the clearance $C_{INU} = k_{01}V_1$, the permeability time constant $t_{21} = \ln(2)/k_{21}$ etc.

The exact solution of the model formally described by expressions (1) to (6) generalized to both single-injection and constant-infusion inputs is given by a superposition of the solution of the eigenvalue problem posed by the corresponding homogeneous system and the particular solution of the inhomogeneous problem which can be found by the method of undetermined coefficients.

Expressions (9) to (28) constitute the exact solution of the model described.

$\lambda_1 = - \frac{1}{2}((k_{01}+k_{21}+k_{12})-((k_{01}+k_{21}+k_{12})^2 - 4k_{01}k_{12})^{1/2})$ (9)

$\lambda_2 = - \frac{1}{2}((k_{01}+k_{21}+k_{12})+((k_{01}+k_{21}+k_{12})^2 - 4k_{01}k_{12})^{1/2})$ (10)

$a = (k_{01}+k_{21}+\lambda_1)/k_{12}$ (11)

$b = k_{21}/(k_{12}+\lambda_2)$ (12)

$x_{1s} = (D/\tau)/k_{01}$ (13)

$x_{2s} = x_{1s}(k_{21}/k_{12})$ (14)

$y_{1s} = \rho/k_{01}$ (15)

$y_{2s} = y_{1s}(k_{21}/k_{12})$ (16)

$M_1 = ((x_{10}-x_{1s})b-(x_{20}-x_{2s}))/(b-a)$ (17)

$M_2 = ((x_{20}-x_{2s})-(x_{10}-x_{1s})a)/(b-a)$ (18)

$x_{1\tau} = M_1 \exp(\lambda_1 t)+M_2 \exp(\lambda_2 t)+x_{1s}$ (19)

$x_{2\tau} = M_1 a \exp(\lambda_1 \tau)+M_2 b \exp(\lambda_2 \tau)+x_{2s}$ (20)

$N_1 = ((x_{1\tau}-y_{1s})b-(x_{2\tau}-y_{2s}))/(b-a)$ (21)

$N_2 = ((x_{2\tau}-y_{2s})-(x_{1\tau}-y_{1s})a)/(b-a)$ (22)

If $0 <= t < \tau$:

$x_1(t)=M_1 \exp(\lambda_1 t)+M_2 \exp(\lambda_2 t)+x_{1s}$ (23)

$x_2(t)=M_1 a \exp(\lambda_1 t)+M_2 b \exp(\lambda_2 t)+x_{2s}$ (24)

If $\tau <= t < T_c$:

$x_1(t)=N_1 \exp(\lambda_1 (t-\tau))+N_2 \exp(\lambda_2 (t-\tau))+y_{1s}$ (25)

$x_2(t)=N_1 a \exp(\lambda_1(t-\tau))+N_2 b \exp(\lambda_2(t-\tau))+y_{2s}$ (26)

The temporal profiles of the concentrations $c_1(t)$ and $c_2(t)$ in their respective compartments are defined by relations 27 and 28:

$$c_1(t) = x_1(t)/V_1 \qquad (27)$$

$$c_2(t) = x_2(t)/V_2 \qquad (28)$$

The symbols in the expressions are:

f(t) the input strategy as a function of time t,

x_1 the amount of the marker in the central compartment,

x_2 the amount of the marker in the peripheral compartment,

k_{21} the relative rate of transport from compartment 1 to 2,

k_{12} the relative rate of transport from compartment 2 to 1,

k_{01} the relative rate of elimination,

D the priming dose,

τ the injection duration,

ρ the infusion rate,

T_c the duration of the constant-infusion experiment,

V_1 the volume of the central compartment,

V_2 the volume of the peripheral compartment.

Steady-state techniques generally need much more time for the establishment of stationary concentration values than is suggested by traditional clinical recipes. This is due to the difficulty in guessing the glomerular filtration rate from endogenous creatinine levels via a general statistical regression relation in the individual case.

This semiquantitative test function is inflicted with an extremely large spread; thus, at an endogenous creatinine level of 5 mg/100 ml as measured in the patient of figure 5 the estimates for the glomerular filtration rate range from 7 to 35 ml/min.

Figure 5 illustrates firstly the adaptation of the model described to experimental plasma concentration data of a clearance marker after a bolus injection of this marker and secondly the prediction of the model on the basis of the parameters gained and the given injection and constant-infusion strategy.

The difficulty to obtain correct clearance estimates by traditional clinical constant-infusion techniques can be deduced from equations (1) and (2) for the steady-state situation.
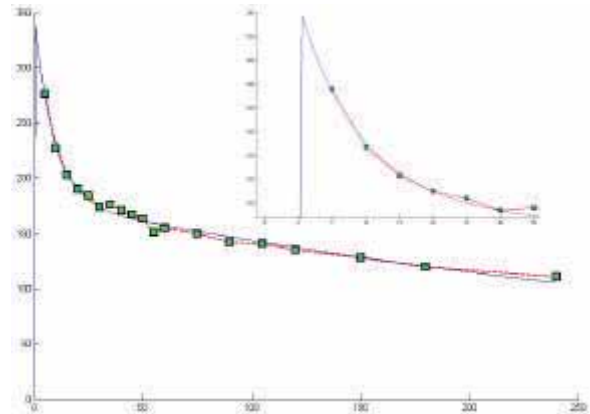
Fig. 5 Measured data and Identification results

In this case, i.e., for $t \rightarrow \infty$, dx_1/dt and dx_2/dt are both zero with $x_1 = x_1^*$ and $x_2 = x_2^*$ (x_1^* and x_2^* constants). Thus, two algebraic equations result:

$$0 = \rho - (k_{01} + k_{21}) x_1^* + k_{12} x_2^* \qquad (1')$$

$$0 = k_{21} x_1^* - k_{12} x_2^* \qquad (2')$$

Equations (1') and (2') combine result in the expression

$k_{01}c_1^*V_1 = \rho$ or Clearance $= k_{01}V_1 = \rho/c_1^*$. Thus, the recipe for traditional clearance determination is valid in the asymptotic case only!

Model-based adaptation of parameters to kinetic experiments as outlined appears especially of importance in assessment of renal functional reserve, i.e., in consecutive clearance determinations with dietary or pharmacologic loads in between [9].

Evaluation of acute dynamic changes in kidney function by traditional steady-state methods of GFR determination appears to be a mathematically too naive approach, despite its general acceptance as 'gold standard' for single clearance determination. By their nature, however, these methods require equilibration of marker concentrations between the different compartments, and therefore especially between marker influx and elimination.

As shown constant infusion methods for calculation of renal clearance are correct only over a long experimental time horizon. However, in clinical experiments time horizons are necessarily limited for practical reasons all the more so for the longer clinical protocols required for assessing experimentally induced changes in renal function. Thus the earlier dynamic test methods probably were either not sensitive enough or even inappropriate.

EUROSIM SOCIETIES

EUROSIM
Federation of European Simulation Societies

www.eurosim.info

EUROSIM, the Federation of European Simulation Societies, was set up 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. EUROSIM members may be regional and/or national simulation societies. At present **EUROSIM** has ten full members and three observer members:

- **ASIM** – Arbeitsgemeinschaft Simulation (Austria, Germany, Switzerland)
- **CROSSIM** – Croatian Society for Simulation Modelling (Croatia)
- **CSSS** – Czech & Slovak Simulation Society (Czech Republic, Slovak Republic)
- **DBSS** – Dutch Benelux Simulation Society (Belgium, The Netherlands)
- **FRANCOSIM** – Société Francophone de Simulation (Belgium, France)
- **HSS** – Hungarian Simulation Society (Hungary)
- **ISCS** – Italian Society for Computer Simulation (Italy)
- **SIMS** – Simulation Society of Scandinavia (Denmark, Finland, Norway, Sweden)
- **SLOSIM** – Slovenian Simulation Society (Slovenia),
- **UKSIM** – United Kingdom Simulation Society (UK, Ireland)
- **AES** – Asociación Española de Simulación (Spain; observer member)
- **PSCS** – Polish Society for Computer Simulation (Poland, observer member)
- **ROMSIM** - Romanian Society for Modelling and Simulation (Romania; observer member)

EUROSIM Board

EUROSIM is governed by a Board consisting of one representative of each member society, plus the organizer of the last and next EUROSIM Congress (past president and president), and of prepresentatives for the official EUROSIM publicatiosn (journals SIMPRA and SNE).

At the **EUROSIM'01** Congress the Board elected new officers for a three years period: Y. Hamam (president), L. Dekker (past president), M. Savastano (treasurer), P. Fritzson (secretary), J. Halin (SIMPRA), F. Breitenecker (SNE), F. Maceri (member).

The Executive Board met in June 2002 in Paris in order to discuss daily affairs and to prepare the Board Meeting (planned for winter 2002). At this occasion SLOSIM and ASIM presented their application for organisation of **EUROSIM'07** (suggested for Sept. 2007 in Slovenia).

EUROSIM Publication SNE and SIMPRA

SNE. EUROSIM societies are offered to distribute to their members the journal **Simulation News Europe** (**SNE**) as official membership journal:

www.argesim.org/sne/, www.eurosim.info/sne/

SIMPRA. Furthermore members can subscribe the scientific journal **Simulation and Modelling, Practice and Theory** (**SIMPRA**) at a significantly reduced price: www.elsevier.nl/locate/simpra/

Conferences, EUROSIM Congress

EUROSIM societies are organised national and international conferences and workshops, with the common trademark *EUROSIM Conference*, or *EUROSIM Event*, resp. For details please refer to the announcements of the member societies.

The EUROSIM Congress is arranged every three years by a member society of EUROSIM. **EUROSIM'01**, the 4th EUROSIM congress, took place in Delft, The Netherlands.

The next congress, **EUROSIM'04**, the 5th EUROSIM Congress, will take place in September 2004 in Paris (announcement see below). SLOSIM and ASIM have offered to organise the 6th EUROSIM Congress, **EUROSIM'07**, in Slovenia

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Congress Announcement
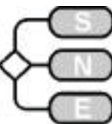
EUROSIM '04
5th EUROSIM Congress
Sept. 6-10, 2004, Noisy-le-Grand / Paris, France

More information about EUROSIM and EUROSIM societies may be found at EUROSIM's WWW Server. Due to technical reasons the web address of EUROSIM has changed to www.eurosim.info

For personal information about EUROSIM and about the congress EUROSIM'04 please contact the EUROSIM president, Mr. Y. Hamam.

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EUROSIM SOCIETIES

ASIM
German Simulation Society
Arbeitsgemeinschaft Simulation
www.asim-gi.org

ASIM (Arbeitsgemeinschaft Simulation) is the association for simulation in the German speaking area. ASIM was founded in 1981 and has now about 700 individual members, and 20 institutional or industrial members.

From the ASIM Board

Annual Meeting. During the ASIM Conference ASIM'2002 in Rostock, September 2002, about the members met for the annual meeting of ASIM. As usual reports about activities of ASIM and the working groups, of publications and finances were given. This year additionally the ASIM board was elected.

The following 8 members of the board were elected for the following three years:

- Felix Breitenecker, TU Vienna
- Rüdiger Hohmann, University Magdeburg
- Veronika Hrdliczka, ETH Zürich
- Markus Klug, ARCS Vienna / Seibersdorf
- Klaus Panreck, University Paderborn
- Thorsten Pawletta, University Rostock
- Peter Schwarz, FhG Dresden
- Sigrid Wenzel, FhG Dortmund

At the next meeting of the board (end of November / begin of December), the speaker and vice-speaker will be elected out of those 8 persons. Ingrid Bausch-Gall and Gerald Kampe, both longterm members of the board did not candidate any more.

Additional members of the board are all speakers of the working groups and members, which are specialists and a field and chosen by the current members.

At this meeting subjects like preparation of ASIM 2003, cooperation amongst the working groups, cooperation with other organizations, etc. will be discussed. Please contact the speaker, if you feel an important issue should be discussed there.

ASIM Publications

ASIM is publishing (co-publishing) **ASIM-Nachrichten** and **SNE** (Simulation News Europe). Both journals are regularly published and sent to all ASIM members (as part of their membership 700 issues) and spread for promotion (500 issues).

Furthermore, the ASIM working groups report in so-called **ASIM - Mitteilungen** about their meetings, about special developments, etc - either as ASIM self-publication or as publication is series of other publishers (e.g. **ARGESIM Reports**).

ASIM co-operates with SCS Europe and with **ARGESIM** (TU Vienna) in publication of two book series:

- ASIM / SCS book series „Fortschritte in der Simulationstechnik – Frontiers in Simulation"
- ASIM / ARGESIM / SCS book series „Fortschritts-berichte Simulation – Advances in Simulation"

For detailed information see advertisement in this SNE issue or go to ASIM's web server.

ASIM Promotion

ASIM is aware of the fact, that modelling and simulation has become a widespread method, which is not only found in simulation groups. Many application societies are running themselves successfully working groups on modelling and simulation. If in the German speaking area such groups in application societies exist, it makes no sense to set up a new ASIM working group with the same focus. It also turns out, that the smaller ASIM working groups are faced with such working groups in other societies.

As it makes no sense to reinvent the wheel again,

- ASIM intends to co-operate with such working groups on level of ASIM working groups,
- and ASIM will actively seek contacts with other societies and groups, **also at international level**.

Last year the first steps have been done. ASIM took part at the international Trade Fair and Knowledge Exchange on Applied Simulation and Visualisation SIM'2001, Freiburg / Breisgau, Germany, June 2001.

This event opened the doors to cooperation with people from CFD (computational fluid dynamics). Furthermore ASIM organised there a workshop on *Education in Simulation*. This co-operation will be continued during the **SIMPAT'2003** Trade Fair and Conferences, Nuremberg, Germany, Mai 13-15, 2003 (see announcement in this **SNE** issue).

ASIM - Buchreihen / ASIM Book Series

Reihe Fortschritte in der Simulationstechnik / Series Frontiers in Simulation – with SCS

kürzlich erschienen / recently appeared:

- Dj. Tavangarian (Hrsg.): Proc. 16. Symposium Simulationstechnik, Rostock, Sept. 2002K. Panreck, F. Dörrscheidt (Hrsg.): Proc. 15. Symp. Simulationstechnik, Paderborn, 2001
- W. Borutzki: Bondgraphen – Eine Methodologie zur Modellierung multidisziplinärer dynamischer Systeme;
- H: Szczerbicka, T. Uthmann (Hrsg.): Modellierung, Simulation und Künstliche Intelligenz
- S. Wenzel (Hrsg.): Referenzmodelle für die Simulation in Produktion und Logistik
- I. Bausch-Gall (Hrsg.): Simulation technischer Systeme – Stand und Entwicklungen

Schwerpunkte / Topics:

- Statusberichte über Simulation in den ASIM Fachgruppen / Status Reports
- Allgemeine Monographien / General Monographs
- Proceedings der ASIM Tagungen / Proceedings of Conferences

Reihe Fortschrittsberichte Simulation / Series Advances in Simulation – with ARGESIM / SCS

kürzlich erschienen / recently appeared:

- S. Pawletta: Erweiterung eines wissenschaftlich-technischen Berechnungs- und Visualisierungssystems zu einer Entwicklungsumgebung für parallele Applikationen
- Ch. Almeder: Hydrodynamic Modelling and Simulation of the Human Arterial Bloodflow
- Th. Preiß: Relationale Datenbanksysteme als Basis für Modellbildung und Simulation von kontinuierlichen Prozessen
- E. Hajrizi: Intelligentes Online – Planungs- und Steuerungssystem für Flexible Produktionssysteme basierend auf Simulation und Optimierung mit genetischen Algorithmen
- Th. Fent: Applications of Learning Classifier Systems for Simulating Learning Organizations

Schwerpunkte / Topics:

- Spezielle Monographien (Dissertationen, ...) / Special Monographs (PhD-thesis, ...)
- Erweiterte Berichte der ASIM Fachgruppentreffen / Workshop Proceedings
- Handbücher für Simulationssprachen, Berichtband / User Guides, Reports

Preis / Price: € 20.- (ASIM-Mitglieder € 15.-) + Versandkosten

Bestellung, Information, Informationen für Autoren / Info, Orders:

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Fax: +49-89-3231063, or online: info@asim-gi.org, www.asim-gi.org
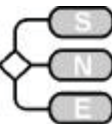
ASIM Working Groups

A discussion on working groups is taking place. While some working groups are very active and consequently have many members, some working groups attract only few people to workshops and cannot attend more members, due to various reasons.

The big working groups organise themselves workshops and conferences, and they cooperate with societies and groups of their application area, regionally and internationally. In order to promote ASIM, and in order to support the small working groups, ASIM will be present at some conferences of application areas and ASIM will try to contact groups or societies in the specific application area.

The bigger working groups (Methods, Technical Systems, and Production and Logistics...) cooperate with VDI/VDE and partly with other groups from GI (ASIM itself is a subgroup of GI, the German Society for Informatics). Cooperation with GOR (Society for Operation Research), with societies in area of biomedical engineering and with KI - groups of GI could provide support for the smaller ASIM working groups.

It is also discussed either to combine small working groups, or to put them as subgroup into a big working group.

ASIM Conferences

ASIM organises the annual ASIM Conference, the ASIM Working Groups organise workshops (up to 100 participants) and conferences (more than 100 participants). ASIM cooperates in organising the three-annual EUROSIM Congress.

ASIM and SCS Europe will continue the cooperation at conferences based on co-sponsoring of ESM and ESS conferences (but not of the many other conferences of SCS Europe BVBA). Some organisational problems are to be solved, e.g. the co-operation with local chairs and conference fees.

ASIM also supports other annual international conference series, the long-running series *SIMVIS Simulation and Visualisation* (Magdeburg, Germany), and the new series *Agent-Based Simulation* (Passau, Germany).

With respect to international simulation conferences, the board suggested again,

- that the competition of too many simulation conferences (especially how it happened around the EUROSIM Congress 2001 in June 2000) is contra-productive,
- that the EUROSIM Congress should be scheduled regularly in September (as from 1993 - 1995) in order to have more ASIM participants – and as it is planned for EUROSIM Congress 2004 in Paris,

- and that it would be of advantage to combine simulation conferences with conferences from application areas and / or to organise simulation conferences on the occasion of trade fairs

In order to support this plans, ASIM is willing

- to skip the annual ASIM conference in 2004, as the EUROSIM Congress EUROSIM'04 (Paris) takes Place in September,
- to co-operate with other EUROSIM societies in organising conferences: CROSSIM and ASIM have sent an application to the EUROSIM board for organising jointly the EUROSIM Congress 2007 in Slovenia,
- to organise working group meetings on the occasion of the SIMPAT Trade Fair and Conferences, and
- to continue this conference strategy for further years.

Because Modelling and Simulation is dealt with not only in ASIM and other simulation societies, ASIM will be present also at simulation tracks of conferences from various applications and on trade fairs.

Also the 2nd Call for ASIM'2003 is available, which will take place in September 2003 in Magdeburg.

ASIM will co-organise or participate at the SCS Conferences **ESS'2003** (Oct. 2003, Delft) and **ESM'2003** (June 2003) - please refer to www.scs-europe.org – and at the SIMPAT Trade fair and Conferences (May 2003, Nuremberg) – please refer to www.simpat.de.

Conference Announcements

4th MATHMODV Vienna
Workshop ASIM GMMS'02
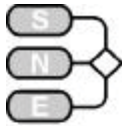
Feb. 5-7, 2003, Vienna

SIMVIS 2003

March 6-7, 2003, Magdeburg, Germany

Workshop ASIM STS 2003

Simulation of Technical Systems
March 11-13, 2003, Ulm, Germany

Workshop ASIM SKI 2003

Simulation and Artificial Intelligence
March 24-25, Berlin, Germany

EUROSIM SOCIETEIES

Workshop ASIM SUG 2003

Simulation in Environmental Systems
March 27-28, 2003, Osnabrück, Germany

SIMPAT 2003

International Exhibition & Conferences
„Simulation und Visualisation in Processes,
Applications and Technologies.
May 13-15, 2003, Nuremberg, Germany

Workshop ASIM GMMS/STS 2003

(at SIMPAT 2003)

Methods in Modelling and Simulation
March 14, 2003, Nuremberg, Germany

ASIM 2003

17th Symposium Simulation Technique

September 16-19, 2003, Magdeburg, Germany

Reports from the Working Groups

The working group „Grundlagen und Methoden der Modellierung und Simulation" will meet on one of the days of May 13th-15th during the SIMPAT conference in Nürnberg and organize together with the working group „Simulation technischer Systeme" a one day workshop with the subject Simulation of fluid systems.

The working group „Simulation technischer Systeme" will organize additionally in March the traditional two-day meeting. Main subjects are simulation in automotive development, car electronics and aerospace simulation. Especially the subjects alternative drive line concepts, HIL-test systems, methods and tools, such as VHDL-AMS, state machines and Modelica will be discussed.

The working group „Simulation in Produktion und Logistik" had several successful meetings in 2002:

- 6th - 8th March 2002, biannual conference in Dortmund, conference proceeding see below
- 11th June 2002, meeting at Siemens Dematic in Nürnberg with the subject „Werkzeughersteller stellen sich!", more than 40 participants
- to come: 26th November 2002, at Micro Compact Car smart GmbH in Hambach

They also pulished and supported two books in German Language:

- Proceedings of the conference from 6th-8th March 2002 in Dortmund: "Anwendungen der Simulationstechnik in Produktion und Logistik"; FS 11, Frontiers in Simulation, SCS-Europe BVBA, 2002, ISBN 3-936150-16-8)
- Bayer, Collisi, Wenzel (Hrsg.): Simulation in der Automobilproduktion, Berlin, Springer, 2002 (ISBN 3-540-44192-1)

The next conference will be in 2004. Several meetings are planned in 2003, for the exact date and location contact the speaker of the group, Dr. Sigrid Wenzel (address see below).

Detailed reports of the working groups are found in the ASIM-Nachrichten in German Language. They are sent to the ASIM-Members with the mailing of this SNE.

Contact Addresses of Working Groups

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SKI Simulation und künstliche Intelligenz (Simulation and Artificial Intelligence)
Prof. Dr.-Ing. Helena Szczerbicka, Univ. Hannover, Inst. f. Informatik A, Welfengarten 1 D 30167 Hannover,
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SUG Simulation in den Umwelt- und Geowissenschaften (Simulation of Environmental Systems)
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SMBB Simulation in Medizin, Biologie und Biophysik (Simulation in Medicine, Biology and Biophysics)
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STS Simulation Technischer Systeme (Simulation of Technical Systems)
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EUROSIM SOCIETIES

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(Simulation in Production and Logistics)
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SBW *Simulation in der Betriebswirtschaft (Simulation in OR)*
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SVS *Simulation von Verkehrssystemen*
(Simulation of Transport Systems)
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http://www.asim-gi.org/svs

Report ASIM 2002
16th Symposium Simulation Technique, Rostock, September 2003

The 16th Symposium of Simulation Methods took place at the University of Rostock at September 10-13, 2002. More than 150 scientists (developers, users and interested persons) in all fields of research, education area and in the industry attended the symposium.

This annual German-speaking conference 'Innovation in the simulations technique' was held by „Arbeitsgemeinschaft Simulation" (ASIM) of German Informatics Society (GI). Many scientists, national and international, took part in this session.

The objective of this symposium was to point out the relevance of simulation methods, simulation models, and simulation tools. These methods, models and tools are effective instruments of verification for analysing, optimizing and researching of complex systems in different technical, economical, social and natural scientific areas. Simulation methods substitute experiments that might be harmful to the object. It aims to understand the context and the interactions within a system; it helps to concept and plan real systems as well as procedures of dimension; it enables the whole view of time-dependent and dynamic processes and intensifies the study of complex procedures.

The organisation committee presented a broad session-program with more than 30 sessions and up to four parallel sessions. It was supervised by Professor D. Tavangarian, Chair of Computer Architecture, and Professor R. Grützner, both from the Department of Computer Science at the University of Rostock.

The topics of this year's conference included:

- environmental simulation
- distributed simulation
- simulation used in teachings and e-learnings
- simulation and traffic
- simulation and world wide web
- production and business processes
- medical technology
- artificial intelligence, agents in the simulation methods
- modelling of technical systems in VHDL-AMS
- automotive engineering
- communication systems
- circuitry / mechatronic systems
- modelling / simulation methods

The 80 contributions of the symposium included presentations of simulation methods, tutorials of current topics as well as workshops of special simulation problems. With this the organiser gave a view in new developments and applications of modelling. Innovative simulation and modelling methods were discussed, new developments and simulation tools were presented and an interesting exhibition of simulation hardware and software were shown.

The emphases of this year were on fields of simulation and modelling methods as well as simulation tools in industrial applications. In addition exemplary studies about topics like distributed simulation, simulation used in teachings, medical technology, mechatronic systems were presented.

The conference was a great success thanks to the supporting organizations, SCS Europe (Society for Computer Simulation), IMACS (International Association for Mathematics and Computers in Simulation), EUROSIM (Fed. of European Simulation Societies) and GI (German Informatics Society). The scientists participated in lively discussions during the whole symposium.

ASIM 2002 was an excellent opportunity for exchanging information and knowledge between people in the industry, research and education area, working with modelling and simulation.

The publisher of the ASIM 2002 conference proceeding "Simulationstechnik, 16th Symposium in Rostock, September 2002" (ISBN: 3-936150-19-2) is SCS- European Publishing House, Erlangen-Germany.

Helena Unger
Helena.Unger@informatik.uni-rostock.de

ASIM 2003 – Magdeburg
17th Symposium Simulation Technique

Magdeburg, September 16-19, 2003

Organiser. ASIM and Otto-von-Guericke-Univ. Magdeburg, Institute for Simulation and Graphics, Prof. Dr. R. Hohmann

Conference Office: Otto-von-Guericke-Univ. Magdeburg, Fr. P. Janka, Universitätspl. 2, D-39106 Magdeburg, Tel +49 (0)391 67-18772, Fax - 11164

Deadlines: April 15, 2003 Deadline for Paper Abstracts (1-2 pages A4; 12 pt; 1,5-rows; pdf-File via e-mail); May 15, 2003 Notification of acceptance; June 30, 2003 full paper due

INFO: asim2003@isg.cs.uni-magdeburg.de
- asim2003.cs.uni-magdeburg.de
-

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    admin@asim-gi.org *(for administration)*

CSSS

Czech and Slovak Simulation Society
General Information

CSSS (The Czech and Slovak Simulation Society) has about 150 members in 2 groups connected to the Czech and Slovak national scientific and technical societies (Czech Society for Applied Cybernetics and Informatics, Slovak Society for Applied Cybernetics and Informatics -SSAKI).

The main objectives of the society are: development of education and training in the field of modelling and simulation, organising professional workshops and conferences, disseminating information about modelling and simulation activities in Europe to its members, informing the members about publishing in the field of modelling and simulation. Since 1992 CSSS is a full member of EUROSIM
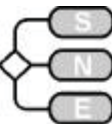
Past Event

The 36th International Conference on "Modelling and Simulation of Systems" (MOSIS'2002) that took place on the 22th to 24th of April 2002 in Rožnov pod Radhoštem, Czech republic, was organised by the Department of Computer Science FEEI VŠB – Technical University Ostrava and Department of Computer Science of FEECS University of Technology Brno and sponsored by CSSS, ASU EUROSIM and SCS. Technical journal AUTOMATIZACE Praha was a medial sponsor.

The Conference was connected with two Workshops: workshop ISM'2002 -Modelling of Information System and workshop MANAM'2002 -Modelling in Manager Works. Some 90 participants from Czech republic, Slovakia, Poland, Germany, Greece, Russia attended the workshop

The XXIV International Colloquium on "Advanced Simulation of Systems" (ASIS 2002) that took place on the 11th to 13th September 2002 in Krnov, Czech Republic was organised by the Department of Computer Science FEEI VŠB – Technical University Ostrava and Department of Computer Science of FEECS University of Technology Brno.

The chairman of the international program committee was Dr. Ing. Jan Štefan. Some of the interesting point in topic were "Simulation in Hydrodynamics", "Education of Modelling and Simulation in Education", Parallel and Distributed Simulation", New Modelling Paradigm", "Simulation Case Studies". Some 50 participants from Czech republic, Slovakia and Poland attended the workshop. The Colloquium was connected with annual meeting of CSSS.

EUROSIM SOCIETEIES

The 3rd International Carpatian Control Conference ICCC'2002 that took place on May 27-30, 2002, Ostrava - Beskydy (Malenovice, Hotel Petr Bezruc), Czech republic. One of parallel sesions of conference was also "Identification, modelling and simulation of processes and systems". The president of International Program Committee was Prof. Ing. Antonín Vítecek, Phd, dean of faculty of Mechanical Engineering, Technicval University of Ostrava, Czech republic. Some 150 participants from Czech republic, Slovakia, Poland, Germany, Greece, Russia, Slovenia attended the workshop

The 5th International Scientific Conference on "Electronic Computers and Informatics'2002" took place on October 10-11, 2002, in Herlany Slovak Republic. One of the topics was concentrating on Modelling and Simulation of the Systems. Some 62 participants from Czech republic, Slovakia, Greece, Ukraina, Russia and Romania attended the workshop The general chair of the conference was prof. Jelšina, Technical university of Košice.

