SIMULATION NEWS EUROPE

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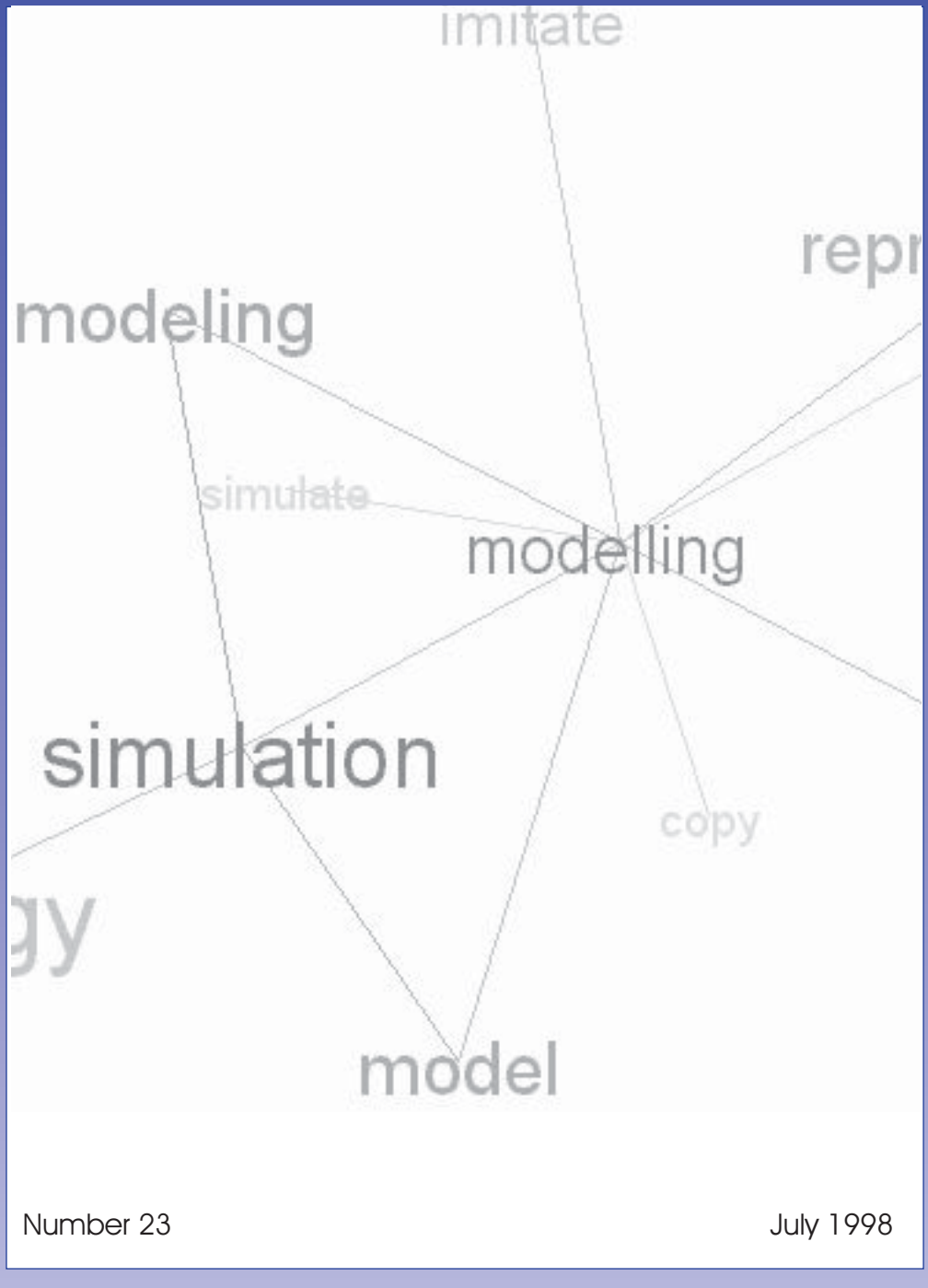


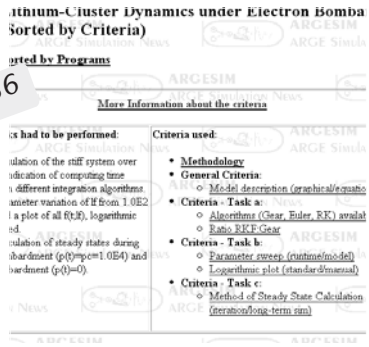
Number 23 July 1998

A EUROPEAN FORUM ON SIMULATION ACTIVITIES

In this issue ...

12 comparisons, 150 solutions and a database ...

... an attempt to evaluate 8 years work and experience with simulation software



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$$q_1^2 + q_2^2 \le 1$$

... Discontinuity and Chaos

A discontinuity is an event after which things are not the same as they were.

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