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Conference Announcement
MOSIS 2003
April 28-30, 2003, Brno, Czech Republic

The 36th International Conference on "Modelling and Simulation of Systems" (MOSIS'2003) will take place on April 28-30, 2003, in Brno, Czech republic. The Conference will be connected with two Workshops: workshop ISM'2003 -Modelling of Information System and workshop MANAM'2003 -Modelling in Manager Works. The chairman of the international program committee is Dr. Ing. Jan Stefan. For more information – jan.stefan@vsb.cz.

Conference Announcement
ZEL 2003
May 27 - 28, 2003, Zilina, Slovak Republic

The 10th International Symposium „Railways on the edge of third millennium"(ZEL '2003) will take place on May 27-28, 2003 in Zilina, Slovak republic. One of the interesting point in topic is „Simulation of Railways Stations".

Accompanying Activities organised before Symposium (26 of May) is seminar " Intelligent Transportation Systems", sponsored by CeTra (Centre for Tranportation Research). The chairman of the international program committee is Prof. Ing. L. Skyva, FRI-KTK, University of Zilina.

Conference Announcement
ASIS 2003
September 9-10, 2003,
St. Hostin, Czech Republic

The 25th International Workshop „Advanced of Simulation Systems" (ASIS'2002) will take place in the Moravian town St. Hostin, Czech republic on September 9-10, 2002. The chairman of the international organising committee is Dr. Ing. Jan Stefan. The workshop will be connected with annual meeting of CSSS.

Conference Announcement
MOSMIC 2003
October 7-9, 2003,
Zilina- Sulov, Slovak Republic

The 4th International Workshop "Modelling and Simulation in Management Informatics and Control" (MOSMIC'2003) that took place on October 7-9, 2003 Zilina- Sulov, Slovak republic, was organised by the Faculty of Management, Control and Informatics - University of Žilina, Slovak Society for Applied Cybernetics and Informatics, Bratislava and CSSS. The chairman of the international program committee is Prof. Mikulas Alexik. The CSSS board meeting will take place during workshop.

CROSSIM

Croatian Society for Simulation Modelling

http://rudjer.irb.hr/~crossim
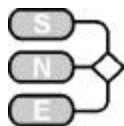
General Information

CROSSIM (The Croatian Society for Simulation Modelling) was founded in 1992 and became a full member of EUROSIM in 1997. This year we celebrate the 10th anniversary of the Society.

CROSSIM is a non-profit society with the goal to promote knowledge and use of simulation methods and techniques and development of education and training in the field of simulation modelling. The Society is engaged in organization of professional meetings and publishing in the field.

The Society is represented by president, vice-president and a representative in international organizations and governed by the executive board consisting of the president and 8 members. Prof. Vlatko Ceric was the founding president of CROSSIM, and Asst. Prof. Jadranka Bozikov is the present woman president. The General Assembly of the Society meets once a year and every third one is electoral.

Information, Contact Address

The e-mail distribution list serves for communication among the members. To spread the information to all members you are invited to send an e-mail message to the: crossim@list.carnet.hr

CROSSIM www site is accessible at rudjer.irb.hr/~crossim.

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Activities

Most CROSSIM members belong to the academic community and work with applications of simulation modelling in such diverse fields as engineering, economy, biology, medicine, health care, agronomy, forestry, ecology, and others. Many of them teach simulation modelling methods, both dicrete and continuous, to graduate and postgraduate students. Simulation modelling methods are often employed within work on master and PhD theses.

We are proud to report that two of our members defended their theses during the last six months: Mirjana Pejic Bach from the Faculty of Economics, Uni-

versity of Zagreb, earned her PhD degree in Economics with the thesis *System dynamics modelling and simulation of resource management and business,* and Milan Rimac, MD, earned his MSc in medical sciences (neuroscience) with master thesis *Dynamic simulation model of cerebral cortex neurogenesis.*

The Society co-operates with the University Computing Centre, Zagreb, in organization of international conference *Information Technology Interfaces* (*ITI*) that traditionally has a strong modelling and simulation section, and in publishing *The Journal of Computing and Information Technology* (*CIT*). The journal covers the area of computer science and engineering, modelling and simulation, and information systems, and publishes original scientific and professional papers, short notes, review articles and surveys, as well as book reviews. All information concerning CIT is available at cit.srce.hr/home.html.

The Society organizes regularly seminars and workshops on simulation. Members are encouraged to present their ongoing work in order to discuss the problems and exchange experience.

Past Events

24th International Conference *Information Technology Interfaces ITI 2002* took place in Cavtat near Dubrovnik, 24-27 June, 2002. The Conference was organized by the University Computing Centre (SRCE) and was held under the auspicies of the Croatian Ministry of Science and Technology, and the University of Zagreb. Thirteen topics were included and ten contributions were presented at the session *Modelling, Simulation and Optimization.*

Coming Events

Call for papers, tutorials, workshops and panel sessions proposals for the 25th International Conference *Information Technology Interfaces ITI 2003* is announced at the web site http://iti.srce.hr.

ITI 2003

June 16-19, 2003, Cavtat, Dubrovnik, Croatia

The 25th *ITI Conference* will be held in June 16-19, 2003 in Cavtat near Dubrovnik, where the first Conference took place in 1974. It will include a special session entitled C*omputer at the university: the role of information technology in academic community – past, present, future.* Among ten Conference topics, one is *Modelling, Simulation and Optimization. BIOSTAT 2003,* the 10th Meeting of Researchers in Biometrics/Statistics with the 8th School of Biometrics, will be held as a part of the Conference.

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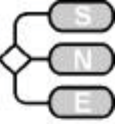
Francosim

Société Francophone de Simulation

FRANCOSIM was founded in 1991 and aims to the promotion of simulation and research, in industry and academic fields. Francosim operates two poles.

Pole "Modelling & simulation of discrete events systems"

To improve the necessary synergy between industry and academia workers in the area of system modelling, the pole co-organises the series of conferences "MOSIM" (Modelling and Simulation). The third conference took place in April this year: *MOSIM'01, Industrial systems design, analysis and management, April 25-27, 2001, Troyes (France).* The 4th conference will take place April 23-25, 2003. Info: www.laas.fr/mosim03/

Conference Announcement

MOSIM '03

April 23-25, 2003, Toulouse, France

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*Pole contact: Professor Henri Pierreval,
IFMA, Campus des Cezeaux,
BP 265, F-63175 Aubiere, Cedex, France.
Tel +33 (0)4 73 28 - 81 06, Fax - 81 00*
pierreva@ifma.fr

Pole "Modelling & simulation of continuous systems"

This pole has launched in 1999 a series of conferences on modelling and simulation in medicine and biology (BioMedSim). The first was organised in April 1999 (BioMedSim'99) and has led to the selection of several papers to appear in a special issue of SIM-PRA. The pole has also co-organised in June 2001 the 2nd BioMedSim'01 in parallel with EUROSIM'2001.

This pole will organise the next BioMedSim Conference on the 27th-30th of May 2003 at the University of Balamand, Lebanon (see call for papers below).

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Call for Papers

BioMedSim 2003

May 27-30, 2003, Balamand, Lebanon

BioMedSim2003 is the third of a series of conferences to be held every 2 years (the first was held in Paris, France in 1999 and the second took place in Delft, Netherlands in June 2001). These conferences are intended to be an opportunity for researchers and industrials to present fundamental work and applications in fields related to the modelling and simulation in living systems. As both biological and mathematical aspects are involved, the organizers expect that this series of conferences will offer researchers and developers in both fields an opportunity to meet, exchange information and establish contact.

In that regards, the Conference committee is delighted to issue a letter of invitation to the biomedical community and to every person interested in the field from all over the world to the 3rd Conference on "Modeling and Simulation in Biology, Medicine and Biomedical Engineering". The event will be held at the main campus of the University of Balamand located in the North of Lebanon.

The conference is concerned with, but not limited to, the following themes:

- Mathematical modelling in biology, medicine, biophysics and biochemistry;
- Mathematical modelling in immunology, neurophysiology, population dynamics, enzyme kinetics;
- Mathematical models for drug administration;
- Modelling and design of control, assist. devices;
- Signal and image processing chains for biological and medical applications (emphasis on diagnosis);
- Biomechanics, artificial organs, muscular motion;
- Models, techniques and simulation tools to case integrated understanding of living organisms ;
- Knowledge based systems and knowledge driven data processing for biological and medical applications with emphasis on aids to explicit diagnostic process and diagnosis rule formation;
- Systems for educational purposes in sub-fields of biology and medicine with explicit emphasis on mathematical models, simulation and display tools.
- Mathematical models and simulation studies on cancer and screening infectious diseases.
- Regulation of gene Expression
- Virtual Reality Assisted Surgery

Furthermore, all related topics will be considered in the scientific program. The submission of papers in areas other than the ones indicated above is highly encouraged provided that they are related to the theme of the conference: Simulation in Medicine, Biology and Biomedical Engineering.

For more information visit the conference web site: www.balamand.edu.lb/docs/biomedsim.html

Yskandar Hamam, y.hamam@esiee.fr

<div style="text-align: right">EUROSIM SOCIETEIES</div>

DBSS

Dutch Benelux Simulation Society
General Information

The Dutch Benelux Simulation Society (DBSS) was founded in July 1986 in order to create an organisation of simulation professionals within the Dutch language area. DBSS has actively promoted creation of similar organisations in other language areas. DBSS is a member of EUROSIM and works in close cooperation with its members and is further affiliated with SCS International, IMACS, the Chinese Association for System Simulation and the Japanese Society for Simulation Technology.

DBSS Steering Committee

A.W. Heemink (TU Delft): Chairman

L. Dekker: Vice-Chairman

W. Smit (E&E Consultants), Secretary, Treasurer

Th.L. van Stijn (Royal Dutch Meteorological Institute/KNMI), Member

H. de Swaan Arons (Erasmus Universtity Rotterdam), Member

Membership - Information

Both corporate entities (companies, institutes, etc.) and individuals are welcome to join DBSS as full corporate or individual member. The contribution is divided in two options:

1. Euro 34,- individual member or Euro 68,- institutional member, which means that you will receive the newsletter Simulation News Europe two times a year (one double, one single issue).
2. Euro 68,- individual member or Euro 114,- institutional member, which means that you will receive the Journal Simulation Practice and Theory eight times a year, and Simulation News Europe two times a year (one double, one single issue).

Becoming member of DBSS includes automatically being member of EUROSIM, the overall organisation of European Simulation Societies. DBSS members enjoy reduction of the fees attending the "EUROSIM events" which include congresses, conferences, symposia, workshops etc. For institutional members counts that they can join national "DBSS events" with three persons against the reduced fee.

Dutch Benelux Simulation Society
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Arnold W. Heemink, a.w.heemink@its.tudelft.nl

HSS

Hungarian Simulation Society

General Information. The Hungarian Member Society of EUROSIM was established in 1981 as an association promoting the exchange of information within the community of people involved in research, development, application and education of simulation in Hungary and also contributing to the enhancement of exchanging information between the Hungarian simulation community and the simulation communities abroad. HSS deals with the organization of lectures, exhibitions, round table discussions and conferences.

Activities Budapest University of Technology. At the Department of Information and Knowledge Management on the Faculty of Economic and Social Sciences of the Budapest University of Technology and Economics classes "Simulation and Modelling in Economy" and an other "Decision Making and Management using Simulation" as well as simulation laboratory practices are held for graduate and postgraduate students studying economy, informatics and electrical engineering. Ph.D. students participate in various simulation research projects aimed at methodological basic research as well as applications.

The establishment of a new doctoral school where simulation and knowledge management is to become a formal program under the leadership of the chairman of HSS is in preparation.

Activities University Gyor. In the town of Gyor at the Szechenyi Istvan University simulation is also taught. Here undergraduate students of informatics, electrical and traffic engineering study the class „Simulation Methodology and Applications". The Hungarian MISS Satellite Center is located in this university. The establishment of a doctoral school within which there will be a program on simulation is in preparation. With regard to this a cooperation with the MISS Satellite Center and its director F. Breitenecker at the Technical University of Vienna is envisaged..

Our efforts mentioned are intended to contribute to the dissemination of the various aspects of the methodology and application of simulation for the young generation. We have participated at EUROSIM and SCS conferences and presented our simulation results. Our members have been and are successfully participating in national and EU simulation projects.

Prof. András Jávor, Ph.D., D.Sc.
Budapest Univ. of Technology and Economics
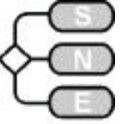*Faculty of Economic and Social Sciences*
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javor@eik.bme.hu

<div style="text-align: right">Issue 35/36</div>

EUROSIM SOCIETIES

ISCS

Italian Society for Computer Simulation

www.iscs.it

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, which recently was elected anew: Ing. Mario Savastano (Chairman), Prof. Franco Maceri (Vice Chairman), Dr. Paola Provenzano (Secretary), Prof. Pasquale Arpaia (Tresaurer)

Conference Announcement
Annual ISCS Congress
Dec. 5-6, 2002, Brindisi, Italy

The Italian Society for Computer Simulation (ISCS) is going to held on 5 and 6 December 2002 the next National Congress in Brindisi, at the branch office of the University of Lecce. The event is organized by Prof. Alfredo Anglani of the University of Lecce in cooperation with Ing. Mario Savastano of the Institute of Bio-images and Biostructures of the National Research Council of Napoli (IBB-CNR) and prof. Franco Maceri of the "Tor Vergata" University of Roma.

The call for paper has reserverd a particular attention to the practical and innovative applications of simulation and papers are expected from very etherogeneous fields. In particular, due to the growing importance of the Biometric Techniques, the Organizing Committee of the Congress will dedicate a session to Biometrics&Modelling which will explore the strategic ovelappings between the two fields of research.

Information, Website. For further information or application for membership, please contact:

ISCS - c/o CNR - IRSIP
Mario Savastano
Via Claudio 21, I – 80125 Napoli, Italy
mario.savastano@unina.it

Please have a look at the new designed website of ISCS: www.iscs.it

Mario Savastano
mario.savastano@unina.it

PSCS

Polish Society for Computer Simulation

General Information

PSCS (The Polish Society for Computer Simulation) was founded in 1993 in Warsaw. PSCS is a scientific, non-profit association of members from universities, research institutes and industry in Poland with common interests in variety of methods of computer simulations and its applications.

At present PSCS counts 258 members. The Board of third cadence consisting of the following persons directs the affairs of the PSCS: Andrzej Tylikowski (President), Leon Bobrowski and Andrzej Chudzikiewicz (Vice Presidents), Zenon Sosnowski (Secretary), Kazimierz Furmanik (Treasurer), and R. Bogacz, J. Rybicki, Z. Strzyzakowski (Members).

Activities. The main activities of the Polish Society for Computer Simulation are annual conferences known as „PSCS Workshops on Simulation in Research and Development": Mielno (1994), Warszawa (1995), Wigry (1996), Jelenia Gora (1997, 1998), Bialystok & Bialowieza (1999), Zakopane – Koscielisko (2000), Gdansk-Sobieszwo (2001).

Past Events. The annual PSCS Workshop on Simulation in Research and Development took place on August 28-31, 2002 in Osiekik/ Koszalina, Poland.

The 57 papers of the workshop covered the following areas: simulation in mechanical engineering, simulation in mathematical problems, artificial intelligence and simulation, simulation in transportation, neural nets and simulation, simulation in automation and control, and simulation tools.

Publications. Proceedings of the 8th PSCS Workshop on „Simulation in Research and Development", J. Rybicki and A. Tylikowski (Eds.), Gdansk Sobieszewo, 2001, (in Polish). The price is 20,- PLN.

Conference Announcement
10th PSCS Workshop
Sept. 9-12, 2003, Zakopane, Poland

Prof. A. Grzyb will organize the 10th PSCS Workshop on „Simulation in Research and Development" Sept. 9-12, 2003, Zakopane, agrzyb@mech.pk.edu.pl

Information, Contact Address

Andrzej Tylikowski
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SIMS

Scandinavian Simulation Society

www.scansims.org

SIMS is the Scandinavian Simulation Society with members from the four Nordic countries Denmark, Finland, Norway and Sweden. The SIMS history goes back to 1959. SIMS practical matters are taken care of by the SIMS board consisting of two representatives from each Nordic country.

The SIMS annual meeting takes place at the annual SIMS conference or in connection to international simulation conferences arranged in the Nordic countries.

Sims Structure

SIMS is organised as federation of regional societies. There are FinSim (Finnish Simulation Forum), MoSis (Society for Modelling and Simulation in Sweden), DKSIM (Dansk Simuleringsforening) and NFA (Norsk Forening for Automatisering).

Membership, SIMS Board

- Peter Fritzson, chairman
- Erik Dahlquist, Brian Elmegaard, Anne Elster, Kaj Juslin, Esko Juuso, Bernt Lie, Kim Sörensen
- Vadim Engelson is SIMS coordinator for practical matters.

You can contact the chair of the SIMS board, Prof. Peter Fritzson (Linköping University, Sweden):

> *Peter Fritzson, IDA, Linköping University*
> *S - 58183, Linköping, Sweden.*
> *Tel + 46 13 281484 Fax +46 13 284499*
> *petfr@ida.liu.se*

To become a member of SIMS you should join one of the SIMS member organizations, as specified on the SIMS web page. Updated SIM web page with news and recent information:

www.scansims.org

Past Events

The **2nd Modelica International Conference** has been organized in March 2002 by DLR near Munich, Germany. The Modelica language becomes increasingly popular due to collection of useful libraries in various physical domains, as well as robust and efficient simulation tools. Automotive applications (e.g. engine, gearbox models) are examples of successful multi-physics systems demonstrated at the conference. Proceedings are available on www.modelica.org
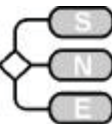
The **43rd SIMS conference** was held on 26 – 27 September, 2002 at the University of Oulu. The conference was organised by Finnish Society of Automation with the University of Oulu (Finland).

The conference covered broad aspects of modelling and simulation and scientific computation. More than 80 people attended the conference mainly coming from the Scandinavian countries but attendees from Canada, Estonia, Russia and Spain were also present.

The programme consisted of three plenary lectures and 34 regular lectures varying from theoretical simulation methods and tools to wide range of industrial applications. Dr. Pekka Taskinen gave an overview of simulation, applications and tools in metals extraction. President Larry S. Wasik and professor Erik Dahlquist shed light on simulation in pulp and paper industry. Main topics of the conference were following:

- Modelling and simulation tools presented interactive tools and development methods for different modelling levels in ever increasing complexity.
- Distributed and parallel simulation included distributing the computation load on many computers, connecting dynamic simulations with automation and operator training, using simulation in various IT applications as well as internet and agent-based techniques for introducing interoperability. Trends to include high-performance computing into cluster computing and their impacts on processor technologies were addressed.
- Training simulators aimed for personnel training in process industry as well as for education, where simulators are connected to both experimental devices and real processes.
- Applications for process development, control and production planning in various industrial areas were presented, including large-scale production systems and specific processes, e.g. chemical pulping, paper machines, continuous casting, solution purification, fluidised bed granulators, water purification and boilers. Real-time simulation of mechatronic machines as well product design and control for elecommunication and simulation of biomass growth were interesting extensions.
- Development methodologies and applications were closely connected, e.g. intelligent methods were essential parts in several applications.

See ntsat.oulu.fi for more information.

VRForum 2002, was organized in October 2002 by Umeå University VR Lab and University Hospital.

Several medical training simulators were demonstrated. Haptic devices, manipulators, physical-based simulation and high quality computer graphics allow to create very realistic surgery simulations. In several reports on the forum the training effect measurements were reported and now they prove that training reduces the probability of medical errors several times. See www.vrlab.umu.se/vrforum/ for details.

Coming Events

Conference Announcement

44th SIMS Conference

Sept. 2003, Västerås, Sweden

The 44th SIMS conference will be held in Sweden, in September 2003. Further information is available from www.scansims.org

Conference Announcement

VForum 2003

Nov. 5-7, 2003, Linköping, Sweden

VRForum 2003, The Forum on Virtual Reality, Modeling, Simulation and Visualization will be held in Linköping, Sweden, November 5-7, 2003. This forum is devoted to simulation of rescue efforts, training and coordination activities in case of accidents. More information is available from www.scansims.org

Conference Announcement

3rd Modelica International Conference

Nov. 2-4, 2003, Linköping, Sweden

The 3rd Modelica International Conference will be organized in Linköping, Sweden, November 2-4, 2003. This is the third conference devoted to new equation-based object-oriented language for physical modeling and simulation. More information is available from www.scansims.org

Contact Address, Information

Updated SIMS web page with news and recent information: www.scansims.org

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UKSim

United Kingdom Simulation Society

ducati.doc.ntu.ac.uk/uksim/

General Information

The UK Simulation Society (UKSim) has more than 100 members throughout the UK from universities and industry. It is active in all areas of simulation and it holds a biennial conference as well as regular meetings and workshops.

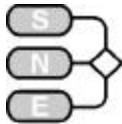Call for Papers

UKSim Conference

April 9-11, 2003, Cambridge, England

The next biennial UKSim conference will be held between 9 and 11 April 2003 at Emmanuel College, Cambridge, England. Papers are invited on any aspect of simulation. The conference venue, Emmanuel College, was founded by Sir Walter Mildmay in 1584 on the site of a former priory of the Dominican Order, also known as the Black Friars or Preachers. The accommodation, renowned catering and conference facilities are an ideal blend of modern and historic. The venue offers an especially attractive opportunity for both professional discussion and socialising.

Full papers (around five pages of A4 with figures) are invited on any aspect of simulation and its applications. The following are suggested topics, but other topics are also welcome; Simulation methodology and practice, software, languages, tools and techniques. Models and modelling tools for software engineering. Data/object bases. Analysis and statistica1 tools. Simulators and simulation hardware, training simulators. Data Mining models and simulation. Integration of simulation with concurrent engineering, integrated design and simulation systems. AI in simulation, philosophical issues, analogies, metaphors, knowledge modelling, acquisition and synthesis of new knowledge/models, intelligent/adaptive behaviour. Parallel and distributed simulation. Grid computing, simulation and challenges. Artificial neural networks, fuzzy systems, evolutionary algorithms.

Simulation applications may include: aerospace; electronic circuits and systems; computer networks; business; management; finance; data mining; economics; leisure, games, war/conflict/rebellion modelling; humanities, literature, semantics modelling/dynamics; biology; medicine; public health; manufacturing; planning; control; robotics; measurement; monitoring; energy; safety critica1 systems; transportation; oil and gas; education and training; military.

There will be an Exhibitions area. Accepted papers will be published in the Proceedings of the Conference.

Although a national event, presenters and participants from any country are particularly welcome, especially EUROSIM member countries.

The registration fee is £235. This includes a copy of the proceedings and all refreshments. Accommodation, including all meals and conference dinner, is £95 per day for single occupancy with en-suite facilities and £75 without en-suite.

Programme Committee/Session Organisers

- Professor Russell Cheng, University of Southampton
- Dr David Al-Dabass, Nottingham Trent University
- Dr Richard Cant, Nottingham Trent University
- Dr Alan Stevens, Rolls Royce, Derby
- Mr Barry Thompson, , CARCO
- Dr Bail Li, Nottingham University
- Professor David Evans, Nottingham Trent Univ.
- Dr Stewart Robinson, University of Warwick
- Dr Vlatka Hlupic, Brunel University
- Dr Helen Karatza, Aristotle University of Thessaloniki, Greece
- Dr Khalid Begain, Bradford University
- Dr Simon Taylor, Brunel University
- Dr Mahdi Mahfouf, Sheffield University
- Profesor Jacques LeFevre, University of Lille
- Professor Robert Pooley, Glasgow University
- Dr John Pollard, UCL
- Dr Yahaya Yusuf, University of Exeter
- Dr Richard Zobel, University of Manchester

Important Dates/Deadlines

- Draft full paper: 15th December 2002.
  (electronic submission preferred, 5 pages of A4)
- Notice of provisional acceptance: 1st Feb. 2003.
- Camera ready copy, registration fee: 1st March 03.

Further details are available from the conference website:

ducati.doc.ntu.ac.uk/
        uksim/uksim'03/CFP-uksim'03.htm

Publications

The UKSIM is publishing the **International Journal of Simulation: Systems, Science & Technology** (IJS³T). At begin of 2002 a special issue on Business Process Modelling (ed. V. Hlupic) was published. For more details please refer to the corner *Journal News* in this **SNE** issue or to the web site:

ducati.doc.ntu.ac.uk/
        uksim/journal/issue-1/cover.htm

Membership, Information

Membership of the UK Simulation Society is very good value at only £20 per year including a subscription to Simulation News Europe.

Those who attend the biennial conferences get free two-year membership untill the next conference. For more information about the Membership please contact the Membership Secretary:

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UKSim Membership Secretary
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Vlatka Hlupiv, UKSIM Secretary
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ROMSIM

Romanian Modelling and Simulation Society

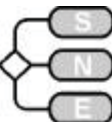**General Information**

No news received.

Information, Contact Address

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EUROSIM SOCIETIES

SLOSIM
Slovenian Society for Simulation and Modelling

msc.fe.uni-lj.si/SLOSIM

General information

SLOSIM (Slovenian Society for Modelling and Simulation) was established in 1994 and become the full member of EUROSIM in 1996. It has 90 members from both Slovenian universities, institutes and industry as well and aims the promotion of modelling and simulation in industrial and academic environments and to facilitate communication among corresponding groups.

Members of SLOSIM are automatically members of the federation of European simulation societies EUROSIM.

News

ERK Conferences. SLOSIM was one of the co-operative societies in the organization of the traditional eleventh ELECTROTECHNICAL AND COMPUTER CONFERENCE ERK'2002 in Portorož, Slovenia (Adriatic Coast). The conference took place from Sept. 23 to Sept. 25, 2002. There were . 250 papers in preprints and more than 200 presented.

The program consisted of 7 invited lectures, 34 conference sessions, 1 student session and some other events. The session part consisted of the following tracks: Electronics (15 papers), Telecommunication (25), Automatic control (23), Simulation (15), Power engineering (32), Measurement (20), Computer science (49), Artificial intelligence (7), Pattern recognition (17), Biomedical engineering (19), Advances in engineering education (8). There was also one special student session with 20 contributions.

SLOSIM was responsible for two simulation sessions which covered methods and algorithms (the emphasise was given to fault detection and diagnose) but also applications.

Military Simulations. In April the Department for Research and Simulation within the Center of Military Education organized a presentation for SLOSIM members. Both sections: the Section for Battle Simulations and the Section for Military Operation Research participated. The department activities are presented in the corner – Simulation centres.

Contributions SNE. The significant improvement of the renewed version of Simulation news Europe gives also SLOSIM members a variety of new possibilities for contributions. These are:

EUROSIM Societies
    Industry news
    Conference reports
    Simulation centres
Book reviews
    Simulationists
    Books and Journals
    Technical notes
    Short notes

Please send by email the possible contributions for items 1-7 to Borut Zupancic (member of SNE News Editorial Board) (borut.zupancic@fe.uni-lj.si) and for items 8 and 9 to Rihard Karba (member of SNE Editorial Board) (rihard.karba@fe.uni-lj.si). The WORD templates for all contributions are available.

Regular annual assembly of SLOSIM is planned for the November 21st. On this meeting new SLOSIM board will be elected. SLOSIM members are kindly requested to propose appropriate candidates.

Information, Contact Address

Borut Zupancic, president of SLOSIM (member of the SNE News Editorial board) Faculty of Electrical Engineering UNiv. of Ljubljana Tržaska 25, SLO - 1000 Ljubljana, SLOVENIA Tel: +386 1 4768 306, Fax: +386 1 4264 631
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Borut Zupancic
.zupancic@fe.uni-lj.si

AES
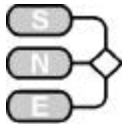### Spanish Simulation Society

No news received.

Contact Address

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Issue 35/36

SCS

Society for Modeling and Simulation International

www.scs.org

www.scs-europe.org

SCS Structure

SCS is the international multidisciplinary forum dedicated to research, development, application and education in modelling and simulation. Since it's founding in 1952 as Society for Computer Simulation, the world changes and topics related to simulation become more complex and methodology oriented.

SCS Europe

SCS Europe runs the SCS European Publishing House, which cooperates very close with ASIM, the German speaking Simulation Society. Moreover SCS Europe organises international recommended scientific conferences on computer modelling and simulation and related fields.

The flagships of which are the "European Simulation Multiconference" (**ESM**) and the "European Simulation Symposium" (**ESS**), and several smaller conferences on specific topics. ESM and ESS are very well accepted by conference participants, shown by the figures of about 180 to 250 participants. In 2000 SCS Europe and ASIM agreed, due to the successful cooperation in the common publication activities, to start a closer cooperation in international conferences.

At present SCS Europe is re-organised. Philippe Geril has left SCS Europe, Mr. Rainer Rimane (Erlangen, Germany) has taken over his duties for the meanwhile. Details will be given in the next issue.

Conferences ESM, ESS, SIMVIS and Agent Based Simulation

ESM and ESS. SCS Europe is running the almost classical conference series **ESM** (European Simulation Multiconference; in June) and **ESS** (European Simulation Symposium; in Oct./Nov.). Sites (prel.) are:

- 17th ESM 2003 Nottingham
- 15th ESS 2003 Delft
- 18th ESM 2004 Marseille
- 16th ESS 2004 Venice
- 19th ESM 2005 Riga
- 17th ESS 2005 Magdeburg

SIMVIS. SCS Europe is co-organising the conferences **SIMVIS** – Simulation and Visualisation, organised by Inst. f. Simulation and Graphics, Univ. Magdeburg. After successful conferences in the last years SIMVIS'2003 is scheduled for March 6 – 7, 2003.

Agent Based Simulation. SCS Europe also co-organises the Workshop series Agent Based Simulation.

The workshop is intended to offer a forum for all interested in agent-based simulation to discuss methodologies, techniques and applications. Topics are, Basic Methodology, Agent Architectures, Model Specification and Languages, Mobile Agents, Multi-Agent Systems: Communication and Cooperation, Multi-Level Simulation, Decision Making, etc.

ASIM, the German Simulation Society, is co-sponsoring as well as the ESM and ESS conferences as well as the SIMVIS and Agent Based Simulation conferences.

If you plan to attend any of the conference mentioned above please contact for more information:

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Tel / Fax + 49 9131 66247
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SCS European Publishing House

The SCS European Publishing House publishes monographs and Proceedings in all areas of Modelling and Simulation. Furthermore, two series, **Advances in Simulation** and **Frontiers in Simulation** are published in cooperation with **ASIM (**German Simulation Society).

This co-operation is still running well, new books have been published. In the following a list of the most recent books:

- Bernd Schmidt: SIMPLEX 3 -The Art of Modelling and Simulation. ISBN 3-936150-06-0, 524 pages, hardbound, English
- Bernd Schmidt: The Modelling of Human Behaviour. 105 pages, hardbound, full colour, English, ISBN 3-936150-11-7 Th.
- Th. Fent: Applications of Learning Classifier Systems for Simulating Learning Organizations
- Y. Monsef: Modelling and Simulation of Complex Systems. ISBN 1-56555-118-4, 296 pages, hardbound, English

SCS

SCS
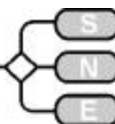
- Helena Szczerbicka, Thomas Uthmann:
  Modellierung, Simulation und künstliche
  Intelligenz. ISBN 1-56555-128-1,
  471 pages, softbound, German
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  Produktion und Logistik. ISBN 3-936150-07-9,
  282 pages, softbound, German
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  Methodologie zur Modellierung multidisziplinärer dyna-
  mischer Systeme. ISBN 3-936150-09-5,
  414 pages, softbound, German
- Ingrid Bausch-Gall: Simulation technischer Systeme -
  Berichte aus der Fachgruppe, ISBN 3-936150-08-7, 278
  pages, softbound, German
- Ch. Almeder: Hydrodynamic Modelling and
  Simulation of the Human Arterial Bloodflow
- K. Panreck, F. Dörrscheidt (Hrsg.): Proc. 15. Symp.
  Simulationstechnik, Paderborn, 2001
- Dj. Tavangarian (Hrsg.): Proc. 16. Symp.
  Simulationstechnik, Rostock, 2002
- S. Pawletta: Erweiterung eines wissenschaftlich-
  technischen Berechnungs- und Visualisierungssystems
  zu einer Entwicklungsumgebung für parallele Applikatio-
  nen
- Th. Preiß: Relationale Datenbanksysteme als Basis für
  Modellbildung und Simulation von
  kontinuierlichen Prozessen
- E. Hajrizi: Intelligentes Online – Planungs- und Steue-
  rungssystem für Flexible Produktions-systeme basierend
  auf Simulation und
  Optimierung mit genetischen Algorithmen

If you are interested in the SCS / ASIM book se-
ries please refer to the SCS Europe website (web or-
der possible) or to ASIM's website, or contact directly
the managing editor.

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MISS - SCS McLeod Institutes of Simulation Sciences

The McLeod Institutes of Simulation Sciences of
SCS are a network of semi-independent centers de-
dicated to advancing the art and science of modeling
and simulation in science, engineering, and related
fields of interest. The idea of MISS was first intro-
duced by the MISS Founder Prof. Dr. emeritus Ralph
Huntsinger, California State University, Chico. The
institute is named to honor John McLeod, the founder
of SCS, and the first editor of the journal simulation.

Hungarian McLeod Center

itm.bme.hu/mcleod/satellite.html

Based on the internationally acknowledged R&D
work in simulation led by Professor Jávor since the
70's he was asked to establish the International
McLeod Institute of Simulation Sciences Hungarian
Center and appointed as its director in 1995. In 1996
the opening ceremony took place where Ralph
Huntsinger founding director of the International
McLeod Institute of Simulation Sciences and Axel
Lehmann senior vice president of SCSI participated.

As simulation is an applied science the strategy of
the Center is to undertake combined efforts in re-
search development and education in the field of
simulation. An inductive-deductive approach is applied
where for solving problems arising in various fields of
application generalized methodologies and algorithms
are elaborated, implemented in simulation software
and applied for solving problems in various fields. The
education is conducted in a way where beyond the
lectures the graduate and postgraduate students are
involved in the R&D work and projects. The main di-
rections of simulation methodology where the Center
is active are: discrete event simulation, high level
Knowledge Attributed Petri Nets and intelligent agent
controlled simulation.

The fields of application include the simulation of
flexible manufacturing and quality controlled systems,
traffic systems, problems of environmental pollution,
micro- and macroeconomic systems, interdisciplinary
and soft systems (as e.g. the development of regions),
etc. The methodological results have been imple-
mented in the CASSANDRA (Cognizant Adaptive
Simulation System for Applications in Numerous Dif-
ferent Relevant Areas) simulation system that has
been applied for solving problems in various EU, in-
ternational and national projects.

Hungarian McLeod Satellite Center

itm.bme.hu/mcleod/satellite.html

The Hungarian Satellite Center was established in
2000. It is operating at the Széchenyi István University
in the city of Gyor. Prof. Dr. Péter Keresztes has been
nominated as its director and Prof. Dr. András Jávor is
its associate director. At the University undergraduate,
graduate and postgraduate courses are held by the
satellite member and recently projects with the appli-
cation of simulation have been initiated. The work of
the Satellite Center is in close cooperation with the
Hungarian Center.

Andras Javor
javor@eik.bme.hu
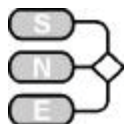
INTERNATIONAL SOCIETIES & USER GROUPS

MATHMOD Conference Series

www.argesim.tuwien.ac.at/MATHMOD/

The MATHMOD Conference Series was started with 1st MATH-MOD Conference in February 1994. In 1997 and 2000 the series was successfully continued by 2nd and 3rd MATHMOD. The series has established as well-accepted and high-standing tri-annual conferences on mathematical modelling and simulation. It will be continued with 4th MATHMOD conference in February 2003.

The scope of the conferences covers theoretic and applied aspects of the various types of mathematical i.e. formal modelling (equations of various types, Petri nets, bond graphs, qualitative and fuzzy models etc.) for systems of dynamic nature (deterministic, stochastic, continuous, discrete or hybrid, etc.).

Comparison of modelling approaches, model simplification, modelling uncertainties, validation, automation of modelling and software support for modelling etc. will be discussed in special sessions as well as applications for control, design or analysis of systems in engineering and other fields of application, and learning networks in modelling, fitting models to real processes, model reduction.

4th MATHMOD Vienna, Feb. 2003

Fourth International Symposium on Mathematical Modelling, February 5 - 7, 2003, Vienna

The 4th MATHMOD will continue the conference series in Vienna, February 5 – 7, 2003.

Conference Publications

There will be regular Conference Proceedings, eds. I. Troch and F. Breitenecker, published in series ARGESIM-Reports, ISBN 3-901608-24-9, and Post Conference Publication in special issues of journals.

- Conference Proceedings Part 1: Printed abstract volume (with a one page abstract of each full paper and each poster)
  Conference Proceedings Part 2: CD ROM with full papers (up to t0 pages)
- Post Conference Publications:
  After the conference, the IPC will invite - after special reviewing - excellent papers for publication in special issue of the journals IMACS-MCS, JIRS, and MCMDS (details are given in the Copyright Regulations – see website)

Contributions

Contributions fitting into the scope of the conferences (given above) are welcomed. 4th MATHMOD offers full papers and posters.

Full Paper Submission: - already passed

Poster Submission: Posters will be on display during the whole congress, and 1-page abstracts of the posters will be published in Proceeding Part 1 (printed) and at the CD-ROM (Proceedings Part 2). Deadlines are:

- Submission of Poster Abstracts: Nov. 15, 2002
- Notification of Authors: December 1, 2002
- Abstract of Poster due: December 15, 2001 (full version and abstract)
- Poster due: begin of conference

Invited Lectures

- Modeling, Analysis and Control of Parallel Hybrid Vehicles. N. A. Kheir, Oakland University, USA
- Modelling and Simulation in Snow Science. K. Kleemayr, Univ. Agricultural Sciences, Vienna
- Modelling and Simulation in Mechatronics. P. Breedveld, Univ. Twente, The Netherlands

Social Programme / Accommodation

A very attractive social programme will be offered to participants and accompanying persons:

- Welcome Party
- Traditional Heurigen Evening,
- Reception in Town Hall
- guided City Tours, etc.

There will be a book exhibition, and an exhibition of modelling software.

AUSTROPA Interconvention will manage accommodation for participants. Hotels chosen are close to the conference site. Booking info and direct booking at https://secure.verkehrsbuero.at/tak/mathmod.htm

Conference Fees

Members of IMCAS or Co-sponsoring Societies	€ 310.-
Non – Members	€ 340.-
Students (restrictions; please ask for conditions via email)	€ 70.-
Accompanying Persons	€ 90.-

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argesim.tuwien.ac.at/MATHMOD/

INTERNATIONAL SOCIETIES

Virtual Action Group on Hybrid Dynamics

www.robotic.dlr.de/control/cacsd/hds/

Hybrid Dynamic Systems

This above website is maintained by the Virtual Action Group on Hybrid Dynamic Systems. It intends to provide a convenient entry point into the world of combined continuous/discrete modeling and analysis. It compiles researchers who are active in the field, research projects that are underway, links to a number of selected papers and software, and it provides news about conferences, workshops, special issues, and the like. Any suggestions or comments to improve this site are more than welcome.

The virtual action group is part of the IEEE Control Systems Society Technical Committee on Computer Aided Control System Design. For additional information refer to the IEEE Technical Committee on Hybrid Dynamical Systems.

Working Groups and Chapters

The objective of the DEVS Standardization effort is to develop standards for a computer processable representation of DEVS that supports common understanding, sharing and interoperability of DEVS implementations. Computer processable forms include all forms of simulation and real-time execution as well as various forms of syntactic and semantic analysis.

The Dutch Institute of Systems and Control is an interuniversitary research institute and graduate school by the Delft and Eindhoven Universities of Technology and the University of Twente. A large majority of the participants in the school are affiliated with the faculties of electrical engineering, mechanical engineering, and mathematics of these three universities. A large number of other faculties and institutes in the Netherlands participate in DISC under various agreements.

Groupe de travail sur les Systèmes Dynamiques Hybrides Les objectifs du groupe de travail commun à l'AFCET et la SEE sur les Systèmes Dynamiques Hybrides sont de favoriser les échanges entre les différents spécialistes qu'ils soient issus du monde de l'automatique continue ou de celui de l'automatique événementielle, théoricien ou praticien, universitaire ou industriel et permettre ainsi une meilleure connaissance des problèmes liés aux SDH et des solutions qui peuvent y être apportés.

IEEE 1076.1 Working Group on Mixed-Signal Extensions to VHDL has been created with the charter to develop and to maintain analog and mixed-signal extensions to the VHDL language.

These extensions enhance VHDL such that it can support the description and simulation of circuits and systems that exhibit continuous behavior over time and over amplitude.

IEEE Technical Committee on Hybrid Dynamical Systems Hybrid Dynamical Systems combine continuous-state and discrete event dynamical systems. Such systems appear frequently in engineering and are particularly evident when a system is required to operate in a number of distinct operational modes. The study of such systems requires a multidisciplinary approach using traditional control theory and computer science.

The Eurosim Technical Committee Modelica aims at the specification of a EUROSIM standard concerning a Unified Object-Oriented Language for Physical Systems Modeling. The language is called Modelica. In this way EUROSIM wants to promote cooperation between simulation language developers and the elaboration of a new obviously needed common standard suitable for modern software concepts.

The Modular Design of Hybrid Systems project develops a specification technique for the formal design and analysis by logical verification of continuous-discrete models and facilitates the modular development of distributed process control software. It is based on TLA (Temporal Logic of Actions) and concentrates on practical topics: specification language, application methods, libraries of specification patterns (particularly for control of chemical processes), and tools.

OOMS The goal of the OOMS (Object-Oriented Modeling of Continuous/Discrete Systems) project of the DLR Oberpfaffenhofen and the Process Control Laboratory at the University of Dortmund is the further development of object-oriented modeling methodologies to model and simulate complex hybrid dynamic systems.

The unifying modeling language Modelica is used for model specification and the DSblock model description as the implementation platform.

For information, comments, etc. to all topis of the viral group, i. e. hybrid glossary, groups, centers, publications, centers, software, benchmarks, please contact Pieter J. Mosterman

Pieter J. Mosterman
pieter_j_mosterman@mathworks.com

SIMPAT Conference and Trade Fair

www.simpat.de

In June 2001, **SIM 2001**, the first Industrial Trade Fair and Knowledge Exchange on Applied Simulation and Visualisation took place in Freiburg / Breisgau, Germany, June 2001.

The basic idea of this SIM event was and of the continuing SIMPAT event is:

- to organize a trade fair with hardware and software for modelling, simulation and visualisation
- and to gather around conferences on modelling, simulation and visualisation – from methodology to applications.

SIM'2001 has proven successful, and Löffler and Associates, organisers of SIM'2001, continued with this idea and could set up the biennial series of trade fair with conferences, now called **SIMPAT**:

SIMPAT 2003

International Exhibition & Conferences „Simulation und Visualisation in Processes, Applications and Technologies. May 13-15, 2003, Nuremberg, Germany

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After checking a lot of places for a trade fair, Löffler and Associates together with the SIMPAT advisory board (consisting of representatives of the main sponsors) decided for Nuremberg, where Nürnberg-Messe Gmbh offered the best infrastructure for the event.

The first event, SIM'2001, was focussed on computational fluid dynamics and visualisation – mainky because of the big accompanying 5th WUA-CFD Conference in Applied Fluid Dynamics. The new SIMPAT event opens to exhibitors of hardware, software and services in the following basic technologies for many applications in numerous branches of industry:

- · Acoustics
- · Animation
- · Boundary Element Method (BEM)
- · Computer Aided Design (CAD)
- · Casting
- · Circuit Layout

- · Computational Fluid Dynamics (CFD)
- · Continuous Simulation
- · Crash Simulation
- · Discrete Simulation
- · Electrodynamics
- · Finite Element Method (FEM)
- · Forging, Molding, Extrusion
- · Heat, Ventilation and Climate (HVAC)
- · Molecular Modeling
- · Optics
- · Recasting
- · Robotics, Automation
- · Virtual Reality, 3D Visualisation

The organisers hope for more than 100 exhibitors, and conference will accompany the trade fair.

Call for exhibitors. It is hard to imagine business, science and industry without process simulation and visualisation. The applications are very complex and the products numerous. The necessary hardware and software forms a promising market with an annual growth potential of 25%. These subjects will be dealt with at SIMPAT'2003.

Highly qualified decision-makers will gather information here about the state of the art in simulation technology and its use in their own companies. Experts, manufacturers and potential customers will discuss future possibilities and developments at conferences and events. SIMPAT therefore offers you as software and hardware supplier a high-caliber environment for the presentation of your products and services.

As international exhibition venue, Nuremberg with its outstanding location and site advantages creates the ideal conditions for establishing SIMPAT as a worldwide forum in Europe.

Löffler & Associates GmbH of Basel, Switzerland, as competence partner ensures the quality of the contents. NürnbergMesse GmbH as organizer of specialized trade fairs guarantees you a smooth organization with competent planning support and a comprehensive exhibition service.

Interested exhibitors are kindly requested to contact Löffler and Associates for more information, www.loeffler.ch, info@loeffler.ch

Sponsors (preliminary):

Trade visitors. SIMPAT is an interdisciplinary meeting-place for international experts in Planning/Design, Engineering/Construction, Manufacturing, Logistics, Training and Communication in all conceivable application fields (cf. nomenclature in Application form). The main applications are in the following domains of:

- Aerospace and Aeronautics
- Automotive Electronics
- Mechanical Engineering
- Medical Engineering
- Chemical Engineering ·
- Power and Electricity
- Transport, Materials
- Engineering and Logistics.

SIMPAT Conferences

SIMPAT Trade Fair will be accompanied by two big conferences and by smaller workshops. Almost traditionally, the world fluid dynamics community will gather to its biennial congress, and a conference on simulation and visualisation – with invited speakers – will intriduce into the area and will show the trends for the future. Smaller workshops, e.g. meetings of ASIM Working Groups will emphasise on special themes. ASIM, the German Simulation Society, together with ARGESIM Group from Vienna will be also exhibitor ans sponsor of SIMPAT.

World Fluid Dynamics Days 2003

6th WUA-CFD Conference in Applied Fluid Dynamics

In today's drive towards optimisation of product life cycle, integrated product development imposes high demands on engineering designs. The 2003 conference focuses on how CFD is to be strategically embedded in the most appropriate way into the product development cycle. In this context three questions are of crucial importance:

- What makes CFD indispensable in the product development cycle and what are the industrial applications that would impossibly have been developed without CFD ?
- How does the interfacing between CFD and other simulation tools work and what are the technical prerequisites in order to achieve an appropriate work flow?

- Can CFD – as presently widely discussed – become an automated tool that eventually fits a so called "Template-Philosophy"?

Specialists from manufacturing industry and software vendors will discuss the integration process and present most advanced applications.

SIMPAT 2003 Conference *Simulation and Visualisation Technologies in Product Development, Production and Logistics*

The conference as part of SIMPAT 2003 will become the special meeting-place for discussions on the use of the potential of simulation and visualisation.

Simulation and visualisation are the instruments that make it possible to view and test the functionality of complex processes in all engineering domains and production and logistic flows. For example, the construction of prototypes can be distinctly reduced in future and complex "just-in-time" planning can be optimized in many organisational domains.

The SIMPAT 2003 Conference – like the complete exhibition – reflects the vital importance of this technology of the future. It deals especially with applications in Aerospace and Aeronautics, Automotive Engineering, Electronics, Materials, Mechanical Engineering, Chemical and Medical Engineering, Power and Electricity, Transport, Engineering and Logistics.

Further information on the conferences are available at www.simpat-conferences.de.

ASIM – ARGESIM Presentation / Workshops

ASIM and ARGESIM will be present at SIMPAT'2003 with a booth and with organising meetings or workshops of ASIM Working Groups:

- Workshop "Methods in Modelling and Simulation (14.5.2003)", together with
- Meeting Working Group "Simulation of Technical Systems (14.5.2003)"
- Meeting of Working Group "Simulation in Production and Logistics" and "Education in Modelling and Simulation"

For more information, refer to www.asim-gi.org.

SIMPAT Info and Contact

INDUSTRY NEWS

Dymola Version 5.0 released

www.Dynasim.se, www.BauschGall.de

The new version of Dymola, Dymola Version 5.0 has been released by Dynasim. Customers with a support agreement can download this new version: www.Dynasim.se/newupdate

New features in Dymola Version 5.0: The graphical user interface of Dymola has been totally redesigned to exploit modern GUI elements (tool bars, dockable windows, etc) and to obtain better organization and reuse of windows. Two usage modes, Modeling and Simulation have been introduced. The new features include:

- Browsing facilities for navigating large and complex systems.
  This includes a package browser for navigating libraries and a component browser (navigating complex models).
- New text editor for Modelica textual representation with syntax highlighting.
- GUI support for advanced Modelica features such as redeclare.
- New experiment facilities: naming of experiment results, several results available for browsing, online plotting, multiple diagrams in each plot window, direct comparison of variables.
- Instantaneous 3D visualization of MBS models. Import of 3D shapes in STL format. Export of animations in VRML format.
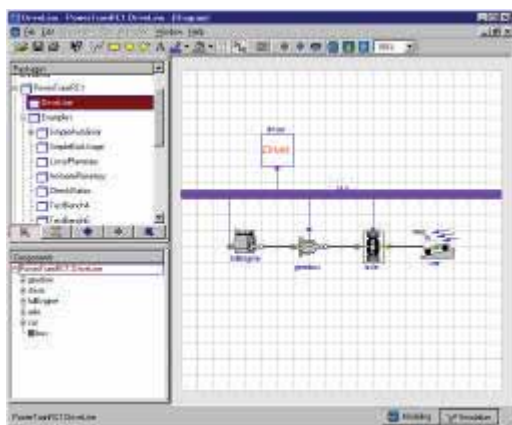
NEW: POWERTRAIN-Library for Dymola

The PowerTrain library contains 1-dimensional rotational mechanical components to model vehicle powertra trinas. It is used in combination with the Modelica.Mechanics.Rotational sublibrary, which is a free Modelica standard library. All components are implemented with the modelica language and are open source files.

Version 1.0 of the PowerTrain Modelica library will be released soon. Features of PowerTrain 1.0:

- 45 user-callable components, such as engines, clutches, gears (with and without losses), axles, drivers, controlers
- 10 examples show typical applications
- 45 new components for the Modelica standard library were developed with the PowerTrain library
- A bus concept has been introduced. If physical models are combined with control elements, it might happen that many signal lines connect the components. To get rid of these complex signal connections, all signals are collected in a signal bus.
- Variant selection: Using the replaceable feature of Modelica allows to use one component with a choice of variants. Basically, there is now just one model - PowerTrain.DriveLine - consisting of a typical drive line from which all the main variants provided in the library can be selected, e.g., 3 different types of automatic gearboxes but also user-defined gearboxes.
- Torque dependent losses have been added, according to a new theory which allows a robust simulation without chattering. Most gears in the library have now optional speed and torque dependent losses.
- Animation of gears and shafts of a drive line as built-in feature of many components allow better evaluation of simulation results. Animation can be switched off with a parameter to remove the animation code completely from a model, e.g., for hardware-in-the-loop simulation.
- Sophisticated examples may be used as a starting point for user drive line models. Examples for power consumption calculation and analysis of shift strategies based on detailed models of 4 and 6 speed automatic gear boxes allow first parameter studies, without setting up own examples.
- Control units are available to allow control of the various parts of a drive line. All of them are parameterized with the control lever position of the driver (P,R,N,D,1,2,3,...) and do not depend on a specific number of gears.
- A online tutorial helps to build a first own model and describes the most important parts of the library
-

The Powertrain Library was developed by: Martin Otter and Christian Schweiger, DLR, Germany; Ingrid Bausch-Gall, Bausch-Gall GmbH, Germany; Mike Dempsey, Claytex Services Ltd., Great Britain

For further information contact:

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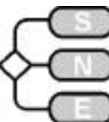
New Release MATLAB R13

www.mathworks.de

The new Release 13 CD of the entire MathWorks product family is now available. The release includes 10 new products and 33 updates, which New include:

- Aerospace Blockset
- Embedded Target for Motorola® MPC555
- Embedded Target for TI C6000 ™ DSP
- MATLAB COM Builder
- MATLAB Excel Builder
- MATLAB Link for Code Composer Studio
- SimMechanics for mechanical modeling

New — MATLAB 6.5 extends the desktop and lab

- JIT-Accelerator technology for fast execution
- Deployment to Excel, COM, and C/C++
- Connection to instruments via TCP/IP, UDP, and to new data acquisition boards
- Statistical methods and curve fitting tools

New — Simulink 5 extends simulation:

- Modeling for wireless, mechanical/power systems
- Intrinsic fixed-point
- Rapid control prototyping with new xPC Target-Box™ hardware
- Next generation of automatic production code
- Targeting for microcontrollers, DSPs, and FPGAs

The Mathworks GmbH
Friedlandstr. 18, D- 52064 Aachen
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info@mathworks.de, www.mathworks.de

TNI-VALIOSYS introduces CosiMate

www.tni-valiosys.com

TNI-VALIOSYS, a French company providing software solutions for embedded, real-time and critical systems design, is pleased to introduce CosiMate, its co-simulation software.

CosiMate enables several heterogeneous simulation environments to communicate together across the network, thus providing system validation at different abstraction levels. Connected environments include : Simulink, AMESim, Saber, VHDL/Verilog, SDL, C/SystemC, Cossap. New environments can easily be added on customers requests. CosiMate's architecture is shown in the following figure.

CosiMate can connect an unlimited number of simulation environments together. Once the co-simulation process has been launched, users can interact with the native simulators transparently, just as if CosiMate were not present.

The entire system's behaviour can be validated early in the development cycle prior to implementation of any of its parts. Models at different abstraction levels can be mixed and matched, providing a high degree of flexibility while at the same time ensuring the overall system's quality.

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www.tni-valiosys.com

COMSOL: VisSim 5.0 New Features

www.vissol.com, www.comsol-online.com

VisSim is an award winning program for the modeling and simulation of complex dynamic systems. VisSim combines an intuitive drag and drop block diagram interface with a powerful simulation engine. VisSim has been selected by the US airforce because of its superior simulation performance & speed.

VisSim 5.0 New Features. Delivering unmatched power, flexibility, and extensibility, VisSim 5.0 is one of the most sophisticated simulation environment on the market today. New features in this release expand your modeling, simulation, and visualization options: more than 20 new features in the area of modeling, simulation and in visualization. Detailed information: www.vissol.com/products/vissim5.html

VisSim offers application specic solutions for the following areas: Motion Control, Rapid Prototyping incl. automatic code generation, DSP, Communication, Embedded control. VisSim also offers translation tools from Matlab/Simulink and can be used together with Mathcad.

Please contact COMSOL for further information:

Germany: +49 (0)7253 278 178,
Switzerland: +41 (0)31 998 44 11
Sweden: +46 (0)31 335 85 10
www.comsol-online.com

silux - Multi-Body Dynamic Simulation

www.silux.com

The company silux ag located in Switzerland developed a multi-body dynamic simulation software for the simulation of technical machinery. This software enables mechanical engineers and technical designers to evaluate their ideas and visions before a prototype is ever made. It is unique in that it utilizes the leading edge technology of Cellular Automaton* (CA) put into life by the Finite Differences (FD) method (as opposed to the Finite Elements method (FE) which is widely used in other simulation software products).

In 1994 silux started the full scale development of this revolutionary concept applied to the dynamic simulation of mechanical systems. This is the very first comprehensive program at our knowledge that utilize systematically this emerging technology. But in this case, the use of the Cellular Automaton methodology creates a real Paradigm Shift in the simulation world.

That's why we put the full silux version of the dynamic simulation software on our homepage www.silux.com for free-download. Users can so better discover the enormous advantages of this new simulation technology. You are cordially invited to use it, and we would be very pleased and thankful to know your opinion about it. We have plenty of ideas how to expand and improve the silux software. To check if we're on the right track your expert's opinion for us would be very important.

By the way silux was a.o. the winner of the Byte Award at the CeBit'97 in Hanover/Germany for the best software application.

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Tel +41 41 710 5052, Fax (+41)-1-391 31 36
www.silux.com

Scientific Computers shipping Maple 8

www.scientific.de

New Release Maple 8. Scientific Computers, distributor for the German speaking area, is pleased to present Maple 8, the newest version of the widely adopted Maple mathematical computation product line.

Maplets™. A revolutionary package called Maplets™ provides tools to create custom Java™-based graphical user interfaces – called maplets – to the thousands of routines in the Maple library, as well as to your routines.

Maplets allow users to perform Maple calculations and display graphics without knowledge of Maple syntax.

Nonlinear ODEs. Enhancements to dsolve include a new implementation of integrating factor methods that can systematically determine integrating factors of varied types and perform multiple reductions of order in one step when more than one integrating factor is found.

Furthermore, MAPLE 8 offers numerical solutions to PDEs and new versions of the Mathematics Packages, with extension and advanced features; the Graphical User Interface has been improved, and much more. Maple 8 is available for all supported platforms, including Windows (from XP to 95), Linux and UNIX.

Scientific Computers GmbH
Friedlandstrasse 18, D-52064 Aachen
Tel + 49 (0241) 40008 - 0, Fax – 13
info@scientific.de, www.scientific.de

ExpertControl – New Provider for Engineering Development Tools

www.expertcontrol.com

ExpertControl provides powerful development tools for various technical development environments such as EXCEL, MATLAB and MATHCAD. Developing systems in Application Areas like Mechanics, Electronic Systems, Mechatronics, Hydraulics, Automotive, Aerospace, etc.

In Germany and Austria ExpertControl is distributor of the MathSoft products. The Mathcad 2001i Premium Suite consists of the following products: Mathcad 2001i Professional, AXUM 7.0, SmartSketch 4.0, VisSim, and Solving and Optimization Ext. Pack.

ExpertControl also distributes the (MATLAB) Toolboxes ACD, IDCON linear, IDCON nonlinear, Conti, Micromon, CANbus, Hydraulic (developed by Delzer Kybernetik, www.delzer.de). The Toolboxes ACD and IDCON are now also available for EXCEL (developed by Delzer) and for MATHCAD (developed by Expertcontrol)

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Tel +49 – 8153- 9844-0, Fax - 11
www.expertcontrol.com, info@expertcontrol.com

CALENDAR OF EVENTS

From	To	Abbr.Titel	Titel	Location	WWW
04.12.2002	08.12.2002	EMBEC'02	2nd European Medical & Biomedical Engineering Conference	Vienna, Austria	www.embec.org
05.12.2002	06.12.2002		Annual ISCS Congress	Brindis, Italy	www.iscs.it
08.12.2002	11.12.2002	WSC 02	Winter Simulation Conference	San Diago, California, USA	www.wintersim.org
05.02.2003	05.02.2003	ASIM - GMMS	ASIM Working Group Meeting "Methods in Modelling and Simulation"	Vienna Univ. of Technology, Austria	www.gmms.asim-gi.org
05.02.2003	07.02.2003	4th MATHMOD	4th IMACS Symposium on Mathematical Modelling - 4th MATHMOD	Vienna, Austria	simtech.tuwien.ac.at/MATHMOD
19.02.2003	21.02.2003		VIth Conference on Computer Simulation and Industry Applications	Tijuana, Mexico	starracz@netservice.com.mx
06.03.2003	07.03.2003	SIMVIS 2003	Conference on Simulation and Visualisation	Magdeburg, Germany	www.simvis.org
11.03.2003	13.03.2003	ASIM STS 2003	ASIM Workshop "Simulation of Technical Systems"	Ulm, Germany	www.sts.asim-gi.org
24.03.2003	25.03.2003	ASIM - SKI 2003	ASIM Working Group Meeting "Simulation and KI"	Humboldt Univ., Berlin, Germany	www.asim-gi.org
27.03.2003	28.03.2003	ASIM - SUG 2003	ASIM Working Group Meeting "Simulation of Environmental Systems"	Cottbus, Germany	www.asim-gi.org
30.03.2003	02.04.2003		36th Annual Simulation Symposium	Orlando, Florida	agent.csd.auth.gr/~karatza/ANNSS36
09.04.2003	11.04.2003		UKSim Conference	Cambridge, UK	ducati.doc.ntu.ac.uk/uksim/uksim'03/CFP-uksim'03.htm
28.04.2003	30.04.2003		Agent-Based Simulation 2003	Montpellier, France	www.scs-europe.org
28.04.2003	30.04.2003	MOSIS 2003	36th Int. Conf. " Modelling and Simulation of Systems"	Brno, Czech Republic	jan.stefan@vsb.cz
13.05.2003	15.05.2003	SIMPAT 2003	Int. Exhibition & Conferences Simulation und Visualisation in Processes, Applications and Technologies	Nuremberg, Germany	www.simpat.org
14.05.2003	15.05.2003		ASIM Joint Working Group Meetings at SIMPAT 2003	Nuremberg, Germany	www.asim-gi.org
23.05.2003	25.05.2003	MOSIM '03	FRANCOSIM Conference "Modelling and Simulation"		www.laas.fr/mosim03/
27.05.2003	30.05.2003	BioMedSim 2003	3rd Conference "Modelling and Simulation in Medicine and Biology"	of Balamand, Lebanon	www.balamand.edu.lb/docs/biomedsim.html
27.05.2003	28.05.2003	ZEL 2003	10th Int. Symp. "Railways on the edge of third millennium"	Zilina, Slovak Republic	alexik@frtk.fri.utc.sk
09.06.2003	11.06.2003	ESM 2003	17th European Simulation Multiconference	Nottingham, UK	www.scs-europe.org
16.06.2003	19.06.2003	ITI 2003	25th Int. Conf. "Information and Technology Interfaces"	Cavtat, Durbrovnik, Croatia	iti.srce.hr
14.07.2003	17.07.2003	MOSIM 2003	Congress of the Modelling and Simulation Society of Australia and New Zealand	Townsville, Australia	http://mssanz.cres.anu.edu.au/modsim2003.html
14.07.2003	20.07.2003		17th IMACS WORLD CONGRESS	Lille, France	www.cs.rutgers.edu/~imacs/
	Sep.03		44th SIMS Conference	Västeras, Sweden	www.scansim.org
09.09.2003	12.09.2003		10th PSCS Workshop	Zakopane, Poland	agrzyb@mech.pk.edu.pl
09.09.2003	10.09.2003	ASIS 2003	25th International Workshop "Advances of Simulation Systems'	St. Hostin, Czech Republic	jan.stefan@vsb.cz
09.09.2003	12.09.2003		Mathematical Modelling of Ecosystems	Almaty, Kazakhstan	usultann@sri.academset.kz
15.09.2003	19.09.2003		4th IMACS Seminar on Monte Carlo Methods		mcm2003@wias-berlin.de
16.09.2003	19.09.2003	ASIM 2003	17th Symposium Simulation Technique (Annual ASIM conference)	Magdeburg, Germany	asim2003.cs.uni-magdeburg.de
07.10.2003	09.10.2003	MOSMIC 2003	4th International Workshop "Modelling and Simulation in Management Informatics and Control'	Zilina-Sulov, Slovak Republic	alexik@frtk.fri.utc.sk
26.10.2003	29.10.2003	ESS 2003	European Simulation Symposium	Delft, The Netherlands	www.scs-europe.org
02.11.2003	04.11.2003		3rd Modelica International Conference	Linköping, Sweden	www.scansim.org
05.11.2003	07.11.2003	VFORUM 2003	Forum on Virtual Reality, Modeling, Simulation and Visualization	Linköng, Sweden	www.scansim.org
06.09.2004	10.09.2004	EUROSIM'04	5th EUROSIM Congress	Noisy-le-Grand, Paris, France	y.hamam@esiee.fr

SIMULATION SOCIETIES

MSSANZ

Modelling and Simulation Society of Australia and New Zealand Inc.

mssanz.cres.anu.edu.au

Purpose. The Modelling and Simulation Society of Australia and New Zealand Inc. (MSSANZ), formerly the Modelling and Simulation Society of Australia (MSSA), and the Simulation Society of Australia Inc. (SSA), is an affiliate of the International Association for Mathematics and Computers in Simulation (IMACS), and the Society for Computer Simulation (SCS).

The aims of the Society are to promote, develop and assist in the study of all areas of modelling and simulation.

The Society has more than 500 members from 50 countries, including Australia, Canada, China, France, Germany, Japan, New Zealand, the Netherlands, South Africa, Spain, Switzerland, the United Kingdom and the United States. Members are from a wide range of professional disciplines including hydrology, agricultural science, economics, engineering, atmospheric science, ecology and many others.

MSSANZ encourages students through regular student prizes and by subsidising their registrations at conferences.

Scientific Meeting. About every two years, the Society organises a major international conference. MODSIM 2003, the next MSSANZ International Congress on Modelling and Simulation, will be held in Townsville, Queensland, Australia, 14-17 July 2003.

Newsletter / Journal Publications. As a means of communication among members, the Society publishes one or two newsletters per annum.

Awards. The Society awards Biennial Medals, Fellowships and Student Prizes in each of the following three categories: Natural Systems, Socioeconomic Systems and General Systems.

Medals go to outstanding contributors to modelling and simulation over a sustained period. Medallists automatically become Fellows of the Society.

Fellows are recognised for their unselfish dedication to the aims of the Society as well as for their contributions to modelling and simulation.

Students presenting the best papers at Biennial Conferences in the three categories are awarded a cash prize and a Commendation Certificate.

As from 2001 the Society will also be granting Early Career Research Excellence (ECRE) Awards in each of the three categories (for further information see July 2000 Newsletter).

MSSANZ Info

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MOSIM 2003

The Biennial Congress of the Modelling and Simulation Society of Australia and New Zealand.

Integrative Modelling of Biophysical, Social, and Economic Systems for Resource Management Solutions
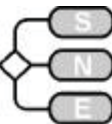
July 14-17, 2003, Townsville, Queensland, Australia

Papers are invited in all areas of modelling and simulation. Selected papers will be published in international journals. Keynote speakers are:

- Professor Peter Phillips, Cowles Foundation for Research in Economics, Yale University, USA. Laws and Limits of Econometrics.
- Professor John Norton, University of Birmingham, UK. Prediction for decision making under uncertainty.
- Claudia Pahl-Wostl, Professor for Resource Flow Management, Institute for Environmental Systems Research, University of Osnabrück, Germany. The importance of the human dimension in integrated assessment models and processes: Actor based analysis and modelling approaches.
- Dr Graham Harris, Chair CSIRO Flagship Programs. Ethics, biodiversity and complexity: An ecologist's view of catchment modelling and management.

The MODSIM 2003 Program will cover a broad range of topics within the theme including:

- Water Resources, Oceanography, Climate
- Global Change, Ecology, Agriculture, Forestry, and Fisheries
- Socio-Economic Systems, Demography, Business

- Econometrics, Economics, Statistics, Finance, Risk and Uncertainty
- Information Systems,Decision Analysis,Computing
- ndustrial, Mining and Operation Research
- Medical Research, Public Health, Epidemiology
- General Aspects of Modelling and Simulation

Call for Papers: Abstracts (300 words) by 29 November, 2002; Acceptance of abstracts by 20 December, 2002; Final papers (6 X A4) by 28 February, 2003

MODSIM 2003 Entitlements: Registration entitles participants to congress icebreakers, bound proceedings or abstract volume and CD, lunches, morning and afternoon teas, a Congress bag with pen and notepad, access to all sessions and the Congress dinner.

For further details, see the Congress website mssanz.cres.anu.edu.au/modsim2003.html or contact the Convenor, Dr David Post, CSIRO Land & Water, david.post@csiro.au

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LSS – The Latvian Simulation Society

The Latvian Simulation Society is organising, in co-operation with Genoa and Latvian centres of the International McLeod Institute of Simulation Sciences (MISS) and the Department of Production Engineering of the University of Genoa, the International Workshop on Harbour, Maritime & Multimodal Logistics Modelling and Simulation, HMS2003. The workshop will be held in Riga, Latvia, during September 18-20, 2003. For details please refer to the workshop web site at http://st.itim.unige.it/hms2003/index.html. The previous HMS workshop, HMS2002, took place during October 3-5, 2002 in Italy.

Further information on this event:

(http://st.itim.unige.it/hms2002/index.html).

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SNE Reports Editorial Board

www.argesim.org/sne/

SNE (Simulation News Europe) is the official membership journal of EUROSIM and sent to most members of the EUROSIM Societies as part of the membership benefits. Furthermore SNE is distributed to the members of SCS Europe, and to User Groups and for promotional purposes via ARGESIM.

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If you have any information you want to see published, please contact the corresponding member of the editorial board (society news, conference announcements, conference reports, events, etc.).

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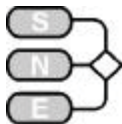### SCS Europe

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SIMULATION CENTRES

Center of Military Education, Research and Simulation Department at the Ministry of Defense of Republic Slovenia, Ljubljana

Introduction

The use of analogy is a well-proven teaching method, through which an understanding of complicated situations can be achieved by relating them to simpler and more ordinary equipment arising from developments in technology. Within the Armed Services, simulation had its early development in flying training but gradually spread to other areas. Until now it has become a standard training technique in all Services where sophisticated and expensive weapons systems are being used. However, this spread has been aided by developments in technology, especially in the field of computers.

Land Warfare. Soldiers and their commanders with their staffs must be exposed to various battlefield conditions and environments in order to develop their skills and knowledge. Simulation will have a significant impact in the area of refresher training, skill maintenance, retaining combat proficiency, and the evaluation of units prior to live firing or operational deployment. Simulation includes the use of practice ammunition, sub-calibre devices, embedded training software in operational equipment, computer simulation of enemy activity, instrumented training ranges, etc.

Each simulation can be performed by different methods according to the objective to be attained. The overall regulations, procedures for the scenario and the devices and techniques being used make up what is usually called " the model." When simulations involve decision makers, then a competitive situation arises, usually between two opposing factions, and 'the model' is then best formulated as a game.

The use of simulation model permits decision makers rather than an intervening model to competitively determine nearly all outcomes of the war game. In this application, manned simulators are linked into operational combined arms teams. These teams engage each other on common terrain in free-form, force on force exercises, even though the individual participants and their simulators may be widely dispersed and communicating using local area networks, land lines, and/or satellites.

Such networks may be used for training, acquisition support, and test and evaluation of war-fighting concepts and weapon system capabilities. They are typically not used for training individuals, but for training crews, units and commanders and their staffs.

The main objectives of war games are: to train military leaders to make decisions, to enable them to gain relevant experience, to provide them with the information required to perform their command activities under conditions that do not consume resources such as personnel and ammunition.

In order to optimize the player's performance, it is usual to plan a game in such a way that the player fully attains some objectives, but only partially attains others. Games that predominantly give decision-making experiences are called instructional games and have as their main purpose the training of the players to make decisions based on the information provided in the course of the game. The impact of their decisions, together with details of the problems stemming from them in the course of the game, are related to the players by the controller of the game, or umpire. Frequently, only partial information is given so as to simulate for fog of war.

The other main type of war games are known as analytic games and are aimed at collecting information that may assist commanders in their decisions concerning the choice of plans, tactics, doctrines, etc. As an excellent and cheap instrument of analysis, simulation enable the effects of plans, tactics or doctrines to be tested in a variety of environments by repeating and replaying the scenario, thus, by different means, providing the opportunity to make objective choices based on the results obtained.

1 Elements of CAX

If we would like to create environment for efficient Computer Assisted Exercise (CAX) we have to provide presence of basic elements:

1. Technical element
2. Operational element
3. Educational element.

With the technical element, we will ensure hardware and software for execution of exercise.

The technical support team should be included in planning phase, preparation, execution and analysis phases.

The main task for the team is to provide technical conditions for execution and analysis of the CAX.

SIMULATION CENTRES

This is the first interaction between elements: input of information about battle space and operational units in simulation model due to exercise concept, AAR process according preplanned educational objectives.

Operational element will define content and shape of decision-making process. The process in working cells is the same as in conventional staff process except feedback, which is produced by a simulation model. We will receive information about the quality of a commander's intention through analytical tools in the computer.

Once again we have interaction of three basic elements. The exercise director has to define the educational objectives prior to start of the CAX in order to create conditions for a reasonable tactical problem on available technical capacities.

With educational element, we will achieve desirable level of quality, which depend on the training objectives.

2 THE SYSTEMS APPROACH TO TRAINING (SAT)

A system has been defined as a set of parts co-coordinated to accomplish a set of goals. The component parts of a training system are interrelated and exist to accomplish a common function. If one of the parts is altered, the way in which the system functions, or the system output, will also change. The Systems Approach is simply a way of thinking about systems and their components.

The System is predicated on an ability to describe requirements in definitive and measurable terms. The way used to accomplish the statement of training requirement is the training objective to reflect, as accurately as possible, the cognitive, affective, and psychomotor elements of performance. Taken in a larger context, SAT is a sub-system of the larger military organization.

Training must co-exist with and is dependent upon other sub-systems such as equipment, financial and personnel resources. A modification to the training system may have an impact on another sub-system.

The models at Fig. 1-1 and Fig. 1-2 represent 2 simple sub-systems, which are integral part of any organization.

The open-loop system at Fig. 1-1 reflects a basic systems approach. The system reacts to input providing relative output; however, there is no monitoring of the process.

INPUT → PROCESS → OUTPUT

Fig 1-1 - A Simple Open-Loop System

Without this monitoring function there is no way to measure system effectiveness and thus identify deficiencies in the system. The simple closed-loop system precludes this kind of disaster but it too has an inherent flaw.

A closed-loop system as depicted at Fig. 1-2 ensures output is automatically monitored and then compared to desired output. Desired output can be achieved through modification of input when necessary. Therefore, change cannot occur during the process phase.

INPUT → PROCESS → OUTPUT
FEEDBACK

Fig 1-2. - A Simple Closed-Loop System

A more comprehensive closed-loop system has been designed which is immediately responsive to COMPUTER ASSISTED EXERCISE.

The comprehensive system, referred to in the figure at the bottom, represents a systems approach to problem solving, which has a feedback loop and adjusts output to reflect requirements.

The process involves logical interacting steps beginning with the identification of a need and ending with a pre-determined output.

SCENARIO

TAKTICAL PROBLEM → MODEL → SIMULATION

ANALYSIS

As military weapons and support systems become more and more complex, the demands placed on their associated training systems raise exponentially. As these escalating demands must be faced, in a climate of increased competition for the recruit able populations in most NATO nations, with limited defense budgets, more efficient training strategies and methods must be introduced. We must find ways to minimize the expenditure of manpower, time and money needed for high quality training.

CONCLUSIONS

Simulation had its early development in flying training, but it has now extended to all areas of military training. The reasons explaining the increasing uses of simulation techniques in training are numerous. First, the complexity of the weapons systems existing in the inventories of all Armed Forces requires more training than before to achieve and maintain a high level of combat readiness.

It can be used to sustain skill levels when employment of the actual equipment is not practical for a host of reasons (for example, when deployed for an extended period on a peacekeeping mission).

Also, from a learning standpoint, simulation allows realistic experimentation in a context sometimes difficult or impossible to replicate with the real equipment (as for example, an engine room fire at sea).

A clear vision stands as an essential component of collective success. Leaders with an eye to the future must develop their vision with simulators based on a careful analysis of their experiences in sufficient detail to be of actual use in the future. The leader and his key colleagues must assemble a thorough set of milestones that assist the day -- by -- day work that actually creates the vision in the real world.

Finally, the leader has to commit time and energy to the hardest work of all -- maintaining focus on achieving milestones and, eventually, the inspiring vision. Few items in your preparation and execution of command will be as important or as rewarding.

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SIMULATION CENTRES

SIM-SERV
the Virtual Simulation Institute

www.sim-serv.com

Abstract. This paper introduces the virtual institute on production-oriented simulation Sim-Serv (www.sim-serv-com) which started operating with financial support by the European Union a year ago. The paper describes Sim-Serv's objectives, its organisation and the services it offers to researchers as well as to commercial suppliers and users of simulation tools and services.

Introduction: Virtual Institutes in the EU-GROWTH Programme

Sim-Serv has been set up with financial support by the European Union in the framework of its research programme GROWTH (for more info about GROWTH or EU funded research, see www.cordis.lu). It is one of currently 15 Virtual Institutes which focus on different areas of technology. The mission of these virtual institutes is to stimulate and co-ordinate application oriented research and development in dedicated areas, and to ensure a smooth transition of results into applications in industry and society. Each Virtual Institute (VI) is financed by the EC for a limited period, but is meant to operate beyond this period; hence each VI will establish a self-financing organisation which will carry on the activities at the end of the EU funded project.

The VI Sim-Serv (www.sim-serv.com) focuses on product- and production-oriented simulation. It provides practical support to researchers and developers, to those offering tools and services on a commercial basis as well as to industrial users.

Objectives of SIM-SERV

It is widely accepted that simulation – in spite of its obvious power and benefits – is not widely used in industry, clearly not as wide as it should be. The estimated potential for savings and improvement in European industry, which could be achieved by proper use of simulation, is enormous. The main objective of Sim-Serv is therefore to help turn potential into real benefits.

To this end, Sim-Serv builds up a **central entry point** for those seeking information, guidance and support. Newcomers find general information, case studies about successful applications (with an emphasis on the business dimension), a data base of papers and articles about all aspects of simulation, links to experts as well as a help desk ready to answer any questions regarding the use of simulation.

A network of experts is available for specific questions which cannot all be answered by the help desk staff themselves.

In addition, industrial users find **independent consultation and advice** about the possibilities of applying simulation technology to their business, the expected cost and benefits. An in-depth analysis of the problem leads to a recommendation of suitable solutions and suppliers who are able to deliver them.

On the other hand, the supply side consists of numerous small or even micro-enterprises offering in many cases highly specialised tools and solutions. Many of them are recently born spring-offs from research institutes. They tend to have problems getting Europe-wide visibility and finding customers from a broad range of industry sectors. Through massive dissemination and marketing activities, Sim-Serv facilitates **access to a European market** even for small or medium-sized providers.

Sim-Serv also stimulates **co-operation and joint developments** of suppliers and – on the long run – aims at the development of a suite of complementary tools, offered under a common brand.

Finally, Sim-Serv will provide an overview of the state of the art in simulation; it will identify trends and unsolved problems, and thus provide **guidance for research and - last not least – research policy**. Sim-Serv will play an active role also in future EU research programmes.

Organisation

Sim-Serv is currently lead by a **Core Team** consisting of three partners:

- VTT Technical Research Centre of Finland, Systems Dynamics Group (Espoo, FI, www.vtt.fi)
- Simulations-Dienstleistungs-Zentrum SDZ (Dortmund, D, www.sdz.de)
- City University, Centre for Systems and Modelling, Manufacturing Support Unit (London, UK)

VTT and SDZ clearly belong to the largest and most experienced suppliers of simulation services in Europe. Both developed own tools which are commercially available. Within Sim-Serv, VTT covers primarily the domain of continuous simulation; SDZ focuses on discrete event simulation. City University is mainly responsible for Public Relations and disseminates information on simulation and Sim-Serv to industrial enterprises and organisations.

The Core Team is responsible for running the institute's web site and help desk, for dissemination and marketing activities and for overall co-ordination of the network of suppliers and users described below.

Moreover, it supports potential users in analysing their problems, identifying options to apply simulation and finding the best suited supplier(s).

In order to continue the activities after the end of the funded project in October 2004, the Core Team will set up a commercial company Virable Oy based in Finland.

The **Sim-Serv Supplier Group** consists of currently 25 members, the number is steadily growing. They represent a good mix of complementary skills and cover the majority of EU member states plus some Central European countries. At present there is almost a balance of academic and commercial partners in the group.

The role of suppliers is to deliver customised solutions on request on commercial terms, and to provide input to the institute's web site. Whenever the Core Team has received a request from an industrial user, it forwards this request to the Supplier Group. By an internal bidding mechanism the best supplier is then identified and brought in touch with the user.

Suppliers also co-operate in working groups dealing with technical or economic matters of common interest. All suppliers are presented on the institute's web site.

The **User Group** comprises approx. 50 enterprises which have shown an interest in simulation. Their number is growing rapidly. The majority of them have no prior experience in this area. They receive periodic information on recent achievements in technology, on commercially successful applications, and on activities and offers of Sim-Serv. They may visit and use the web site and join working groups.
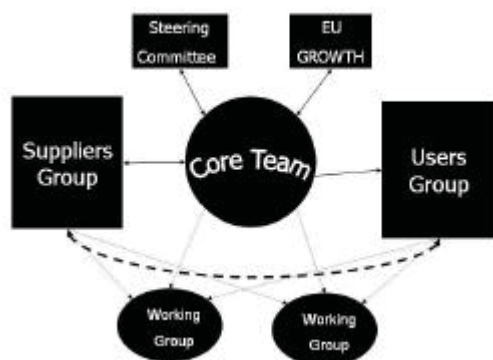
Both groups, the Supplier Group as well as the User Group, are open to new members at any time. It is indeed one of the aims of Sim-Serv to expand both groups substantially.

In addition, **Working Groups** (WGs) are being set up dealing with various technical or commercial issues of common interest. WG members may be suppliers or users, members or non-members of the Sim-Serv network. Also WGs generated elsewhere are invited to use Sim-Serv's facilities and make them known via Sim-Serv.

Finally, a **Steering Committee** consisting of high level representatives from research and industry, supervises the operation of the project.

SIM-SERV's Services

The central service of Sim-Serv is the web site. It contains general information about simulation, a database of technical and scientific information, news and information on relevant events, case studies and success stories, a list of suppliers and links to them as well as to other sites of interest, e.g. to European simulation societies. The working groups find their place on the web site, and reports about test cases can also be found.

Besides, Sim-Serv offers different services to different partners:

To potential users, the following is offered:

- the web site www.sim-serv.com contains general information on simulation, success stories, information about suppliers and relevant links
- the help desk answers specific questions and offers a first and rough evaluation of problems
- independent technical consultation supports the user in analysing his problem and checks if simulation should be applied and how,
- a supplier-independent functional specification of the application /solution is developed on request by technical experts
- the best suited supplier(s) of the specified solution are found
- project management support and an evaluation of the solution after its implementation are offered
- working groups provide a forum to express user problems and needs

To suppliers, the following is offered:

- the web site, containing news and information about relevant events
- a data base containing up to date technical information

SIMULATION CENTRES
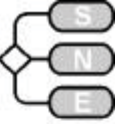
- working groups as a possibility to co-operate with other suppliers
- the chance to contribute to joint (funded) research and development projects
- professional, European- wide marketing activities
- offerings for additional commercial projects acquired by the Core Team

Special services for the research world are currently being discussed internally. Ideas for such services are:

- a "market place" of themes for diploma and PhD theses. Such themes might be proposed by industry and picked up by any student willing to work on the theme in co-operation with the proposing enterprise
- a database of completed or ongoing graduate and PhD theses
- periodic "state of the art" surveys and discussions of open issues, providing reference and guidance for research work
- support for the development of prototype software tools in order to increase their chances to be integrated with established tools and to reach industrial applications.
- informal working groups already established in the past may find a "home" in Sim-Serv and use the web site for communicating their results and finding new members.

More ideas are welcome at any time.

The most attractive offer to users and suppliers at the moment is certainly the possibility to take part in a so-called **test case**.

A test case is an industrial application of simulation, a project where a member of the supplier group and a member of the user group co-operate in order to solve the user's problem.

Test Cases help Sim-Serv evaluate and improve its services, therefore they are financially supported. They also help the dissemination activities because each test case has to produce a success story in the end which will be published on the web site and used in dissemination activities. Test cases may be found by the Core Team, they may also be proposed by users or suppliers.

The main pre-requisite for proposing is to be a member of Sim-Serv. To become a member is very easy, and test cases can even be proposed by organisations which are just applying for membership.

SIM-SERV's Future

Sim-Serv as a funded project will terminate end of October 2004. Until then, it plans to run approx. 20 test cases and at least an equal number of commercial applications. A detailed business plan describes the transition from funded to fully self-financed operation.

Sim-Serv closely co-operates with other virtual institutes, mainly with the virtual institute for advanced manufacturing technologies ADMAN (www.max-serv.com). These two institutes seem to complement each other in a most natural way.

The Sim-Serv Core Team is aware of the existence of numerous organisations active in the simulation field. The intention is by no means to compete with them.

We rather intend to complement the more science-oriented organisations such as the national simulation societies or EUROSIM, and to support the commercial organisations in order to promote our common goal:

To improve the general knowledge about simulation and its benefits, particularly in industry, to stimulate and facilitate a wider take-up, and to create an environment for fruitful **and** *exciting further developments of simulation technologies.*

Information

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Adresse http://www.sim-serv.com/index.php ✓ → Wechseln zu

Sim·Serv

The World's first Virtual Centre for simulation

SIMULATIONISTS PERSONALITIES

This new SNE corner – introduced in December 2000 in SNE 29 - follows two aims: to introduce young simulationists or simulationist of the rising generation, resp., and to report about awards and personal events. In both cases a curriculum vitae gives inside into the carrier of the simulationist:

- A young researcher or simulationist of the rising generation will be introduced in this corner, if e.g. his Ph.D. thesis is outstanding, or if he has got a research position, if he has got his first professorship or leading position, etc.
- Simulationists with high reputation often receive awards, or they are honoured in symposia, etc - these events will be reported here too.

Aleš Belic

Dr. Aleš Belic

University Ljubljana

Fac. of Electrical Engineering

Laboratory of Modelling Simulation and Control

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Asst. prof. dr. Aleš Belic univ. dipl. inž. el. is an assistant at the Faculty of Electrical Engineering, University of Ljubljana. He works at the Laboratory of Modelling Simulation and Control.

He received his diploma and doctoral degree in electrical engineering from the University of Ljubljana, Slovenia in 1994, and 2000 respectively. In 1996 he received Student Prešern Prize for his work on modelling of histamine pharmacokinetics.

In 1994, after diploma, he started his scientific and educational work at the Faculty of Electrical Engineering as a junior assistant. Until now he has been an author or co-author of 9 articles in scientific journals, 4 invited lectures and 35 papers in scientific conferences.

He is a member of the Slovenian Society for Simulation and Modeling - SLOSIM.

Main areas of his professional interest are artificial intelligence modelling techniques in pharmacokinetics and pharmacodynamics and modelling in bio-medical area. Lately he is also involved in modelling of genetically controlled processes in living beings. However, due to his background as a control engineer, he is also involved in several projects and activities of his laboratory that deal with control engineering problems.

In the frame of TEMPUS project he visited Fachhochschule Hannover, Germany, and University of Glamorgan, Pontypridd, Wales (GB).

Due to the interdisciplinary component of his work, he is a member of pharmacokinetic and pharmacodynamic modelling group that consist of prof. dr. Rihard Karba from Faculty of Electrical Engineering and prof. dr. Aleš Mrhar, and dr. Iztok Grabnar from the Faculty of Pharmacy, University of Ljubljana. The group maintains contacts with the group of prof. dr. Roger Jelliffe at the University of Southern California, Keck School of Medicine, Los Angeles, California, USA, and with the group of dr. John Young at the University of Little Rock, Arkansas, USA.

Part of his not so professional and not too simulated area of interest is running (marathon).
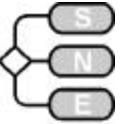
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Markus Klug is currently scientific assistant in the business field Process Optimisation at the ARC Seibersdorf research. Focussing on simulation in the field of logistics, project management and project acquisition are additional responsibilities.

During the study of Technical Mathematics, I focussed mainly on statistics, probability theory and operations research. Starting with computer services, I came in touch with simulation at the department for modelling and simulation at the Vienna University of Technology.

SIMULATIONISTS

Becoming a student of Prof. Felix Breitenecker and am member of the local ARGESIM group, the simulation career was started, focussing on discrete event simulation. From that time, all the theoretical stuff from the study became practical. Obviously the master thesis dealt mainly about general discrete event simulation being adapted for traffic simulation.

Still not being in favour of hard-core programming, my first simulation package, I used, was GPSS/H & Proof. This simulation package showed all basics, which are needed for simulation. For demonstrational purpose I still use this package to show simulator internals.

After finishing the studies, a half year trip abroad to Glasgow extended the simulation knowledge. Under the supervision of Prof. David Murray-Smith my research field became neural networks. Main intention is, to adapt the technologies out of this field for new developments in simulation.

For three years I was employed by the Computing Service Department, where, problems related to simulation like licensing played a major role. At that time, the computational knowledge increased for connecting simulation models to other programs.

At that time I started to get interested in a second topic: "e-learning". Even, if the two topics simulation & e-learning seem to be independent from each other, there are many possibilities to interact between them, as recent ASIM congresses show.

In September 2001 I started to work for the business field Process Optimisation at the ARC Seibersdorf research. At that time, I returned to my original profession, which I was educated in. In this position, to solve the daily work, results from the academic area have to be integrated in the solutions of practical world problems.

Since fall 2002 I give lessons at the polytechnic school in Wiener Neustadt in process simulation for students of Logistics as well as for Production and process Design.

Being honoured by being elected into the ASIM board at the ASIM 2002 my main intention is to strengthen the industrial aspect and to build an interface between academic research and industrial needs.

Summarizing, my scientific research is mainly business driven. Therefore I am developing new results up to a certain extend, which is necessary for solving problems, while I still try to keep the wide view to all aspects within and related to simulation.
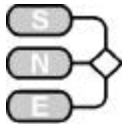
Markus Klug, markus.klug@arcs.ac.at

Golomb's Dont's of Mathematical Modelling:

1. Don't believe the 33rd order consequences of a 1st order model.
   CATCH PHRASE: 'Cum grano salis.'

2. Don't extrapolate beyond the region of fit.
   CATCH PHRASE:'Don't go off the deep end.'

3. Don't apply any model until you unterstand the simplifying assumptions in which it is based, and can test their applicability.
   CATCH PHRASE:'Use only as directed.'

4. Don't believe that a model is the reality.
   CATCH PHRASE: 'Don't eat the menue.'

5. Don't distort reality to fit the model.
   CATH PHRASE: 'The "Procustes Method".'

6. Don't limit yourself to a single model:
   More than one may be useful for understanding different aspects of the same phenomenon.
   CATCH PHRASE: 'Legalise polygamy.'

7. Don't retain a discredited model.
   CATCH PHRASE: 'Don't beat a dead horse.'

.8. Don't fall in love with your model.
   CATCH PHRASE: 'Pygmalion'.

9. Don't apply the terminology of subject A to the problems of subject B if it is to the enrichment of neither.
   CATCH PHRASE: 'New names for old.'

10. Don't expect that by having named a demon you have destroyed him.
    CATCH PHRASE: 'Rumpelstiltskin.'

From:
Arthur Bloch
MORE MURPHY'S LAW-
Wrong reasons why things go more;
London 1982 (Methuen)
ISBN 0 413 51540 0

ARGESIM
Working Group Simulation News

Arbeitsgemeinschaft Simulation News
www.argesim.org

ARGE Simulation News (ARGESIM) is a non-profit working group disseminating information on simulation, organising activities in the area of modelling and simulation (e.g. courses, comparative studies), publishing journals and books in this area, and providing the infrastructure for the administration of EUROSIM and ASIM activities.

ARGESIM works at three levels:

- European and International Activities: Journal SNE (editing and publishing; printing and WWW - publication), ARGESIM Comparisons on Simulation Technique and Simulation Software, Publication of Books, EUROSIM WWW - Server, Calendar of Simulation Conferences, Simulation Hotlinks

- Regional Activities: publication of ASIM-Nachrichten and User Group Newsletters, administration for ASIM and for User Groups, ASIM WWW - Server, WWW - servers for Austrian Research Centres (medinet.org, etcanet.org)

- Local Activities: seminars "Modelling and Simulation", simulation software support at Vienna University of Technology, various simulation projects

ARGESIM supports ASIM, EUROSIM and other institution in promoting publications, in advertising, etc. ARGESIM also runs for ASIM and EUROSIM boothes at conferences congresses, etc.

ARGESIM supports Education for Technical University Odessa

In summer ARGESIM started with special seminars on modelling and simulation for students from Technical University Odessa.

Based on an agreement between Vienna University of Technology and Technical University Odessa Ukrainian students from computer science, mathematics and electrotechniques visited TU Vienna for two weeks. During this time they attended courses in ARGESIM's seminar series "Seminar in Modelling and Simulation", which were arranged especially for the needs of the Ukrainian students. Topics were modelling and simulation with MATLAB and MAPLE.

In end of August an ARGESIM delegation visited Odessa, discussing with representatives of TU Odessa the next steps in the education program. Further details will be given in the next issue of SNE

Felix Breitenecker, Head ARGESIM
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www.argesim.org/sne/

SNE (Simulation News Europe) is the official membership journal of EUROSIM and sent to most members of the EUROSIM Societies as part of the membership benefits. Furthermore SNE is distributed to the members of SCS Europe, and to User Groups and for promotional purposes via ARGESIM.

SNE is registered with ISSN 1015-8685, continuing the ISSN 0929-2268.

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JOURNAL NEWS

New Journal: Biomechanics and Modeling in Mechanobiology

www.springer.de/engine/journals/c_10237.html

ISSN: 1617-7959 (printed version)

ISSN: 1617-7940 (electronic version)

Aims and Scope

Mechanics regulates biological processes at the molecular, cellular, tissue, organ, and organism levels. The goal of this journal is to promote basic and applied research that integrates the expanding knowledge-bases in the allied fields of biomechanics and mechanobiology. Approaches may be experimental, theoretical, or computational; they may address phenomena at the nano, micro, or macro levels.

Of particular interest are investigations that

- quantify the mechanical environment in health, disease, or injury,
- report discoveries that advance therapeutic and diagnostic procedures,
- detail inter-relations between mechanics and the associated biological processes, including growth, remodeling, and repair, and
- identify and quantify mechanosensitive responses and their mechanisms.

Especially encouraged are analytical and computational models based on solid mechanics, fluid mechanics, or thermomechanics, and their interactions; also encouraged are reports on new experimental methods that expand measurement capabilities and new mathematical methods that facilitate analysis.

Features & Benefits of this new journal are: i) First journal focusing on emerging field of mechanobiology; ii) Peer-reviewed; *Online First* for faster publication

Editor / Editorial Board

Editors-in-Chief: Gerhard A. Holzapfel, Graz University of Technology; Jay D. Humphrey, Texas A&M University College Station

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BOOKS AND JOURNALS

Issue 35/36

SIMPRA - Simulation Modelling Practice and Theory

www.elsevier.nl/locate/simpra

EUROSIM scientific journal Simulation and Modelling Practice and Theory (SIMPRA) is EUROSIM's scientific journal, published by Elsevier Science.

It publishes high quality contributions on modelling and simulation. Instructions for authors and other information can be found on the journal's webpage.

Submissions of manuscripts, inquiries

Authors are kindly requested to send enquiries or to submit their papers to the following address:

L. Dekker, c/o D. Georgescu, Editorial Office Mathematics & Computer Science Dept., Elsevier Science, P.O. Box 103, 1000 AC Amsterdam, The Netherlands Email: l.dekker@pa.twi.tudelft.nl

SIMPRA Special Issues

Apart from publishing regular papers, several special issues are in preparation, e.g.

- an issue on simulation of smart systems in civil engineering/modeling and simulation of large-scale and complex structures;
  Guest-Editors: prof.dr. Franco Maceri and Prof.dr. Fabio Casciati

- an issue on the BioMedSim part of the EUROSIM 2001 Congress
  Guest-Editor: Prof.dr. Y. Hamam

- in due course some papers will be published in the field of Air Traffic Management
  Prof.dr. Gaspare Galati

- Prof.dr. Helen Karatza will be the Guest-Editor of a special issue on Modeling and Simulation of Distributed Systems and Networks (see announcement)

- Dr. Stewart Robinson and dr. Simon Taylor are organizing a special issue based on good papers from the UK OR Conference 2002

- From the second international conference on simulation in food and bioindustries FOODSIM at Cork (June, 2002) one will propose some selected papers to the EUROSIM Journal

- The Italian Simulation Society had their annual conference beginning this year.
  They also will submit/have submitted some selected papers to our journal.

Please contact the Editor-in-Chief, Prof.dr. Len Dekker, for further information.

Call for Papers Special Issue " Modeling and Simulation of Distributed Systems and Networks"

A Special Issue of the Elsevier Journal: Simulation Practice and Theory, about Modeling and Simulation of Distributed Systems and Networks is planned for 2004. Guest Editor: Dr. Helen D. Karatza, Aristotle University of Thessaloniki, Greece

Distributed Systems offer considerable computational power, which can be used to solve problems with large computational requirements. Many different types of these systems consisting of large numbers of processors are available to the user community. These types range from distributed shared memory MIMD systems, to distributed memory MIMD systems, and to clusters or networks of workstations or PCs.

The considerable availability of different distributed systems as well as the diversity of the available hardware and software makes the arbitration and management of resources among users a difficult problem.

In these systems, it is crucial to decide where and when an application should execute, i.e., on which processors and in what order the application processes (or threads) will run.

Distributed computing is valuable for problem solving in many scientific domains and has gained a large amount of attention. Performance studies have explored a wealth of alternatives with respect to distributed systems aimed at improving system performance by improving the performance of its individual components.

Furthermore research efforts have focused on improving networks in order to deliver high-speed, reliable message passing and high performance response as well as solve multi-commodity flow problems with distributed routing techniques.

The most straightforward way to evaluate the performance without a full-scale implementation is through a modeling and simulation approach. Detailed simulation models help determine performance bottlenecks inherent in the architecture and provide the basis for refining the system configuration.

Authors of papers, which explore modeling and simulation studies focused on problems in this area, are invited to participate in the Special Issue. Topics of interest include, but are not limited to:

- Load-Balancing and Load-Sharing
- Distributed Real-Time Systems
- Fault-Tolerant Distributed Systems
- Performance Modelling/Evaluation
- Scheduling in Distributed Systems
- Coscheduling of Applications on Multiple Proc.
- Scheduling in Distributed Shared-Memory Systems
- Scheduling of Parallel Applications within Distributed Systems (e.g. Clusters)
- Scheduling Methods for Networks of Workstations
- Scheduling of Heterogeneous Processors
- Novel Distributed Applications
Performance Modelling and Distributed Simulation
Improvement in System Performance through Optimization and Tuning
- Performance of Communication Networks for Distributed Systems
Autonomous/Peer-to-Peer Systems
Grid/Cluster Computing in Distributed Systems
- Routing in Interconnected Networks
- Modelling and Performance Evaluation of Large-Scale, Scalable Network Algorithms
- Data Dissemination Schemes in Distributed Networks
- Network Workload and Traffic Characterization

Results of both theoretical and practical significance will be considered. Instructions for authors etc. can be found at the Journal website at.

Papers have to be submitted ONLY directly to Elsevier (simpra@elsevier.com) mentioning that it is for this special issue.

Important Dates, Information

- Submission deadline April 15, 2003,
- Review results and acceptance decision: August 15, 2003;
- Final revised paper: October 1, 2003;
- Tentative publication date: January 2004.

Further information can be obtained by contacting the Guest Editor:

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IJS³T
Int. Journal of SIMULATION:
Systems, Science & Technology

ducati.doc.ntu.ac.uk/uksim/
journal/issue-1/cover.htm

IJ S³T — *International Journal of* **Simulation: Systems, Science & Technology**

UKSIM, the United Kingdom Simulation Society, has started an International Journal: IJS³T, printed at Nottingham Trent University. ISSN: 1473-8031 Print, 1473-804x Online.

Aims and Scope. The aim of the journal is to present high quality papers which are relevant to simulation researchers, practitioners, teachers, students and users of simulation systems in practice, scientific theory, history or technology of simulation.

Special Issue on **Modelling & Simulation of Parallel & Distributed Systems** (June 2002). Guest Editor: Helen Karatza, karatza@csd.auth.gr, Aristotle Univ. of Thessaloniki, 54124 Thessaloniki, Greece.

- Editorial Paper: Current Trends in Modelling and Simulation of Parallel and Distributed Systems. H. Karatza
- A Dynamic, Tunable QoS-Fair Scheduling Scheme for Multimedia Streams. M. S. Boykin, T. F. Znati
- Communication Support for Thightly-Coupled Distributed Mobile Parameters. I. Gerasimov, R. Simon
- Profile-Based Characterization and Tuning for Subsurface Sensing and Imaging Applications. M. Ashouei, D. Jiang, W. Meleis, D. Kaeli, M. El-Shenawee, E. Mizan, Y. Wang, Ch. Dimarzio, C. Rappaport
- Performance Analysis and Capacity Assignment Optimisation of Wireless GSM Cells wirh Re-Use Partitioning. D. D. Kouvatsos, S. Tantos, I. Awan, K. Al-Begain
- Simulating the Reliability of Distributed Systems with Unreliable Nodes. Z. He, Y. Tian, Y. Chen
- Performance Equivalence in the Simulation of Multiprocessor Systems. W. M. Zuberek
- Adaptive Load Sharing in heterogeneous Systems. Policies, Modifications, and Simulation. K. Y. Kabalan, W. W. Smari, J. Y. Hakimian
- The Development and Evaluation of a Monitoring Technique for M-FAC. A. Maqousi, F. Ball

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Systems Analysis Modelling Simulation

www.tandf.co.uk/journals/titles/02329298.html

Aims and Scope:

Devoted to the art, techniques and applications of modelling and simulation in systems analysis. Systems analysis is an interdisciplinary activity.

Articles are published on systems analysis and systems theory, modelling and mathematical models and tools for decision and control, computer simulation systems, modelling and simulation in environmental protection, macroeconomics, agricultural production, regional planning, biosciences, traffic control, large engineering systems, resources distribution, management systems etc.

In addition to original papers, survey articles, reports on conferences as well as letters on modelling by invited scientists will be published. Books covering the above mentioned and related subjects are also reviewed.

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Information

CrossRef –
Citation Linking backbone

www.crossref.org

CrossRef is the citation linking backbone -- a collaborative reference linking service that allows the user to click on a citation and be taken directly to the target content. Online publishing is raising the bar for resource discovery. The scientific and scholarly community now demands navigational ease at the desktop. More than ever, publishers, librarians, and information aggregators are expected to provide seamless integration of current and archived content across publishers.

With the advent of new technologies and an online playing field, scholars, researchers, students, and professionals insist on access to information that is relevant, timely, easy to obtain. Those navigating digital information want to retrieve and follow live, dynamic links to full text or high-quality citations without awkward maneuvers. Those authoring the intellectual content expect further and easy dissemination of their work to others.

CrossRef is a publisher-driven initiative to enable users to click on a reference citation and be taken directly to the cited material. And *CrossRef costs the researcher nothing*. While citation linking for electronic journals was its initial focus, CrossRef has recently expanded its coverage to conference proceedings, reference books, and other content types.

An independent, non-profit membership organization that employs open standards, CrossRef was established in cooperation with leading scholarly publishers and the International DOI Foundation. Both commercial and non-profit publishers sit on its Board of Directors. Since the service went live in 2000, CrossRef has linked millions of articles from thousands of journals, and hundreds of thousands of content items are being added yearly.

To date, there are over 150 publishers participating in CrossRef, accounting for thousands of journals and millions of individual content items registered in our database. As a publisher, librarian, an A&I service, agent, or aggregator, membership in CrossRef gives you the opportunity to participate, influence the process, use CrossRef data and services, and learn how this collaborative initiative benefits the researcher and facilitates information access.

What CrossRef is: A not-for-profit network founded on publisher collaboration, with a mandate to make reference linking throughout online scholarly literature efficient and reliable. As such, it is *an infrastructure for linking citations across publishers*, and the only full-scale implementation of the Digital Object Identifier (or DOI) System to date.

What a DOI is: A *unique alphanumeric string* assigned to a digital object – in this case, an electronic journal article or a book chapter. In the CrossRef system, each DOI is associated with a set of basic metadata and a URL pointer to the full text, so that it uniquely identifies the content item and provides a persistent link to its location on the internet. For more information on the DOI itself, which is a NISO standard syntax, please visit the International DOI Foundation website at www.doi.org.

What CrossRef **is not:**
- A product for sale
- An article database
- A direct-to-end-user service
- A search interface
- A broker of full-text content
- Made up of just big commercial publishers

CrossRef's mission: To serve as the *complete citation linking backbone for all scholarly literature online*, as a means of lowering barriers to content discovery and access for the researcher. We are currently expanding our citation linking services beyond journal articles, to conference proceedings and books.

Who developed CrossRef? Scholarly publishers developed CrossRef. The initial service was based on a prototype developed by John Wiley & Sons and Academic Press, in cooperation with the International DOI Foundation (IDF). It built on the DOI-X project led by the IDF, Association of American Publishers (AAP) and the Corporation for National Research Initiatives (CNRI).

Who participates in CrossRef: Any publisher of primary research material in digital form -- whether large or small, commercial or non-profit, traditional or non-traditional -- can register their content with CrossRef by joining our growing list of members. A variety of other organizations also participate:

- Libraries use the CrossRef system as part of their localized linking solutions, enriching online catalogues and databases with links to their own full-text holdings where appropriate.
- Intermediaries, including secondary publishers and journal hosting services, use CrossRef as affiliates and agents, enhancing their own products and content offerings with DOI-based citation links.

- Technology companies are creating software tools that interface with CrossRef.

Key benefits of the CrossRef system:

- No state links: Because a DOI link is a persistent link, unlike a URL , publishers and others who use CrossRef create reliable, persistent links in citations and database records.
- A single agreement with CrossRef serves as a linking agreement with all participating publishers. Avoid having to sign numerous bilateral linking agreements with publishers.
- Add value to your electronic publications: Readers have come to expect online material to contain outbound links to cited sources. At the same time, CrossRef linking will augment the accessibility of your content through inbound links.

How the system works and what publishers have to do: Publishers of electronic scholarly content join as members and are assigned a DOI prefix. For each content item a publisher wishes to register in the system, it creates a unique DOI (incorporating the assigned prefix) and tags it to the article's metadata and the URL where the article resides. The publisher submits the record to the CrossRef metadata database (MDDB) in a strict XML-based DTD format. CrossRef then registers each article DOI and URL in a central DOI directory. This allows for permanent inbound links to the publisher's content, because other publishers, librarians, and affiliates (such as subscription agents and secondary publishers) can retrieve from CrossRef the DOIs that link to that content.

In a separate process, the publisher also submits the citations contained in each deposited article to the Reference Resolver, the front-end component of the MDDB that allows for the retrieval of DOIs. This way, the publisher can add outbound links to any of an article's citations that point to content already registered in the CrossRef system. The CrossRef website includes technical specifications for querying.

The DOI Resolution system is run by CNRI on behalf of the IDF. When a user clicks on a link containing the DOI, the DOI Resolution system directs the user to the URL submitted by the publisher. The process of resolving a DOI happens outside of CrossRef.

CrossRef is not an article database: CrossRef does not aggregate full-text content. Rather, it uses a system of "distributed aggregation" whereby full-text content is linked through a database consisting of minimal publisher metadata. Each record in the database is essentially a triplet: {metadata + URL+DOI}.

Who pays, and how much: Publishers pay a nominal membership fee based on the number of online publications they produce, as well as small transaction fees for each DOI deposit and retrieval. Please see the publisher fee schedule. Affiliates pay an Annual Administrative Fee, in addition to DOI retrieval fees. Libraries pay a small annual fee for unlimited access to the system. There is no charge associated with clicking on a CrossRef link.

Why libraries participate: Library users want to navigate directly from citations or database records to journal articles, but library records do not contain article-level information or links. Although CrossRef cannot solve the appropriate-copy problem on its own, because it is not a customizable software product, CrossRef is a key piece of the puzzle in localized linking solutions for digital collections. Library affiliates can use the CrossRef system to look up both DOIs and metadata, which makes all CrossRef publishers OpenURL compliant for the purposes of **article-level linking to local holdings.** At the same time, libraries who want to expand their users' access to content not owned will benefit from CrossRef links to the publisher's full-text source.

CrossRef does **not compete with OpenURL:** OpenURL is a syntax for transporting metadata and identifiers within URLs, and CrossRef is a DOI registration facility.

Researchers do not pay **for CrossRef linking:** Researchers do not pay for following links enabled by CrossRef. A subscribed user is usually IP-authenticated for direct access to the target article. While that does not mean all users automatically get free access to the full text, the system works to reduce some of the friction in online research by allowing the researcher to navigate at the article level.

How researchers use CrossRef: A researcher clicking on a CrossRef link will be automatically connected to a page on the publisher's website showing a full bibliographical citation of the article, and, in most cases, the abstract as well. Subscribers are generally authenticated for full text access, and non-subscribed users presented with other options for access. (such as subscription, document delivery, or pay-per-view.) Researchers in library environments may find that CrossRef links redirect to local holdings.

CrossRef is operated by the Publishers International Linking Association (PILA)

Electronic Archiving by Co-Operation of National Library of Netherlands and Elsevier

www.elsevier.com

In Glasgow, August 20, 2002, at the Conference of the International Federation of Library Associations and Institutions (IFLA) in Glasgow, Elsevier Science and the Koninklijke Bibliotheek, the National Library of the Netherlands, announce a groundbreaking new agreement in relations between publishers and libraries world-wide in the area of electronic archiving. The Koninklijke Bibliotheek (KB) will become the first official digital archive for Elsevier Science journals. This means the library will receive digital copies of all Elsevier journals made available on its web platform, ScienceDirect, which are approximately 1,500 journals covering all areas of science, technology and medicine, and exceeding 7 TB of data. For everybody involved in research and the communication of research results - authors, researchers, librarians and publishers alike - this is a decisive step forward in keeping digital archives available in perpetuity.

The need to provide for permanent digital archiving has been evident to libraries and to Elsevier for several years. Elsevier has been a leader in advocating publisher responsibility in this area. In 1999 Elsevier Science made a public commitment to ensure digital archiving with a trusted repository and made this part of its license with library customers. The KB was the natural partner, as it is a clear leader worldwide in the experimentation with and investment in digital preservation.

In 1994, the KB decided to include electronic publications into its deposit collection. Since then, research and development on long-term digital archiving has been top priority in the KB. "Ensuring permanent availability of information and knowledge is at the heart of the KB's mission," says Wim van Drimmelen, Director General of the KB. Digital archiving is a logical extension of the role we always had and will have in the area of printed material, the modern version of a traditional task. In this era of electronic publishing new arrangements are needed globally in order to preserve our intellectual heritage. The KB wants to take an active part in these evolving new arrangements. It's an exciting challenge to find ways of coping with the fast pace of change in platforms and formats. From the start we committed ourselves strongly to this challenge.

We take pride in this groundbreaking agreement with Elsevier and see it as recognition of our achievements so far and a milestone on the way to our strategic goals."

Elsevier Science is particularly pleased to enter into this arrangement with the KB. As the largest publisher of scientific, technical and medical research information, Elsevier is fortunate to have such an advanced partner in its home country.

Under this historic agreement, the KB will receive digital copies of all Elsevier journals made available on its web platform, ScienceDirect. This is approximately 1,500 journals covering all areas of science, technology and medicine, currently published by Elsevier Science. Should new journals be added to the Elsevier list, these will also be included in the archive. In addition, Elsevier is in the process of digitising the older years of these journals, going back whenever possible to volume 1, no. 1, and all of these digitised backfiles will also be deposited with the KB. It is estimated that the starting collection, when all backfile digitisation is completed in the next two years, will exceed 7 TB of data.

The journals are currently made available to customers of ScienceDirect in two formats: Adobe Acrobat's PDF format (which mimics the printed page) and a tagged, structured text format that permits different on-screen viewing, faster network delivery and sophisticated search, retrieval and linking. Both formats will be sent to the KB. "It is anticipated that these formats, associated retrieval techniques and storage media may change over time," says Johan Steenbakkers, Director Information Technology of the KB. "As part of our commitment to being the official archive, we will take responsibility for migrating the content and associated software as technologies change. Together with IBM, we are developing a new electronic deposit system that can meet large scale and high quality storage requirements and supports digital preservation functionality. The library and IBM jointly have studied and tested long term preservation issues. This fall, the new E-Deposit system will be handed over to the KB and the Elsevier journals will be placed into it. Elsevier will work closely with us to ensure permanent availability."

To solve the problems of digital preservation and long term access, the KB has always looked for strategic partners. Steenbakkers explains: "We have been quite successful in finding excellent partners and in building good working relationship with them. Such partners are IBM and RAND, but also other, advanced national libraries like the NEDLIB partners, the Library of Congress, the National Library of Australia and the British Library.

THE dependability of THE WOLVERINE is WELL-known in these parts.

A second crucial factor for our success, is the close co?operation, right from the start, with some major publishers that has provided the KB with real?life content, first to experiment with and later on to develop the infrastructure and skills needed for handling and maintaining electronic publications. The very first publisher the KB teamed up with was Elsevier Science."

The KB will provide access to the journals on a current basis to all who come to the library and are permitted access to the library's collections. In addition, should there be a catastrophic disaster such that the ScienceDirect system is inoperable for a long period of time; the KB would be part of the interim service system.

Finally, should Elsevier or a successor interest cease to make these journals available on a commercial basis, as an official archive the KB could open access to all on a remote basis (in addition to walk-in).

About ScienceDirect

www.info.sciencedirect.com

ScienceDirect is an open platform offering its subscribers desktop access to more than 2.5 million full-text articles. Coverage includes over 1,500 journals published by Elsevier Science and dynamic linking to journals from around 120 leading STM publishers through CrossRef.

An expanding suite of scientific full text and abstract databases in a rich linking environment provides subscribers with increasingly flexible and extensive access to the world's published STM literature. ScienceDirect is a division of Elsevier Science and part of the Reed Elsevier plc group.

About the Koninklijke Bibliotheek.

The Koninklijke Bibliotheek (KB) is the National Library of the Netherlands. The Library was founded in 1798. The KB is an autonomous administrative body financed by the Dutch Ministry of Education, Culture & Science.

The KB's mission statement is to provide universal access to the knowledge and culture of the past and present by providing high-quality services for research, study and cultural enrichment.

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ARGESIM COMPARISONS

Comparisons of Modelling and Simulation Techniques and Tools

www.argesim.org/comparisons

Simulation News Europe (**SNE**) started in 1990 to publish a series on comparison of simulation software. These software comparisons developed towards benchmarks not only for simulation tools but also for modelling tools and, more generally, for modelling techniques. Furthermore, the solutions – many of them with source codes in various simulators – may be used as examples in simulation courses, etc.

ARGESIM, the Working group Simulation at Vienna University of Technology takes care on definition of these comparisons, on publication of the solutions and of evaluation of the solutions.

The principle idea of the comparison is a mixture of a general simple comparison of features within "yes/no" – tables and the well-known benchmark problems (like PHYSBE).

Based on relatively simple, easily comprehensible models different modelling techniques and their implementation as well as features of modelling and experimentation within simulation languages, also with respect to application area, are compared.

The comparisons started in 1990, and since that time there have taken place new developments in software and algorithms.

Consequently also the comparisons developed further on, from *comparisons of simulation software* to *comparisons of modelling and simulation techniques and tools*. This development is based on following facts:

SNE	Sum	C1	C2	C3	C4	C5	C6	C7	CP1	C8	C9	C10	C11	C12	C13	C14	C15
0		Def															
1	5	5	Def														
2	8	4	4	Def													
3	10	4	3	3	Def												
4	13	1	5	5	2	Def											
5	8	4	-	1	1	2											
6	5	-	2	-	2	1	Def										
7	7	1	2	1	2	-	1	Def									
8	5	-	1	-	-	-	1	3									
9	5	-	-	-	-	-	2	3									
10	7	1	2	-	-	-	1	2	Def/1								
11	8	2	2	1	-	1	-	-	2								
12	7	1	-	1	-	-	-	2	3								
13	4	-	-	-	-	-	-	3	1								
14	6	3	-	1	-	-	-	2	-								
15	2	-	-	1	-	1	-	-	-								
16	3	1	-	-	-	-	-	1	-	Def/1							
17	6	-	-	1	-	1	-	1	1	1	Def/1						
18	5	-	-	-	-	-	-	2	2	-	-	Def/1					
19	6	-	-	-	-	-	-	-	1	1	1	3					
20	5	-	-	-	-	-	-	1	-	1	1	2					
21	10	-	1	-	1	-	1	5	-	-	-	2					
22	10	1	-	1	-	1	-	5	-	1	-	-	Def/1				
23	5	-	2	-	-	-	-	-	-	-	2	-	1				
24	7	1	-	-	1	-	-	2	-	-	-	1	2				
25	7	-	1	-	-	1	-	-	-	-	3	1	1				
26	11	2	1	2	1	1	-	1	-	-	1	1	1				
27	6	-	-	1	-	-	-	-	-	-	2	1	-	Def/2			
28	7	-	-	2	-	1	-	-	-	-	2	-	-	2			
29/30	11	1	1	1	1	-	3	-	-	-	-	1	-	3			
31	6	-	-	-	-	-	-	1	-	-	-	-	1	3	Def/1		
32/33	10	-	1	-	-	-	-	1	-	-	2	1	-	4	-	Def/1	
34	5	1	1	-	-	-	1	-	-	-	-	1	-	1	-	-	
35/36	12	2	-	-	1	2	-	3	-	-	-	1	-	-	2	1	Def/1
Total	232	35	29	22	12	12	10	38	11	5	15	16	7	15	3	2	1

The table is headed **Comparisons** spanning columns C1–C15.

COMPARISONS

Issue 35/36

COMPARSIONS

- Nowadays different modelling approaches are offered by simulators – especially in case of discrete systems.
- The paradigm of Classes and Objects has changed software engineering dramatically. Also in modelling and simulation OO approaches give better insight into structures. All discrete comparisons may be handled with OO techniques, on model level and on execution control level.
- In continuous modelling the OO approach allows modelling on a higher (non-causal) graphic level. This holds especially for the continuous comparisons with examples from mechatronic.
- Hybrid approaches become more and more important; and as simulators offer environments with complex features, hybrid approaches can now be set up easily. All continuous comparisons with events can be solved also by hybrid approaches.
- Symbolic computation is an alternative to analysis in the time domain. Nowadays symbolic computation systems can analyse also nonlinear systems and can handle complex semi-numerical tasks. All continuous and hybrid comparisons can be approached by these highly developed tools
- Up to now missing are approaches to the discrete comparisons by means of statistical tools. In combination with symbolic computation discrete event systems can be approximated by queuing theory
- Furthermore, many simulators have been developed continuously. So it makes sense to solve a comparison from time to time with the new version of a specific simulator, to show the advance of this specific tool

We also are working on a classification of the solutions. Key words should characterise a specific solution: method or approach used generally modelling technique, methods used in the tasks. A database will support this classification.

Definitions

This issue presents a new comparison, **C15 Clearance Identification**, taken from physiology, analysing a model used in diagnosis and therapy. Furthermore, a revised definition of C13 Crane Crab with Embedded Control is given, as there were misunderstandings with a too short first definition.

- **C1 Lithium-Cluster Dynamics**, **SNE 0** (11/90), checks integration of stiff systems, parameter variation, and steady state calculation.
- **C2 Flexible Assembly System**, **SNE 2** (3/91), discrete system, compares features for submodel structures, control strategies, and optimisation.
- **C3 Generalised Class-E Amplifier**, **SNE 2** (7/91), simulation of electronic circuits, table functions, eigenvalue analysis, and complex experiments.

- **C4 Dining Philosophers I**, **SNE 3** (11/91), general comparison, involving not only simulation but also analysis e.g. by Petri nets and, etc.
- **C5 Two State Model**, **SNE 4** (3/92), checks high accuracy features and state event handling).
- **C6 Emergency Department - Follow-up Treatment**, **SNE 6** (11/92), discrete system, tests features for modelling, concepts of availability, and complex control strategies.
- **C7 Constrained Pendulum**, **SNE 7** (3/93), checks features for hybrid modelling, comparison of models, state events, and boundary value problems.
- **CP1 Parallel Simulation Techniques**, **SNE 10**, (3/94), deals with the benefits of distributed and parallel computation for simulation tasks; three test examples test parallelisation techniques.
- **C8 Canal-and-Lock System**, **SNE 16** (3/96), discrete system, checks features for complex logic control, validation and variance reduction.
- **C9 Fuzzy Control of a Two Tank System**, **SNE 17**, (7/96), asks for approaches and for implementations of modules for fuzzy control.
- **C10 Dining Philosophers II**, **SNE 18** (11/96), reviews discrete simulators with respect to concurrent access to resources and with deadlocks.
- **C11 SCARA Robot**, **SNE 22** (3/98), deals with implicit and hybrid systems with state events.
- **C12 Collision of Spheres**, **SNE 27**, November 1999, allows numerical or analytical analysis as well as continuous or discrete approaches
- **C13 Crane Crab with Embedded Control**, **SNE 31** (3/01), revised **SNE 35/36** (11/02) checks techniques and features for embedded digital control with sensors and with DAE-systems
- **C14 Supply Chain**, **SNE 32/33** (11/2001), **SNE 34** (7/2002) addresses discrete simulators - features for supply chain systems (messages, strategies)
- **C15 Clearance Identification**, **SNE 35/36** (11/02), checks identification features (based on measured data) and influences of noise

Solutions

We invite all readers to participate in these comparisons. Please, simulate the model(s) with any tool of your choice and send in a solution.

A solution should consist of: 1. a short description of the simulator, 2. modelling technique, model description, 3. results of the three tasks. Additionally we ask for: 1. suggestion for classification (see WWW), 2. model codes, if available. The solution should fit into one page of SNE – templates are found at our web page. Solutions sent in are reviewed. Source codes of model and / or experiment description are highly appreciated.

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C15 Clearance Identification - Definition

Simulation and Identification of a Model for Renal Clearance

This comparison is a practical model approach in the field of physiological simulation. It was originally introduced to improve medical analysis of the renal clearance (for further informations refer to Short Note *Renal Clearance – Modelling and Identification*, SNE 35/36, November 2002, p. 42-44).

The renal clearance i.e. the possibility of the kidney to transport a given substance or marker is investigated. To estimate the renal clearance a marker is injected. For a certain time control samples of the concentration of the marker are done. Then a two-compartment model has to be identified with these experimental marker concentration profiles.

Model Equations

In the compartment model the extracellular space is considered to be composed of two functionally separated spaces, a well perfused central volume and a less perfused peripheral compartment. The marker kinetics as represented by the temporal courses of the marker amounts in the two compartments is the result of the infusion strategy, the exchange transports between the two compartments, and finally the renal elimination process (1,2,3).
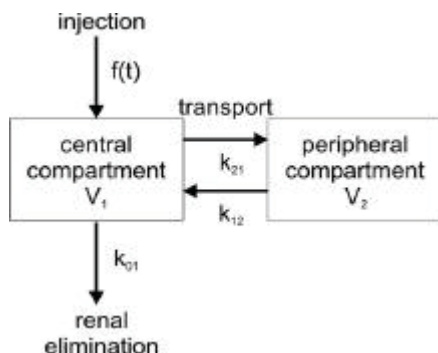
Figure 1: Compartment Model

The model can be formulated by a set of two simultaneous differential equations describing the rates of change of the marker amounts in the two respective compartments:

$$dx_1/dt = f(t) - (k_{01} + k_{21})x_1 + k_{12}x_2 \qquad (1)$$

$$dx_2/dt = k_{21}x_1 - k_{12}x_2 \qquad (2)$$

$$f(t)=D/\tau, \qquad 0 \le t < \tau \qquad (3)$$

$$c(t) = x_1(t) / V_1 \qquad (4)$$

Equations (1) and (2) can be stated verbally in the following way: Firstly, the rate of change of the marker amount in the central compartment, dx_1/dt, is determined by the input strategy chosen, the loss of marker from the central to the peripheral compartment, its gain by the central from the peripheral volume, and its elimination through the renal excretion mechanism. The renal clearance C is defined as $C = k_{01} V_1$.

Secondly, the rate of change of the marker amount in the peripheral space, dx_2/dt, is due to gain from and loss to the central pool. These processes are assumed to be proportional to the marker amounts momentarily contained in the respective distribution.

Data

Not only the amount of the injected marker D can vary but also the time of the injection τ can differ between seconds an hours. The parameters k_{01}, k_{21}, k_{12}, and V_1 may be given, but normally – as mentioned before - it is the task to find those parameters by adapting the system to given concentrations c(t). Note, that also V_1, the conatnt volume in the central compartment, is an unknown parameter.

The following test data resulted from a test which lasted for 4 hours and should be used for identification of the four parameters k_{01}, k_{21}, k_{12}, and V_1.

Time	Concentration
5 min.	276 mg/l
10 min.	227 mg/l
15 min.	203 mg/l
20 min.	190 mg/l
25 min.	184 mg/l
30 min.	174 mg/l
35 min.	176 mg/l
40 min.	171 mg/l
45 min.	167 mg/l
50 min.	163 mg/l
55 min.	151 mg/l
1 hr.	155 mg/l
1 hr. 15 min.	150 mg/l
1½ hrs.	142 mg/l
1 hr. 45 min.	141 mg/l
2 hrs.	135 mg/l
2½ hrs.	128 mg/l
3 hrs.	120 mg/l
4 hrs.	111 mg/l

Table 1: Meassured Concentrations c(t)

Methods

Adaption to the given experimental data should be done with the least square method. For the set of parameters $p = (k_{01}, k_{21}, k_{12}, V_1)$ we can do this by searching the minimum of the criterion:

$$E(p) = \sum (c_1(t_i) - c_{exp}(t_i))^2, (i = 1 \ldots n) \qquad (5)$$

The identification of the model should be done with an appropriate algorithm, e.g. with the Levenberg-Marquardt algorithm, allowing to estimate the optimal values of the independent system parameters k_{01}, k_{21}, k_{12}, and V_1 as well as of dependent parameters such as V_2 or the clearance $C = k_{01} V_1$.

The error estimation of the parameters done with a Monte Carlo method, is processed with statistics of a number of adapted "artificial" data, which one gets by superposition of random numbers with mean of 0 and standard deviation

$$s = (E/(n-n_p))^{\frac{1}{2}} \qquad (6)$$

on the given data. n ist the number of experimental data and n_p the number of parameters = 4.

Model Approach

Although the system of linear differential equations can be solved analytical, the problem also can be solved numerical. Furthermore, for other markers the constant parameter k_{01} becomes a function $k_{01}(c(t))$ of the concentration, so that the model becomes nonlinear and cannot be solved analytically.

Give a short explanation of the model approach and implementation, especially give details on bolus modelling. For comparison with the analytic solution see also the Short Note Short Note *Renal Clearance – Modelling and Identification*, SNE 35/36, November 2002, p. xx-xx

Task a: Simulation of the System

Implementation of the model with given parameters, where k_{01}=0.0041, k_{12}=0.0585, k_{21}=0.0498, and V_1=7.3; $x_1(0) = x_2(0) = 0$.

Simulate the system for 240 minutes and assume three different time values for the bolus injection (take that the jumps of the bolus function are implemented correctly, in order to get correct results):

- $D_1 = 2500$, $\tau_1 = 0.5$ min
- $D_2 = 2500$, $\tau_2 = 3$ min.
- $D_3 = 2500$, $\tau_3 = 240$ min.
- Plot the solution and for τ_1 the difference between the concentration of the injection and the real concentration.

- Give the values of x_1 one minute after the injection ends, in case of $\tau = 240$ min at the end of the injection time.

Task b: Identification

The model should be fitted to the experimental data mentioned above (see Table 1 and Figure 2). Evaluation of the cost functionn (criterion (5)) requires simulation of the system for 240 minutes, with type 1 bolus injection (D = 2500, $\tau = 0.5$ min).

The identification of the model should be done with an appropriate algorithm, e.g. with the Levenberg-Marquardt algorithm.
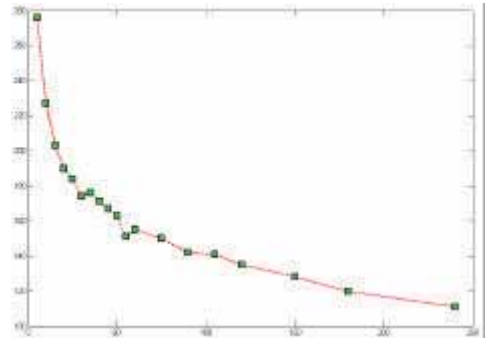
Figure 2: Experimental Data

Take care that the numerical function is evaluated at exactly the same points the experimental data is measured. Explain how the model is implemented (differential equation and Identification).

- Give the identified the values for k_{01}, k_{21}, k_{12}, and V_1, the maximum of the function, the clearance C and the residuum.
- Plot the data points and the solution of the identification problem.

Task c: Error Estimation

Perform 1000 times the identification (simulation) with different "artificial" data sets computed with the method mentioned above (formula (6)), resulting in 1000 parameters sets $(k_{01}, k_{21}, k_{12}, V_1)$.

Give mean and deviation of the parameters k_{01}, k_{21}, k_{12}, , and V_1.

Further info: www.argesim.org/comparisons

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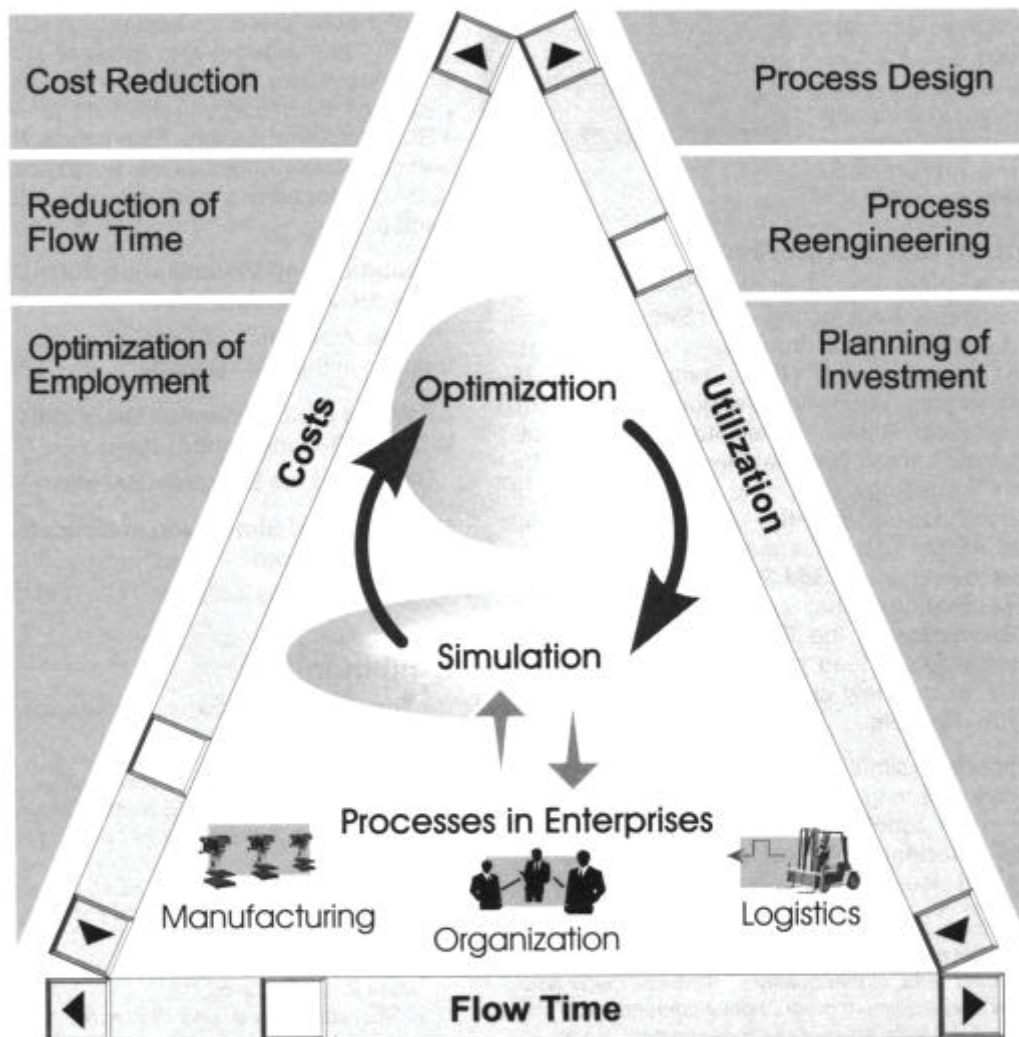
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C15 Clearance Identification - MATLAB / SIMULINK

Numerical Simulation / Numerical Identification

Simulator: MATLAB is a widely used software tool based on numerical vector and matrix manipulation. SIMULINK is a graphical extension for block oriented simulation. Those two parts can work together in both ways. Either by using m-functions as SIMULINK blocks or – as in this case – by controlling the SIMU-LINK model with an m-function. The computation of the following problem was done with the new MAT-LAB version 6.5 using also the Optimization Toolbox for task b.

Model: The system of differential equations is implemented in SIMULINK (see Figure 1). $f(t)$ is implemented with a step block with sample time 0.1.

Task a: Simulation of the System: The simulink model is controlled from an m-file. For the different values τ_1 = 0.5 min, τ_2 = 3 min., τ_3 = 240 min we get three different solutions (Figure 1) and the different values for $x_1(1.5)$ = 320.90, $x_1(4)$ = 302.58, $x_1(240)$ = 145.26. Even in the short time period of the first injection we can already see the clearance of the marker in the small sub-plot in Figure 2.

Figure 3: Data points and identified function

Task b: Identification: The SIMU-LINK model is called by an m-function `NiereFkt` (evaluation of cost functional) and then iterated using the optimization toolbox, in order to identify the parameters..

V_1 is not used in the simulink model (which is computed with the total amount of marker) but only in `NiereFkt`, where it is used to scale to concentration for adapting to the experimental data. So the procedure ilterates 3 parameters in the simulink model and 1 in the m-file.

```
kopt = start values
options = optimset
  ('Large  Scale','off',
  'LevenbergMarquardt','on',
  'TolX',0.0001,
   'TolFun',0.0001);
kopt = lsqnonlin (@NiereFkt, kopt0,
[],[],options,x1,x2,data,time);
```

Resulting parameters are k_{01}=0.0041, k_{21}=0.0494, k_{12}=0.0588, and V_1=7.31, the maximum of the function is 337.35, Clearance 30.33 and the residuum 260.81. Figure 3 shows the identified functions.

Task c: Error Estimation: Data are disturbed at MATLAB level, for each set of disturbed data the numerical identification is performed. The 1000 identifications resultet in mean value and standard deviation for the parameters: k_{01}=0.0041 (st.dev. = 0.0092), k_{12}=0.0586 (std. dev. = 0.0086), k_{21}=0.0503 (st.dev. = 0.0113), V_1=7.31 (st.dev. = 0.4207).

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Figure 2: Plot of the 3 different solutions, task a

C13 Crane and Embedded Control Revised Definition

This Comparison originates from a publication of E. Moser and W. Nebel in the Proceedings of the conference DATE'99 (*Eduard Moser and Wolfgang Nebel, Case Study: System Model of Crane and Embedded Control, Proc. DATE'99, pages 721-724*). The authors set up a benchmark mainly for testing the new VHDL-AMS model description. Therefore, the benchmark comprises digital elements (digital control, sensor action, and diagnosis) as well as a continuous linear model description. Main emphasis is to develop an embedded system for controlling a crane.

The crane moves along a horizontal track and transports a load to a certain position (Figure 1). The car of the crane is driven by the force f_c, which is released from a dc-motor that is controlled by a digital controller. The load is connected to the car by a cable of length r. Several sensors provide information about the current state of the system and actuators to control the crane.
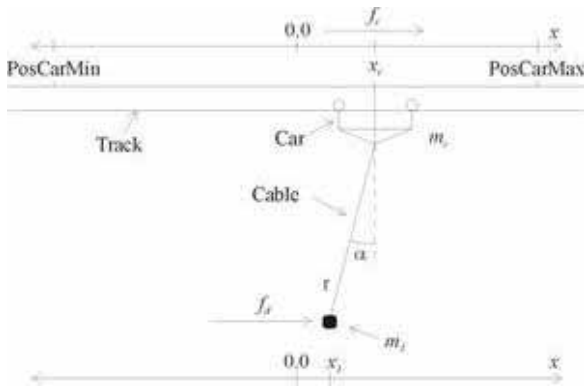
Fig. 1: Classical crane with load

Definition of the Crane Dynamics

In the following the nonlinear and linear equations for the system for x_c, x_l and α are given.

The linear model description originates from the publication and benchmark by Moser and Nebel mentioned above (Figure 2). A detailed version can be read in *O. Föllinger, Regelungstechnik, 1985*. Additionally, in this comparison also the nonlinear model is to be investigated (Figure 3; F. Breitenecker and H. Ecker derived the nonlinear equations used here).

The disturbance (e.g. wind) is modelled as the external force f_d accelerating the load. Basic model parameters are given in table 1.

m_c = 10.0 kg	r = 5.0 m	g = 9.81 m*sec^{-2}
d_c = 0.5 sec^{-1}	d_l = 1.0 sec^{-1}	m_l = 100.0 kg

Table 1: Basic model parameters

$$\ddot{x}_c = \frac{f_c}{m_c} + g\frac{m_l}{m_c}\alpha - \frac{d_c}{m_c}\dot{x}_c$$

$$r\ddot{\alpha} = -g\left(1+\frac{m_l}{m_c}\right)\alpha + \left(\frac{d_c}{m_c}-\frac{d_l}{m_l}\right)\dot{x}_c -$$

$$-r*\frac{d_l}{m_l}\dot{\alpha} - \frac{f_c}{m_c} + \frac{f_d}{m_l}$$

$$x_l = x_c + r\,\alpha$$

Fig. 2: Linear model description

$$\ddot{x}_c\left[m_c + m_l\sin^2(\alpha)\right] =$$
$$-d_c\dot{x} + f_c + f_d\sin^2(\alpha)$$
$$+m_l\sin(\alpha)\left[r\dot{\alpha}^2 + g\cos(\alpha)\right]$$
$$-d_l\dot{x}\sin^2(\alpha)$$

$$\ddot{\alpha}r^2\left[m_l\sin^2(\alpha) + m_c\right] =$$
$$=\left[f_d\frac{m_c}{m_l} - f_c + d_c\dot{x}\right]r\cos(\alpha)$$
$$-\left[g(m_l+m_c) + m_l r\dot{\alpha}^2\cos(\alpha)\right]r\sin(\alpha)$$
$$-d_l\left[\frac{m_c}{m_l}(\dot{x}r\cos(\alpha)+r^2\dot{\alpha})+r^2\dot{\alpha}\sin^2(\alpha)\right]$$

$$x_c = x_l + r\sin(\alpha)$$

Fig. 2: Nonlinear model description

It is to be noted, that the nonlinear model is an implicit one, of type $M(\vec{x})\ddot{\vec{x}} = F(\vec{x},\dot{\vec{x}})$. The systems either has to be transformed into an explicit one (which might cause numerical problems), or algorithms for implicit systems have to be used.

Specification of the embedded control

The embedded control includes sensors, actors, the digital control and the diagnosis.

Actuators - DC-Motor:

The car is driven by a DC-motor, which releases the force f_c. As motor model a first-order transfer function is used:

$$t_m \, \dot{f}_c + f_c = k_m \, v, \quad v = VC \cdot volt$$

t_m = 1.0 sec	k_m = 4.0 N*volt^{-1}
v limited with $abs(v) \leq$ VMax, VMax = 40.0 volt.	

Actuators - Brake:

Sets VC = 0.0, and the car stops immediately.

Actuators - Emergency Stop:

Sets VC = 0.0. All further activity is blocked, the car stops immediately.

Sensors

PosCar Position of the car (x_c [m])

SwPosCarMin Range sensor with Boolean value,
    is true if $x_c <$ PosCarMin,
    PosCarMin = -5.0 m

SwPosCarMax Range sensor with Boolean value,
    is true if $x_c >$ PosCarMax,
    PosCarMax = 5.0 m

Alpha Angle of the cable (α [rad]),
  the sensor is constrained to
    abs(Alpha) < AlphaMax+ΔAlpha,
    with AlphaMax = 0.2 rad,
    ΔAlpha = 0.01.

Definition of control

Control is implemented as a cycle based control algorithm with a fixed cycle time of 10 msec. The index n numbers the time points within the following difference equations.

The idea behind the control is use of a state space observer. This observer "calculates" the internal "fictive" q states based on only one observed "real" state ($PosCar_n$). These "fictive" states are fed into a proportional control, combined with some limitations.

The equations (discrete equations) are as follows, the parameters for the observer system (matrix A, B, K, etc.) can be found in table 2.

$$q_n = [q_{1_n}, q_{2_n}, q_{3_n}, q_{4_n}, q_{5_n}]^T$$

$$q_{n+1} = A * q_n + B * \begin{bmatrix} VC_n \\ PosCar_n \end{bmatrix}$$

$$y_n = K * q_n$$

$$z_n = \begin{cases} PosCar + r * q_{2_n} & \text{if Emergency Mode} \\ PosCar + r * Alpha & \text{otherwise} \end{cases}$$

$$u_n = k_p * (PosDesired - z_n)$$

$$VC_n = \begin{cases} +VcMax & \text{if } u_n - y_n > +VcMax \\ -VcMax & \text{if } u_n - y_n < -VcMax \\ u_n - y_n & \text{otherwise} \end{cases}$$

```
A=[9.9950e-1,  9.8040e-1,  9.9444e-4, -2.9370e1,  4.9032e-3;
   4.9882e-7,  9.9892e-1, -9.9632e-7,  4.8569e1,  9.9963e-3;
   0         ,  0        ,  9.9004e-1, -5.2731e4,  0;
   9.9975e-3,  4.9033e-3,  4.9817e-6,  9.7757e-2,  1.6346e-5;
   9.9739e-5, -2.1569e-1, -1.9888e-4, -9.5679e1,  9.9892e-1];
```

```
B=[ 1.9926e-5,  2.9370e1;
   -1.3296e-8, -4.8569e1;
    3.9800e-2,  5.2731e4;
    6.6485e-8,  9.0024e-1;
   -3.9853e-6,  9.5679e1];
```

```
K=[1.0906e3, -3.2981e3, 5.7106, 0, 3.0647e3];
```

```
kp=5.5e2;
```

Table 2 : Parameters for vontrol (observer, etc.)

In parallel, the condition for activating the brake is observed:

```
If  (not EmergencyMode
     and abs(VC) < 0.01 for 3 sec)
 or (EmergencyMode
     and abs(VC) < 0.01 for 6 sec)
 then
 apply the brake (set Brake).
```
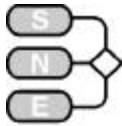
Diagnosis

The Diagnosis runs concurrently to the control algorithm.

- Observe the range sensors:
  ```
  if (SwPosCarMin ∨ SwPosCarMax) for
  more then 20 msec during 100 msec
  then set EmergencyStop.
  ```

- Observer plausibility of angle sensor:
  ```
  if (abs(Alpha) ≥ AlphaMax for more
  than 50 msec during 100 msec then set
  EmergencyMode
  ```
  (hereafter the control algorithm works without the angle sensor).

Tasks

First present the general approach, the implementation idea, and shortly the simulation system used. Especially, make clear, how the implicit nonlinear model was handled with, and how the digital control was implemented (continuous, digital or hybrid approach). Furthermore, it is of interest, how the experiments especially in task b and task c are managed (features of the simulation environment).

Task a) Comparison of nonlinear and linear model without control

Implement the models (crane and motor) once with linear equations (for the crane dynamics) and once with nonlinear equations. Give details about the handling of the implicit nonlinear model (transformation to explicit model, or use of algorithms for implicit models indicating the nature of the algorithm).

Compare the linear and nonlinear models without controller and without brake, simulating the following scenario:

Initial position $PosCar$ = 0.0, f_d = 0.0,

At time 0 set VC = 40 for 15 sec, then VC = 0.0;

At time 4 set f_d = $Dest$ for 3 sec, then f_d = 0.0;

Print a table showing the steady-state difference (reached about after 600 sec) in x_l for $Dest$ = -750, -800, -850 respectively.

Task b: Simulation of the linear fully controlled system

Implement the controller and brake with the DC-motor and the linear system (for the crane dynamics).

Describe how the continuous system and the discrete controller work together and how the brake is implemented.

Simulate the following scenario, resulting in a transient diagram with x_c, x_l, α, and state the time of brake-on events:

At time t = 0:	PosCar = 0.0, f_d = 0.0, PosDesired = +3.0
At time t = 16:	PosDesired = -0.5
At time t = 36:	PosDesired = 3.8
At time t = 42:	f_d = -200 for 1 sec then f_d = 0.0
At time t = 60:	stop simulation

Task c: Simulation of controlled system with sensor diagnosis

Add the sensor diagnosis to the system used in task b; state how the emergency mode and the emergency stop are handled (implemented).

Simulate the following scenario, resulting in a transient diagram with x_c, x_l, α, and state the time of brake-on events, emergency-mode events, and emergency-stop events:

At time t = 0:	PosCar = 0.0, f_d = 0.0, PosDesired = +3.0
At time t = 16:	PosDesired = -0.5
At time t = 18:	Angle sensor brakes, which sets Alpha = AlphaMax + 0.05 permanently
At time t = 36:	PosDesired = 3.8
At time t = 42:	f_d = 200 for 1 sec, then fd = 0.0
At time t = 60:	stop simulation

If you are interested in, please do not forget to send with the 1-page documentation of your solution also the model files. These files are put on our web server, together with the 1-page SNE documentation.

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COMPARISONS

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C1 Lithium-Cluster Dynamics AnyLogic 4.1

Fully Numerical Approach

AnyLogic (www.xjtek.com) is a general-purpose simulator for discrete but also for continuous and hybrid applications. AnyLogic supports modelling with UML – RT and modelling technology is based on Java so that building simulation models using AnyLogic should be easy for experienced programmers.

Model: As you know from java based software, the model is represented by an arbitrary number of Java classes. According to the task of the comparison the complete model is implemented in one Active Object Classes (Root), which is slightly adapted to the subtasks a) – c).
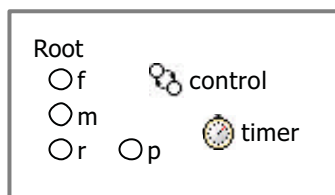
Fig. 1: model layout of root class in AnyLogic

Equations defined in Class Root look like:

```
Import
timer.restart(simTime);
Equations
d(f)/dt = d_r*r + 2*d_m*m - k_r*m*f - 2*k_f*f*f
- l_f*f + p
d(m)/dt = d_r*r - d_m*m + k_f*f*f - k_r*m*f
d(r)/dt = -d_r*r + k_r*m*f
Additional class code
double startTime=0;
double simRealTime=0;
public void executionControl() {
        for ( int i = 1; i <= nRep; i++) {
                        Engine.execute();
```

This class holds control of model repetition and the definition of the ODEs from the model. Control of the model replication is implemented in the static timer and in the control – state chart.

The set of numerical methods included with the simulation engine can handle both stiff and non-stiff systems and you can use explicit algorithms as well as implicit algorithms to deal with the ODEs. The choice of the numerical method is no part of the model but a setting in the AnyLogic engine-options.

Results task a: simulation in the time domain comparing integration algorithms. AnyLogic provides various types of output as charts and real-time values of object variables with the pitfall of increasing demand of system resources and therefore slower execution of simulation. To standardise simulation with different numerical methods, the only generated output is the real simulation time written in an output file (see Figure 2).

Considering the smallest mean simulation-time and sufficient accuracy, it seems to be appropriate to use the default setting (automatic) of the provided ODE – solving method.

	min	max	mean
Automatic	110	230	119,58
Radau (impl.)	110	400	131,34
LSODA (impl.)	260	771	287
RK853 (expl.)	210	230	210,92

Fig. 2: time in [ms] per simulation after 50 replications

Task b: Parameter variation of l_f. The parameter l_f measures the loss of F – centers at the surface. The value of l_f will be varied between 1.0E2 to 1.0E4 in logarithmic step size (additional Java code).
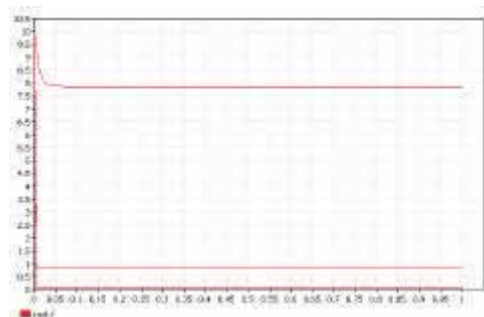
Fig. 3: f(t, l_f) with constant rate of p(t) = 800

f(t, l_f) tends always to equilibrium depending on the values of the parameter p and the escape factor l_f . The plotting function of AnyLogic is unfortunately only capable of linear scaling, so it is hard to visualize the behaviour in the first second.

Task c: Calculation of steady states. AnyLogic does not provide any function for computing equilibrium points of a system – so the simulation runs as long as the values for df, dm and dr converges towards 0 respectively their values become lower than a threshold of 1.0E-7.

The equilibrium points of f, m and r with bombardment p(t) = 0 converges towards 0. Constant bombardment p(t) = 10000 changes steady states for M - centers and F – centers to ~10 and for R – centers to ~1000.

p(t)	F - center	M - center	R - center
0	0	0	0
10000	10	10	1000

Fig. 4:Results for steady states

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C1 Lithium-Cluster Dynamics - Mathematica

Symbolical / Numerical approach

Simulator: Mathematica is an environment for numerical and symbolical calculations in the fields of scientific research, engineering analysis and modelling. It offers an integrated programming environment which allows performing symbolical and numerical tasks with well defined interfaces. Together with a wide range of visualisation commands Mathematica allows the treatment of mathematical / technical problems in a homogenous environment.

Model: The governing equation in this system is an initial value problem of a nonlinear ordinary differential equation. Mathematica offers the possibility for symbolical and numerical treatment. The Dsolve command,

```
Dsolve[equations, dep. vars, indep. vars]
```

tries to solve the given system symbolically. Of course, as expected the solution cannot be given explicitly. Therefore the differential equations have to be treated numerically. Mathematica offers three different numerical methods. For nonstiff equations, a Runge-Kutta-Fehlberg 45 and an Adams Method, for stiff equations the Gear Algorithm is provided. So first, let us analyse the model whether it is stiff or not. This is done symbolically to present Mathematica's features. Define the three equations as g1,g2 and g3:

```
g1=-dr r + kr m r; g2= ...; g3 = ...
```

Then determine the Jacobian Matrix J:

```
J={{D[g1,r],D[g1,m],D[g1,f]},{...},{...}}
```

where the symbol D calculates the differential of the governed equation. The eigenvalues can be computed symbolically with the command

```
Eigenvalues(J)
```

Inserting all data (calculation of steady state see Task c) gives the eigenvalues lying in the range between [-1000, -0.1]. We conclude a stiff system.

Task a: Simulation of the System: Now we discuss the numerical treatment. Use of the NDSolve command

```
   NDSolve[eqns + initconds, dep. Variables,
indep. Range, Method->Gear]
```

chooses the Gear Method. The simulation duration was 0.1sec. on a 1.3 GHz processor. The methods for nonstiff systems failed to converge. It is worth to point out that NDSolve chooses automatically the options of algorithm and gives satisfactory results.

Task b: Parameter Variation: This task shows how to use the rich field of Mathematica Tables. For each parameter we determine the equations and store each function as a table entry

```
Sol=Table[NDSolve[
  r[i]'[t]=...,
  m[i]'[t]=...,
  f[i]'[t]=10^((5+i)/3)f[i][t]...],{i,1,7}]
```

The LogPlot command

```
LogPlot[Evaluate[
    Table[f[i][t],{i,1,7}]/.
    Table[Sol[[i,1,3]],{i,1,7}]],
    {t,-5,1},GridLines-Automatic]
```

can now easily be applied to produce following picture
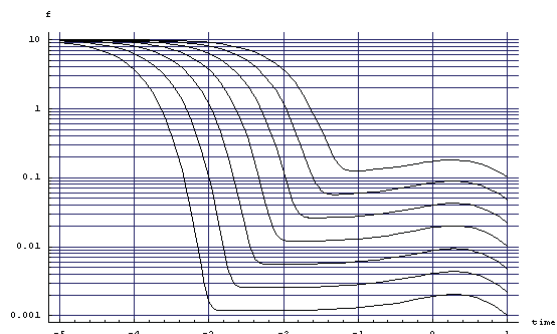
The very flexible data structures in Mathematica offer easy to implement parameter variation tasks.

Task c: Calculation of steady states: We perform this task completely symbolic. The equations are already defined as g1,g2 and g3. With the replacement operator /. and the Solve command we can get steady state solution as

$$\blacksquare\blacksquare r \circledR \frac{kf\,kr\,p^3}{dm\,dr\,lf^3}, \ m \circledR \frac{kf\,p^2}{dm\,lf^2}, \ f \circledR \frac{p}{lf} \ \blacktriangleleft$$

In the case of p==0 we get the zero solution as steady state. With help of the replacement operator we simply can calculate the steady state when p<>0:

```
Solmitp /. {kf->0.1,p->10000,...}
```

and obtain r=1000, m=10, f=10.

As presented above Mathematica offers the framework to easily perform above tasks. Where possible, symbolic calculations were performed. Only in Task a, (and for ODE solving) numerical computations were necessary.

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C4 Dining Philosophers –
Enterprise Dynamics (Taylor ED)

Simulation Approach

Simulator: Taylor ED (Enterprise Dynamics) is a family of software products for modelling, visualisation and control business processes. The 4Dscript Language is the interface through which all Taylor ED functionality is controlled. It's used to define editing fields, to define atom functionality, to create run and analyse models, to define model logic, to control Taylor ED from outside, etc.

Model: For the implementation of this problem in ED the event based approach was chosen, using only main atoms already available in the ED atom library.

The five philosophers are *Servers*, the chopsticks are *Products* to be processed. A *cleaning process* was introduced to manage certain properties.

After having satisfied his hunger the philosopher puts the chopstick back on the table. After a cleaning time of 1 it is now free to be seized on need. In the simulation the chopstick is stored in a queue until being requested again. Figure 1 shows the event / process-oriented graphical model layout in ED.

Each philosopher may be in one of three status: meditating, hungry or eating. He stays in this status for a uniformly distributed time period in the interval (1,10). A full simulation run lasts for 1000 time units.
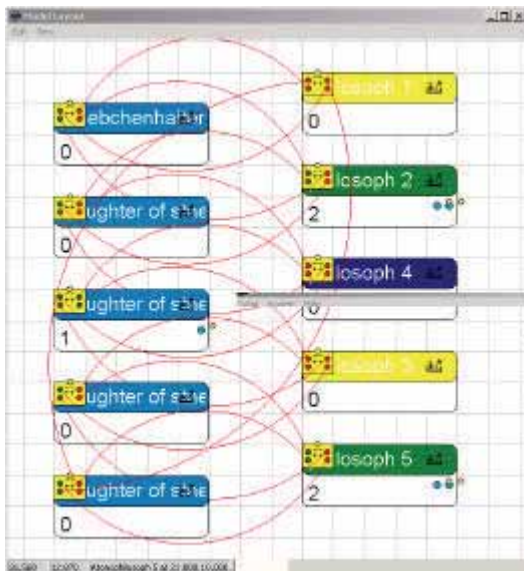
Figure 2: ED Model Layout

Task a: Simulation/Analysis of behaviour: As expected the philosopher's habit of picking up one chopstick first and waiting for the second to be free, leads to their doom: if all five of them get hungry at approximately the same time they will all seize one chopstick to wait for the other one. Therefore all resources are blocked an the system is caught in a deadlock.

Task b: Different strategies. To keep our philosophers from starving to death three different strategies were compared:

- **Strategy 1:** a philosopher has to wait until both needed chopsticks are available until he may pick them up. Using this strategy prevents a deadlock from occurring. Results shown in table 1

	Percentage Eating	Percentage Mediating	Percentage Waiting
Mean	35.84	34.95	29.21
Stand. Dev.	2.622	2.975	4.221

Table 1: Results for Strategy 1

- **Strategy 2:** adding the status dead:
  We assume that a philosopher can only go for a certain time without eating. Then he dies and his chopstick is free. It turns out that at leadt two deaths need to occur until the system is stable, in the worst case only one philosopher survives. A deadlock no longer happens, but the number of philosophers is reduced. Results see table 2.

- **Strategy 3:** returning the chopstick after a certain time:
  After holding one chopstick for a certain time a philosopher gets bored and returns to mediating, his hunger temporarily forgotten. This does not prevent the situation were each philosopher holds one chopstick from happening, but no deadlock occurs.

	Percentage Eating	Percentage Mediating	Percentage Waiting
Mean	23.28	23.36	53.35
Stand. Dev.	1.925	2.31	4.12

Table 2: Results for Strategy 2

For collecting the data needed for analysis the Experiment Atom was used. Here only the number of runs to be done needs to be set. Additionally a task to be executed at the end of each simulation run can be defined. This was used to write the needed data into an Excel file.

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COMPARSIONS

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COMPARSIONS

C5 Two State Model – Maple 7
Fully Analytical approach

Simulator: Maple 7 is a computer algebra system which is mainly used for symbolic calculation but it also includes numerical features. It provides a vast library of built-in functions and operations and allows arbitrary high accuracy by making it possible to change the numbers of digits carried in floats.

Model: This solution doesn't use Maple's integrated ODE solver `dsolve` (although possible): it shows how one can implement an algorithm for solving a system of differential equations. First the eigenvalues and the eigenvectors of the linear homogeneous system of equations are determined, to create a solution basis for the homogeneous system. Therefore Maple's function `Eigenvals` is used.

```
> A:=matrix([[-c1,c1],[0,-c3]]);
> b_1:=matrix(2,1,[c1*c2_1,c3*c4_1]);
> b_2:=matrix(2,1,[c1*c2_2,c3*c4_2]);
> lambda:=evalf(Eigenvals(A,vecs));
> J:=array([[exp(lambda[1]*t),0],
            [0,exp(lambda[2]*t)]]);
> L:=multiply(vecs,J);
```

Next the inhomogeneous part is solved by a simple system of equations because the inhomogenity is constant. (The Matrix doesn't have to be inverted).

```
> const1:=solve({A[1,1]*k1_1+A[1,2]*k2_1=b_1[1,1],
    A[2,1]*k1_1+A[2,2]*k2_1=b_1[2,1]},{k1_1,k2_1});
> const2:=solve({A[1,1]*k1_2+A[1,2]*k2_2=b_2[1,1],
    A[2,1]*k1_2+A[2,2]*k2_2=b_2[2,1]},{k1_2,k2_2});
> Eq:=geneqns(L,[v1,v2],
               vector([y1_init+k1_1,y2_init+k2_1]));
> Eqt:=subs(t=t_init,Eq);
> lsg1:=solve(Eqt,{v1,v2});
> Eq:=geneqns(L,[v1,v2],
               vector([y1_init+k1_2,y2_init+k2_2]));
> Eqt:=subs(t=t_init,Eq);
> lsg2:=solve(Eqt,{v1,v2});
> t_init:=0; y1_init:=4.2; y2_init:=0.3;
> z:=0; i:=0; state:=1;
```

The time instants of the change of states are determined by a modified bisection method, whereby the smallest step size can be constituted.

```
> while (z<5) do i:=i+1;
  sol:=multiply(L,matrix(2,1,[v1,v2])):
 funcy1||i:=unapply(sol[1,1]-k1_||state,t):
 funcy2||i:=unapply(sol[2,1]-k2_||state,t):
 step:=0.01;
 if state = 1 then
   while step>=step_bound do
     while ((funcy1||i(z)<5.8) and (z<5)) do
       z:=z+step;
     end do;
     z:=z-step;
     step:=step/10;
   end do;  else ...
 z:=z+step*10; disc||i:=z;
 state:=(state mod 2)+1; t_init:=z;
 y1_init:=funcy1||i(z); y2_init:=funcy2||i(z);
end do:
```

Results Task a: **Simulation in time domain- switching times and final value.** The table at the right shows the time points for all detected discontinuities and also the value of $y_1(5)$. The associated graph of y_1 is shown in Fig. 1. The result was calculated with `Digits: =15` and a `step_bound` of 10^{-10}.

t_1	1.10830616780000
t_2	2.12968535520000
t_3	3.05415290710000
t_4	4.07553209450000
t_5	4.99999964640000
$y_1(5)$	5.36944281876193
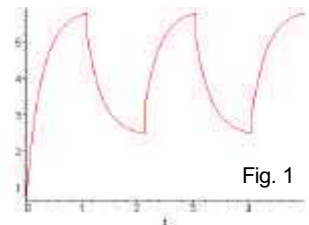
Fig. 1

Task b: Influence of accuracy on solution. The model accuracy can be varied by two parameters. First by changing the number of digits of the used floating-point numbers (Maple's environment variable `Digits`.) Second by the variable `step_bound`, which determines the minimum step size for the time loop. In the next table the results for different values of these parameters are shown. Because there are nearly no differences between values by changing `Digits` (Digits = 30 used), only the `step_bound` is varied.

step	$y_1(5)$	Time of last discontinuity
10^{-6}	5.79999908287093882 550066486064	4.075535
10^{-10}	5.36944281876190194 324447677610	4.9999996464
10^{-14}	5.36931214700633035 514320327281	4.99999964622034

With a step size of 10^{-6} one discontinuity less is found.

Task d: Highly oscillating solution. Figure 2 shows the graph of y_1 for the system with changed state 2 parameter values. It's high frequently oscillating and forces 62 discontinuities. The first and last discontinuities (see table at right) are computed with following accuracy parameters: `step_bound:=`10^{-14} `Digits:=20`
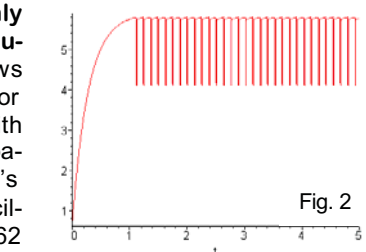

Fig. 2

t1	1.10830616777114
t2	1.12172996789144
...	...
t61	4.92304010708071
t62	4.93646390720101

The final value of y_1 is 5.7804025205614051443.

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C5 Two State Model – Maple 7
Semi-Analytical approach

Simulator: Maple 7 is a computer algebra system which is mainly used for symbolic calculation but it also includes numerical features. It provides a vast library of built-in functions and operations and allows arbitrary high accuracy by making it possible to change the numbers of digits carried in floats.

Model: This solution makes use of Maple's integrated ODE solver `dsolve`. The function `dsolve` is able to handle different types of problems by using classification and symmetry methods. In this special case it classifies the system as a system of first order linear differential equations and gives the solution in the analytical form $y_1(t) = k_1 \cdot \exp(-?_1 \cdot t) + k_2 \cdot \exp(-?_2 \cdot t) + c$. As Maple uses symbolical calculation, first the equations are solved with unknown parameters c_1, c_2, c_3 and c_4. The particular values are substituted into the solution. The search for the time instants of the change of states is realised by a modified bisection method. First the discontinuity is searched for with step size 0.01. Then the step size is divided by 10 and the last interval is inspected again. The process is iterated until a given step size (`step_bound`) is reached. This method makes it possible to find the discontinuities in reasonable time and with a sufficient accuracy.

```
> sys:={diff(y1(t),t)=c1*(y2(t)+c2-y1(t)),
diff(y2(t),t)=c3*(c4-y2(t)),
y1(t_init)=y1_init,y2(t_init)=y2_init};
> sol:=dsolve(sys,{y1(t),y2(t)});
> y1:=subs(sol,y1(t)); y2:=subs(sol,y2(t));
> c1:=2.7*10^6; c3:=3.5651205;
> c2_1:=0.4; c4_1:=5.5; c2_2:=-0.3; c4_2:=2.73;
> t_init:=0; y1_init:=4.2; y2_init:=0.3;
> z:=0; i:=0; state:=1; step_bound:=10^(-10);
> while (z<5) do i:=i+1;
y1||i:=subs(c2=c2_||state,c4=c4_||state,y1);
y2||i:=subs(c2=c2_||state,c4=c4_||state,y2);
step:=0.01;
if state = 1 then
 while step>=step_bound do
  while ((evalf(subs(t=z,y1||i))<5.8) and (z<5)) do
   z:=z+step;
  end do;
  z:=z-step; step:=step/10;
 end do; else ...
z:=z+step*10; disc||i:=z;
state:= (state mod 2) + 1; t_init:=z;
y1_init:=evalf(subs(t=z,y1||i));
y2_init:=evalf(subs(t=z,y2||i));
end do:
```

Results Task a: Simulation in time domain- switching times and final value. The table at the right shows the time for every located discontinuity and the value of $y_1(5)$.

t_1	1.10830616780000
t_2	2.12968535520000
t_3	3.05415290710000
t_4	4.07553209450000
t_5	4.99999964640000
$y_1(5)$	5.36944281876194

Figure 1 shows the graph of y_1 over time. The result was calculated with `step_bound` of 10^{-10} and `Digits:=15`.
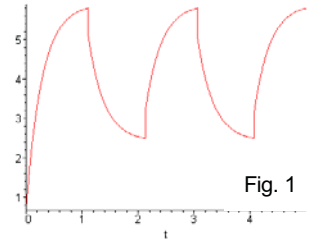
Fig. 1

Task b: Influence of accuracy on solution. Accuracy can be varied in this model by two parameters. First by Maple's environment variable `Digits`, which controls the number of digits that Maple uses when calculating with floating-point numbers and second by the variable `step_bound`, which determines the minimum step size for the time loop. The next tables show the results for different values of these parameters.

$y_1(5)$:

step	Digits=15	Digits=20	Digits=30
10^{-6}	5.79999908 287094	5.79999908287 09388255	5.79999908287093 882550066486064
10^{-10}	5.36944281 876194	5.36944281876 19019434	5.36944281876190 194324447677611
10^{-14}	5.36931208 829560	5.36931214700 63303554	5.36931214700633 035514320327283

Time of last discontinuity:

step	Digits=15	Digits=20	Digits=30
10^{-6}	-	-	-
10^{-10}	4.9999996464	4.9999996464	4.9999996464
10^{-14}	4.9999996462 2025	4.9999996462 2034	4.9999996462 2034

With a step size of 10^{-6} the last discontinuity is not found. Step size 10^{-10} is already small enough to produce result with adequate accuracy.

Task d: Highly oscillating solution. The change of the state 2 parameter values causes a high frequent oscillating behaviour of y with 62 discontinuities. The table below shows the

Fig. 2

first and last discontinuities computed with `step_bound:=10^{-14}` and `Digits:=20`. The final value of y_1 is 5.7804025205614051442.
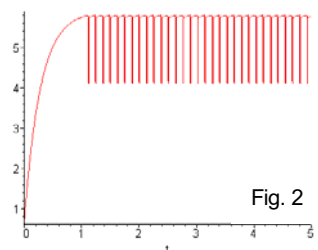
t_1	1.10830616777114	t_2	1.12172996789144
t_3	1.23546396574812	t_4	1.24888776586842
...	...	...	...
t_{59}	4.79588230910372	t_{60}	4.80930610922402
t_{61}	4.92304010708071	t_{62}	4.93646390720101

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COMPARISONS

C7 Constrained Pendulum – AnyLogic

Hybrid approach

Simulator: AnyLogic 4.0 is able to handle continuous, discrete and hybrid models. It is based on JAVA and offers some drag-and-drop dialogues for the model as well as for animation. Everything needed is created as an instance of the ActiveObject class, starting with the 'Root' class which represents the model to variables, statecharts and animation.

Model: Using tangential velocity $v = l \cdot \dot{\varphi}$ instead of angular velocity has the andvantage that only the lenght has discrete changes. The equation of the model transforms to

$$\dot{\varphi} = v/l, \ \ v = -g \cdot \sin\varphi - \frac{d}{m}v$$

$$v = l_l \cdot \varphi_l = l_s\varphi_s$$

Using ActiveObjects for v=x1 , φ=x2, it boils down to the equations

```
d(x1)/dt=1/laenge*x2
d(x2)/dt=-grav*sin(x1)-dae/mass*x2
```

in the equations section of the main object, and a statechart to determine the initial state and the state changes, the lenght beng changed in the transitions.
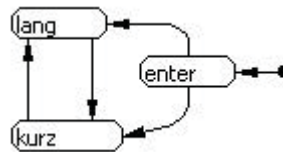
Fig.1: Statechart of the model

Task a: Simulation in the time domain: The runtime engine included in AnyLogic offers convenient routines for plotting variables defined as active objects. Simulating both at once is easily done by creating two instances of the ActiveObject pendulum with different initial values (Fig 2).
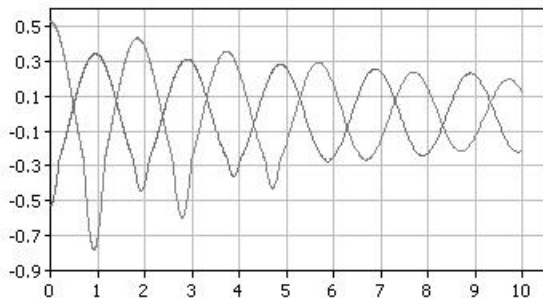
Fig. 2: Angle and Angle Velocity, task a

Task b: Comparison of linear and nonlinear model. The creation of an almost identical ActiveObject for the linearised constrained pendulum with the equations

```
d(x1)/dt=1/laenge*x2
d(x2)/dt=-grav*x1-dae/mass*x2
```

allows the comparison of both models. Placing instances of both types in the 'Root' class as shown in the image allows for a direct comparison in the runtime environment, as a runtime plot forces the numerical integration to use at most the same stepsize.
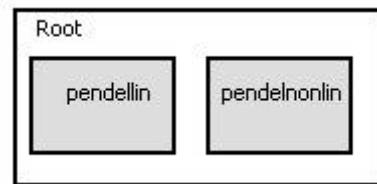
Fig.3: both models as ActiveObjects in the „Root" ActivObject
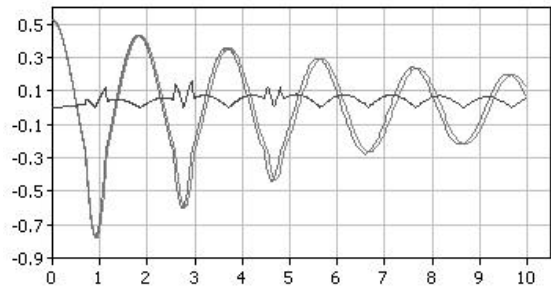
Fig.4: Comparison of linear and nonlinear model (angle, difference)

Task c: Boundary value problem With the simple transformation $\tau = -t$ we reverse the system time. We start with the maximum angle and a tangential velocity of 0. By adding a final state to statechart the calculation can be stopped once the given initial angle is reached. Thus at time t=0.5750 the simulation finishes with a tangential velocity x2=2.0756, which equals the angular velocity, as the length of the pendulum in its long state is 1.
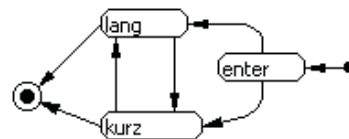
Fig. 5: Model state chart with final state

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COMPARSIONS

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C7 Constrained Pendulum – MATLAB/SIMULINK

Single model using tangential velocity

Simulator: MATLAB is a widely used software tool based on numerical vector and matrix manipulation. SIMULINK is a MATLAB-toolbox for graphical modelling and numerical simulation of dynamic systems, offering some extensions for modelling hybrid systems.

Model: The approach in this solution uses a single full-parameterised model that can solve all tasks of the comparison. Model parameters are set via MATLAB scripts with the `set_param()` function for the specified blocks (constant block, memory block, hit-crossing block and switch block).

Using the tangential velocity $v = \dot{\varphi} \cdot l$ instead of the angular velocity $\dot{\varphi}$ prevents discontinuous integrator results due to switching the length of the pendulum on hitting or leaving the pin, i.e. the formula

$$\dot{v} = -g \cdot \sin\left(\int \frac{v}{l}\right) - \frac{d}{m} \cdot v$$ is implemented via SIMULINK blocks.

To resolve the algebraic loop for calculating the actual pendulum length, the memory block `pLen` and the triggered subsystem `Subsystem1` is used. The hit-crossing block is necessary to catch also short hits on the pin.
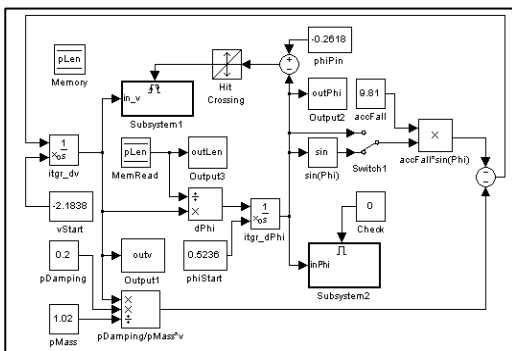
Figure 1: Pendulum model
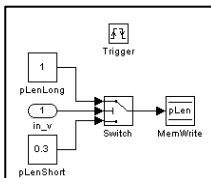
Figure 2: Subsystem1   Figure 3: Subsystem2
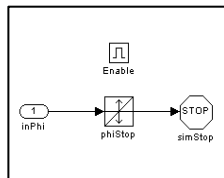
Figure 4: Result of Task a
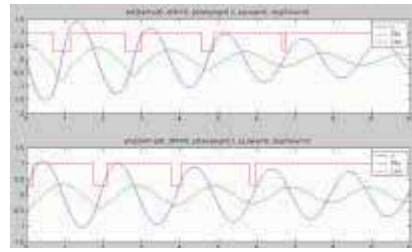
Task a: Simulation in the time domain. The model is just executed via a MATLAB script that sets the parameters and plots the results. The constant block `Check` disables Subsystem2 and the switch Switch1 selects the nonlinear model.

Task b: Comparison of linear and nonlinear model. The model is simulated two times. After the first run, the switch `Switch1` toggles to the linear system, i.e. the `sin` block is shorted. To compare the results, interpolation is necessary because the output vectors are of different size.
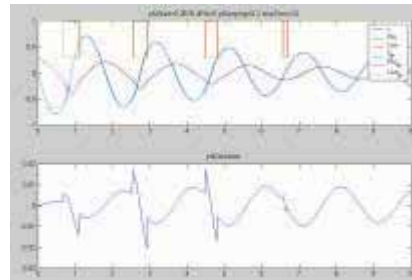
Figure 5: Result of Task b

Task c: Boundary value problem. To calculate the start velocity, the pendulum is started at the given end position using the negative damping d=-0.2 . The subsystem `Subsystem2` (activated via the constant block `Check`) stops the model on reaching the given start position (the hit-crossing offset in `phiStop` equals the start angle). The negative velocity, when the simulation stops, is the required start velocity.

The second plot in figure 6 shows in a further simulation the correctness of the previous result. The position where the shortened pendulum reaches the maximum angle is marked with an x.
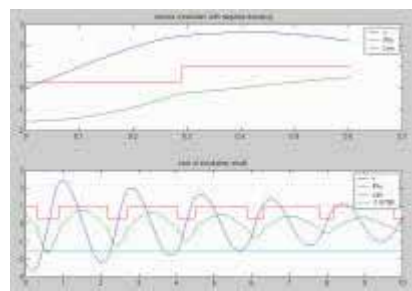
Figure 6: Result of Task c

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COMPARISONS

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C7 Constrained Pendulum – Maple 8

Symbolic/Numerical Approach

Simulator: Maple is a computer algebra system which is mainly used for symbolic calculation but it also includes numerical features. It provides a vast library of built-in functions and operations and allows arbitrary high accuracy by making it possible to change the numbers of digits carried in floats.

Model: In this solution we test the state event detection mechanism in the numerical differential equation solvers in Maple. Not all of the implemented algorithms provide a state event finder. For nonstiff problems the Runge-Kutta-Fehlberg method of order 4(5) and for stiff problems a Rosenbrock method give the possibility to formulate stop conditions. These conditions can be used in two different ways. The first is to give expressions as stop condition, where the integration halts once the expression evaluates to zero. Second, on can provide range conditions where the integration once the value of an expression steps outside a given range. The second possibility is useful when one has to start a new integration beginning from the last event to avoid timestepping in the last event.

Task a: Simulation in the time domain: For the simulation of the motion of the pendulum we define two differential equations. One for the pendulum with length l and one for length ls. As stop condition we define an expression which evaluates to zero when the angle is equal to ϕ_p. When a state event occurs we switch between the model equations for the long and short pendulum.

```
dglsys_long={diff(phi1(t),t)=phi2(t),
diff(phi2(t),t)=-g/lsin(phi1(t))-d/mphi2(t)};
dglsys_short={diff(phi1(t),t)=phi2(t),
diff(phi2(t),t)=..} ;
stopcond:={phi1(t)=Pi/12} ;
sol_long:=dsolve(dglsys_long union initcond,
...,type=numeric,stop_cond=stopcond);
sol_short:=dsolve(dglsys_long union initcond,
...,type=numeric, stop_cond=stopcond);
```

Above code is packed into a loop with a function giving the solution at timepoint t gives the result (fig. 1):

Fig. 1: Angle velocity with events, task a)

Task b: Comparison of linear and nonlinear model. The treatment of the linear model is a straightforward task in Maple. The linear system can be solved explicitly.

```
linsys_long:={diff(phi1(t),t)=phi2(t),
diff(phi2(t),t)=-g/l*phi1(t)-d/m*phi2(t)};
sol_long:=dsolve(linsys_long union
       {phi1(t0)=phi10,
phi2(t0)=phi20},{phi1(t),phi2(t)});
```

The same can be done for the short pendulum. The absolute error between the linear equations and nonlinear results are shown in the picture below.
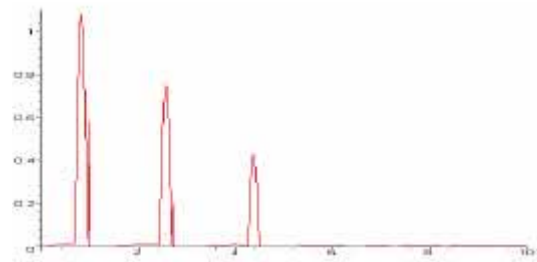

Fig. 2: Differences of nonlinear and linear model

In the following table we show the timepoints of the state events. Right column gives the timepoints calculated with the nonlinear model, left column the timepoints in the linear case.

Nonlinear, [s]	Linear, [s]
0.69337931	0.69202334
1.127779	1.12054473
2.5472503	2.540860458
2.9404404	2.931799150
4.4837766	4.464755483
4.8095060	4.790786113
6.5506487	6.532057557
6.6794029	6.652995455

Task c: Boundary value problem. We transform the problem into an initial value problem with reverse time.

The initial conditions are then $\phi=-\pi/2$ and angular velocity equal to zero. With help of the Newton procedure we calculate an initial angular velocity of -2.184701221 Units.

```
phiinit:=proc(t)evalf(reverse(t)-Pi/6);
Solve(phiinit,t=0.5)
```

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COMPARSIONS

C10 Dining Philosophers II –
Enterprise Dynamics (Taylor ED)

Simulation Approach

Simulator: Taylor ED (Enterprise Dynamics) is a family of software products for modelling, visualisation and control business processes. The 4Dscript Language is the interface through which all Taylor ED functionality is controlled. It's used to to define editing fields, to define atom functionality, to create run and analyse models, to define model logic, to control Taylor ED from outside, etc.

Model: For the implementation of this problem in ED the event based approach was chosen, using only main atoms already available in the ED atom library. The five philosophers are *Servers*, the chopsticks are *Products* to be processed. A *cleaning process* was introduced to manage certain properties.

After having satisfied his hunger the philosopher puts the chopstick back on the table. After a uniformly distributed cleaning time of (1,2) it is now free to be seized on need. In the simulation the chopstick is stored in a queue until being requested again.

Each philosopher may be in one of three status: meditating, hungry or eating. He stays in this status for a uniformly distributed time period in the interval (1,10).

Task a: Simulation/Analysis of behaviour: As expected the philosopher's habit of picking up the left chopstick first leads to their doom: if all five of them get hungry at approximately the same time they will all seize the left chopstick to wait for the right one. Therefore all resources are blocked an the system is caught in a deadlock. The following tables summarize the results for the different status:

	P1	P2	P3	P4	P5
mean	5.55	5.25	5.42	5.18	6.00
St. Dev.	2.84	2.99	2.43	1.60	2.28

Table 1: eating

	P1	P2	P3	P4	P5
mean	6.25	5.54	5.62	4.92	5.75
St. Dev.	2.63	2.54	2.84	2.57	2.60

Table 2 : hungry

	P1	P2	P3	P4	P5
mean	17.09	15.17	13.75	17.36	17.18
st. Dev.	11.56	12.12	12.40	11.53	12.51

Table 3 : waiting

	eating	thinking	waiting
mean	5.47	5.61	16.05
st. Dev.	2.29	2.48	11.05

Table 4: average times for all

ch1	ch2	ch3	ch4	ch5
88	86	86	86	87

Table 5: Chopstick Utilisation

For executing the 50 simulation runs the Experiment Atom was used. Here only the number of runs to be done needs to be set.

Additionally a task to be executed at the end of each simulation run can be defined. This was used to write the needed data into an Excel file for evaluation.

	Time till Deadlock	Percentage Eating	Percentage Meditating	Percentage Waiting
Mean	143.2	21.71145313	27.43	50.86
Stand. Dev.	123.6	10.57447291	9.048	14.1

Table 6: Results for 50 simulation runs

Task b : Deadlock Detection: ED does not recognise a deadlock for what it is- the simulation continues until no more events are listed. Then a time overflow occurs.

To prevent this from happening a query is made each time a philosopher seizes his left chopstick: if a global variable containing the number of philosophers holding a chopstick is equal to five the simulation run is stopped.

```
if(ic(c)=1,do(
inc(model.deadlock),
if(model.deadlock=5,do(createevent(0,atombyna
me([Experiment],model),2),stop)),
```

It may happen that two philosophers try to seize a chopstick at the same time. According to the way ED handles this, the philosopher that comes first in the event list would benefit from being computed first and therefore receive the chopstick.

In the simulation this was blocked by implementing the decision that the philosopher sitting on the right would be given the chopstick.

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# C13 Crane and Embedded Control MATLAB

Hybrid Approach

Simulator: MATLAB is a widely used software tool based on numerical vector and matrix manipulation. SIMULINK is a graphical extension for block oriented simulation.

The model: Control and sensor diagnosis of the system was implemented in MATLAB, of linear and nonlinear dynamics were modelled in SIMULINK. The time base of the controller ($\Delta t=0.01$ sec) was used as discretisation basis of the controlled system: loop with i) sensor check, ii) emergency actions, iii) calculation of new discrete control (with brake) and iv) simulation of the dynamics upon next sampling interval (using the SIMULINK model of the linear dynamics):

```
for systimeind = 0:endtimeind
    [ES,EM,BrakeTrigger] = sensorcheck
        (SensorErrorTime,SensorErrorValue);
    [VCneu,qneu] = control (alpha,PosCar,
        PosLoad,PosDesired,EM, VCalt,qalt);
    VCout = controlbreak(VCneu,ES,
    BrakeTrigger,newPosDesired,IEnable);
    sim('c13sim_lindfe', [0 0.01]);
end %
```

Task a: Comparison of uncontrolled nonlinear and linear model. SIMULINK is a block-oriented graphical simulator, based on directed signal flows, so that implicit systems (i. e. an algebraic loop for the signal flow) cannot be modelled directly. In this solution the `solve` block was used to break the algebraic loop for the equations for car acceleration and angle acceleration. This block constrains the input $F(\ddot{\alpha};\alpha\,\dot{\alpha}\,x_l\,\dot{x}_l)= 0$ to zero wrt $\ddot{\alpha}$ (fed back as output to the input of the subsystem, which represents the implicit equations) - see next figure. It is to be noted, that in each integration step this iterative solver is called to calculate the derivatives. The table shows the differences between in x_l of the linear and the nonlinear model after t=600 sec.
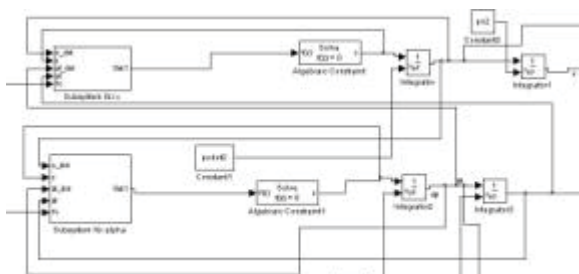
Nonlinear SIMULINK Model with algebraic loop

| disturbance fd	-750	-800	-850
difference Δx_l	-262.89	-325.19	-391.05

Task b: Simulation of the controlled system. Controller and brake logic were implemented in MATLAB m-functions, called in the loop shown before. The next figure position of the car and of the load, and the angel of the cable and the activation times of the brakes, which are: t = 13.17, 29.63 and 56.56 sec.
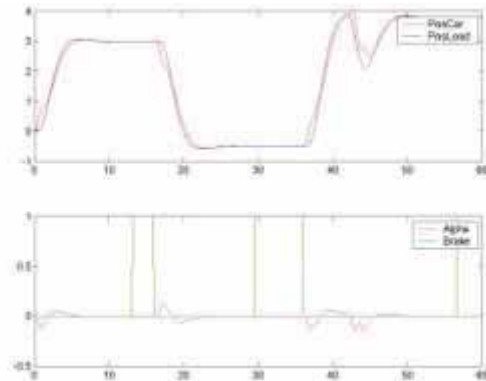
Task c: Simulation of controlled system with sensor diagnosis. Sensor diagnosis is implemented by a fourth action in the core loop (at first position). The last 10 states are scanned in order to perform diagnosis check. In MATLAB this check looks like:

```
function [ES,EM,BrakeTrigger]= sensor-
check(AngleSensorErrorTime,AngleSensorErrorValue)
for i=1:10,
  if ( (ErgPosCar(systimeind-i) < PosCarMin) |
    (ErgPosCar(systimeind-i) > PosCarMax) )
      diagRange(i,1)=1;  end; ……….
……….
  if ( AngleSensorValue >= AlphaMax)
      diagAngle(i,1)=1; end;
```

The whole system goes into Emergency Mode at t = 18.05 and the brake was switched on at 13.17 and 32.64, whereas Emergency stop was activated at 44.47 (see next figure)
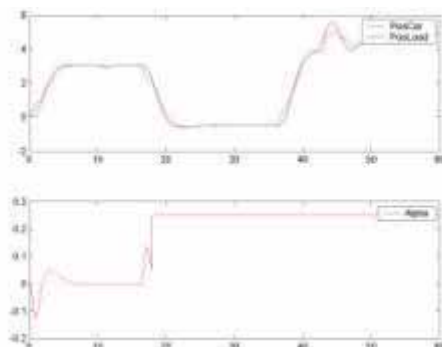
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COMPARISONS

C13 Crane and Embedded Control MATLAB

Hybrid Approach

Simulator. MATLAB is a widely used software tool based on numerical vector and matrix manipulation. Additionally it provides several numerical integration algorithms.

Model: The differential equations of the mechanical model of the crane and the DC-motor are implemented directly in MATLAB. For the numerical integration an Runge-Kutta-Fehlberg ODE Solver is used (`[t,y]=ode45(@lindiffgl,[0 0.01], [init]);`)

To simulate the controlled system, time in general was discretised to the time base of the controller $\Delta t=0.01$ sec. In each sample interval the ODE-solver was started to integrate the system in this interval and the dedicated brake-conditions and controller reactions are evaluated. The following code describes the core loop of the simulation with diagnosis, control, break, and dynamics update. MATLAB is a programming environment; the complex scenarios are programmed directly.

```
for systimeind = 0:endtimeind
    % core loop, loop interval=sampling time
    [ES,EM,BrakeTrigger] = sensorcheck(Inf,0);
    % check sensors at ti
    [VCneu,qneu]  = Control(alpha,PosCar,
            PosLoad,PosDesired,EM, VCalt,qalt);
    % calculate new (intermediate) control
    VCout = controlbreak(VCneu,ES,BrakeTrigger,
            newPosDesired,IEnable);
    % check break conditions, result control
    [t,y] = ode45('lindiffgl',[0 0.01], [PosCar;
            PosCar_dot;alpha;alpha_dot;fc]);
    % Calculate dynamics over sample interval
end
```

Task a: Comparison of uncontrolled nonlinear and linear model. Linear and nonlinear differential equations have been simulated at [0 600] sec with the ode45 – integration algorithm. The implemented ODE solver version allows handling simple DAE systems (mass matrix as implicit term). With `odeset` the option for a mass matrix is set (given in an m-file `MASS`). Results (differences linear / nonlinear see next table.

```
options=odeset('Mass',@MASS);

function M = MASS(t,y)
global mc ml r
y(5)=fc ; M = zeros(5,5); M(1,1)=1;
M(2,2)=mc+ml*sin(y(3))^2; M(3,3)=1;
M(4,4)=r^2*(ml*sin(y(3))^2+mc);M(5,5)=1;return
```

disturbance fd	-750	-800	-850
difference Δx_l	-135,7	-222,0	-311,8

Task b: Simulation of the controlled system. Controller and brake-logic were implemented in MATLAB m-functions, called in the core loop:

```
function [VCneu,qneu] = control(alpha,PosCar,
    PosLoad,PosDesired,EM, VCalt,qalt)
global g mc ml dc dl r ……………….
yn   = K*qalt;
if (EM) zn = PosCar + r*qalt(2);
  else   zn = PosCar + r*alpha;
  end % check brake, emergency
un = kp * (PosDesired - zn); control error
if (un-yn > VCmax) VCneu = +VCmax;
   elseif (un-yn < -VCmax) VCneu = -VCmax;
   else VCneu = un-yn;
end % check limits
qneu=A*qalt+B*[VCneu;PosCar];%calculate control
```

The next figure shows the result of important variables at [0 60] sec, the times for …. Are …….hier fehlen die Zeite, bitte nachtragen:
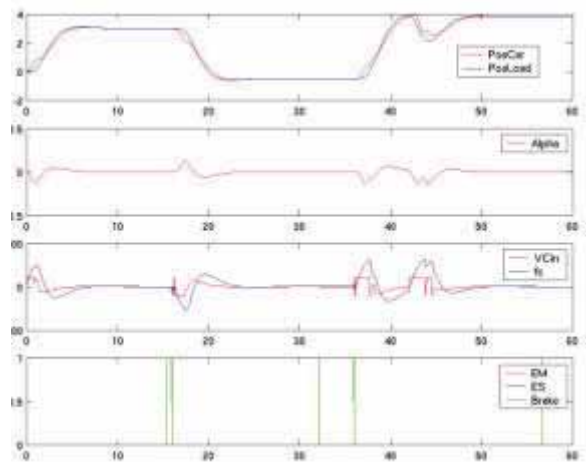
Task c: Simulation of controlled system with sensor diagnosis. This task "simulates" a sensor failure. Before calculation of the new control at sampling time, the sensors are checked. In case of a failure the controller switches to the emergency mode without a consideration of the angle alpha. Time courses see next figure, the time instants are: hier fehlen die Daten bite ergaenzen vcsd dsv sd sd sd s
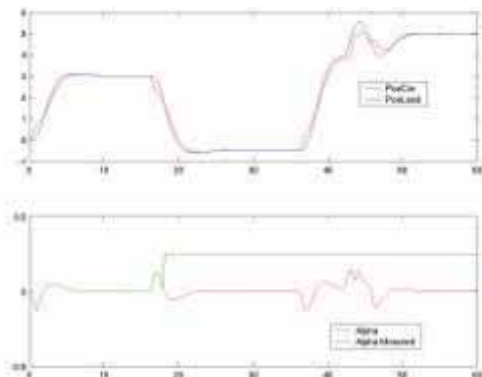
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C14 Supply Chain Management - AnyLogic 4.0

OO Approach / Active Objects and Messages

Simulator. AnyLogic (www.xjtek.com) is a general-purpose simulator for discrete but also for continuous and hybrid applications. The modelling technology of AnyLogic is based on Java so that building simulation models using AnyLogic should be easy for experienced programmers.

Model: According to the task of the comparison there are three Active Object Classes. The customer class corresponds to the wholesaler; the wholesaler class corresponds to the distributor class and to the factory class. In addition there is built a Message class that represents the movable goods as well as the orderings in the supply chain. Instances of the classes and flow control are represented in the fig. 1.

The four factories (classes *factory*) store finished products in (built-in) storages. If an order arrives, the needed amount of products will be sent after duration of transport time. Then the products enter the distributor, who has sent the order. Depending on the wholesalers´ demands, products are then routed to the wholesalers (*customer*).
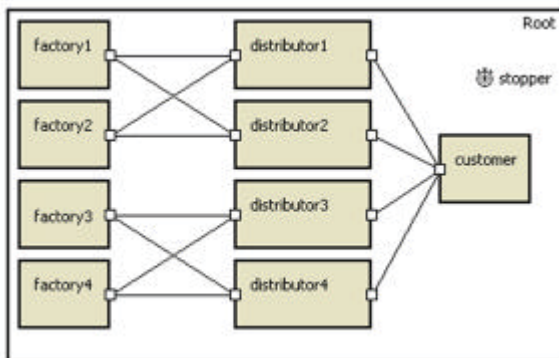
Fig. 2: Model layout of chain supply in AnyLogic root class

To simulate the supply chain, time controlled messages are used. After an initialisation time where factories produce a basic stock of products a timer triggers the distributor's order event. After sending messages to all connected factories, those factories try to meet the distributors' demands. If the needed amount is available the ordered products are sent to the distributor using the same type of messages.

Below there is given the code which handles the orders a distributor sends to the factories:

```
if (msg.receiver==id) {
stock[msg.type]=stock[msg.typ]+msg.anzahl;
```

```
nOFstock=nOFstock+msg.number;
if (msg.number==0) {
    sold[msg.typ]+=demand[msg.type];
        } else {
     costs=costs+10*msg.deliver/6;
} };
```

Results Task a: Simple Order Strategy. The strategy is: each distributor orders every day an amount of two pieces per product at the same factory. As the costs for the distributor depend on the transport time per transported piece, this strategy results in increasing stock for each distributor as the storage becomes fuller. The table shows the costs and the delivered products for distributor D_1.

	stock	costs	delivered
min	266	23050	188
max	350	28208	272
mean	304,59	25959,08	226,77

Task b: On Demand Order Strategy. The distributors accumulate the orders of the wholesalers, no matter if the order was fulfilled or not over 24 hours and order this amount the next day at 00:00. This strategy results in constant stocks and therefore decreasing costs relative to task a (see fig. 2).

root.großhaendler1.stock
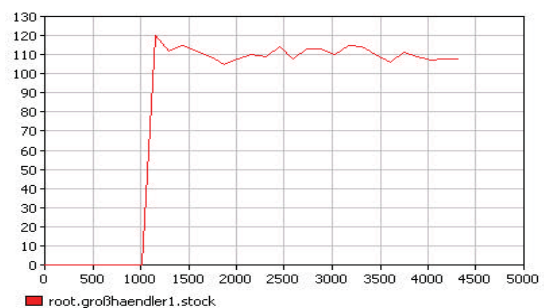
Task c: Minimal SupplyTime – Strategy. In difference to task a and task b, the distributors now try to order at the factory with the minimal supply lead time. If an order can not be fulfilled, the distributor chooses the factory with minimal supply lead time. The model is slightly changed, as every distributor has a connection to every factory and the strategy results in decreasing of costs as shown in the table.

	stock	costs	delivered
min	90	18260	199
max	110	22103	259
mean	99,97	19900,42	227,58

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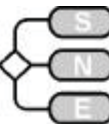
BOOK REVIEWS

Optimal Control

R.Vinter
Birkhäuser, 2000; ISBN 0-8176-4075-4

Main purpose of this book is to bring together major developments in optimal control which are based on nonsmooth analysis. The book focuses on necessary conditions but other topics are covered as well.

The first chapter provides an overview on the main result and on the deficiencies of the 'classical' theory in order to give readers with little experience in modern optimal control theory an overview without analytical details but with emphasis on the underlying ideas. In order to render the book self-contained, chapters on measurable multifunctions and differential inclusions, variational principles, nonsmooth analysis and subdifferential calculus are included which focus on material relevant for the subsequent chapter on optimal control.

A general formulation of the maximum principle its derivation from the extended Euler-Lagrange condition are given as well as the respective proofs. What follows are chapters with the formulations and the proofs of necessary conditions for free end-time problems and for state constrained problems. The last three chapters are devoted to differential inclusions with state constraints, to the regularity of minimizers and to aspects of dynamic programming which match to the analytic techniques of this book. Higher order necessary conditions or numerical aspects are not discussed.

The volume is devoted to theoretic aspects and (except for some short remarks in the introduction chapter) no examples are given. Hence, the book is written primarily for mathematicians but it may be of interest also for those (control) engineers who are interested in the theory of optimal control.

Beginner	Intermediate	Expert
	●	●
Theory	**Mixed**	**Practice**
●	●	
Lecture Note	**Monograph**	**Proceedings**
	●	

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Mechatronic Systems

Mechatronische Systeme (in German)
Isermann, Rolf
Springer, ISBN 3-540-43129-2

Mechatronic systems result from the integration of mainly mechanical and electronic systems as well as the appropriate data processing. The essential point is the integration of mechanical and electronic elements through their arrangement in space and functions, but also in obtaining synergetic effects.

The first part of the book gives an overview and motivation with some examples of mechatronics and introduces the reader in the model building of such systems.

Then, in the second and in the third part, an overview of the most important physical basics like energy bilance for masses, liquids and gases, mechanical principles like the d´Alembert principle or the Lagrange equations and the fundamentals of Newton kinetics is given.

After this basic introduction a well structured overview of the behaviour and model building of elements of mechatronic systems follows. It starts with models of basic mechanical parts like mass swings, deadening parts and bearings followed by the modelling of different electrical engines.

As needed for model building of mechatronic systems the book also shows the model building of machines, sensors, actors and micro computers.

Beginner	Intermediate	Expert
● ●		
Theory	**Mixed**	**Practice**
	● ●	
Lecture Note	**Monograph**	**Proceedings**
●		

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Numerical Recipes in C++: The Art of Scientific Computing

William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery (Eds)
Birkhäuser, 2002; ISBN 0-521-75033-4

This book is a comprehensive and practical guide to numerical algorithms. The book is full of advice, and therefore worth to be recommended.

But the code could be better, even more it is a mindless translation of the C version. C++ has, included in the STL, a complex class. You would think that an author of a numeric computing book would take advantage of such a class. Unfortunately not, but it does use zero based indexing now.

Overall the author's former work "Numerical Recipes in C" has all the same powerful algorithms presented in a simpler way.

Nevertheless, if you have need for numerical algorithms, this publication is a good choice, whereby the "C-style" book is available online for free.

Beginner	Intermediate	Expert
	●	
Theory	Mixed	Practice
	●	
Lecture Note	Monograph	Proceedings
	●	

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Advances in Mathematical Systems Theory

A Volume in Honor of Diederich Hinrichsen

F. Colonius, U.Helmke, D.Prätzel-Wolterrs, F.Wirth (Eds.)

Birhäuser, 2001; ISBN 0-8176-4162-9

This volume collects lectures presented at a workshop on the island of

Borkum (Germany) in April 1999. The contributions are dedicated to Diederich Hinrichsen on the occasion of his 60th birthday, they are written by former students and by colleagues and consequently, are closely related to the scientific work of this outstanding scientist. A wide range of topics in linear and nonlinear systems theory is covered including parameterization problems, behaviours of linear systems and convolution codes, as well as complementary systems and hybrid systems. Functional analytic as well as algebraic approaches are presented in the discussion of controllability and stabilizability of infinite-dimensional systems (allowing also for hysteresis nonlinearities). Stability and robustness of both, linear and nonlinear systems using the concepts of stability radii and spectral value sets constitute a focal point.

In short, a volume which is a must for researchers and a valuable overview for all being involved in mathematical systems theory.

Beginner	Intermediate	Expert
	●	
Theory	Mixed	Practice
●	●	
Lecture Note	Monograph	Proceedings
		●

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BOOK NEWS

Hybrid Simulation Models of Production Networks

V. S. Kouikoglou, Y. A. Phillis, Kluwer, 2001, ISBN 0-306-46592-2

This book records our research work at Boston University and Technical University of Crete concerning discrete event models and optimization of production networks. A number of simple fluid models are developed that approximate discrete traffic (deterministic or random). The models are very accurate and faster than conventional piece by piece simulators.

Book Overview. This book is concerned with a most important area of industrial production, that of analysis and optimization of production lines and networks using discrete-event models and simulation. The book introduces a novel approach that combines analytic models and discrete-event simulation. Unlike conventional piece-by-piece simulation, this method observes a reduced number of events between which the evolution of the system is tracked analytically. Using this hybrid approach, several models are developed for the analysis of production lines and networks. A detailed simulation model of production lines is included (in Fortran 77 source code) and discussed. The hybrid approach combines speed and accuracy for exceptional analysis of most practical situations. A number of optimization problems, involving buffer design, workforce planning, and production control, are solved through the use of hybrid models.

Contents. 1. Introduction. 2. Fundamentals of Simulation Modelling. 3. Two-Machine Systems. 4. Production Lines. 5. Production Networks. 6. Optimization. 7. Closure. References. Appendix A. Index.

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Knowledge and Business Process Management

Vlatka Hlupic (ed.)

Idea Group Inc., Hershey, 2003, 289 pages
ISBN: 1-59140-036-8, www.idea-group.com

In today's competitive business environments, knowledge is one of an organizations most vital assets and effectively capturing and managing that knowledge one of an organizations' most important efforts. *Knowledge and Business Process Management* a new book from Idea Group, Inc. written by Vlatka Hlupic examines the keys to successfully managing knowledge and business processes. This timely new book provides a compilation of the most recent information in knowledge management and business process management research and practice. The contributions, all written by renowned experts from academia and industry will prove useful to academics, researchers and practitioners alike. From practical case studies to complex theoretical discussions the chapters in this book provide the most current information available.

The role of knowledge within organizations is becoming more vital as technology to effectively manage that knowledge becomes more widespread. According to Prof. Hlupic, "With improvements in IT-based systems for handling knowledge, knowledge management is becoming an essential theme of research into business success as well as a subject of new business initiatives." This new emphasis has lead to some controversy as to what exactly knowledge management is and how it can be best utilized by organizations. This book addresses the fundamental questions about how knowledge management techniques can best be utilized to improve and manage business processes.

The definition of knowledge management is a much-discussed question and differs based upon the context in which it is discussed. To the IS professional, knowledge management is largely based on the technical components of capturing knowledge such as data mining. To the business-minded professional, knowledge management is based on organizational learning and creativity. Prof. Hlupic maintains that, "It is increasingly evident that approaches to knowledge management research and practice do not adopt a multi-disciplinary view, despite the multidisciplinary interest in knowledge management."

Considering the many facets and applications of knowledge management efforts is one key to effectively incorporating knowledge management efforts into successful businesses.

Specifically, Prof. Hlupic advocates considering business processes in relationship to knowledge management efforts. She explains, "Knowledge management and business processes are two (often) separated but inseparable areas.

Business processes should incorporate activities related to generation, codification and transfer of critical organizational knowledge.

On the other hand, knowledge about the key business processes should plan an important role in redesigning such processes." Only by considering the multi-faceted nature of knowledge management can organizations get the most out of their knowledge management and business process efforts.

This timely new book, *Knowledge and Business Process Management* addresses the need for a multidisciplinary approach to knowledge management. Divided into three sections, the book addresses the most current research in knowledge management and business process management, the practical concerns of effectively managing knowledge and business processes and, the current socio-technical trends in knowledge and business process management.

These three areas of discussion will prove to be the most important areas of concerns for organizations desiring to improve their knowledge management efforts and redesign their business processes.

Much time and money are invested every day in improving existing business processes and knowledge management practices by organizations. Establishing effective practices and polices that allow for knowledge to be captured by information systems and organizational learning to occur is key for organizations who want to maximize the return on their costly investments.

This book will provide practical guidance for the executives wishing to improve existing practices and policies. The theoretical discussions and applications will be appeal to the researcher and students of knowledge management.

Vlatka Hlupic has compiled some of the most important literature in the multidisciplinary aspects of knowledge management.

This book is a must read for all those interested in understanding the complexities of knowledge and business process management.

Idea Group Inc., Hershey
www.idea-group.com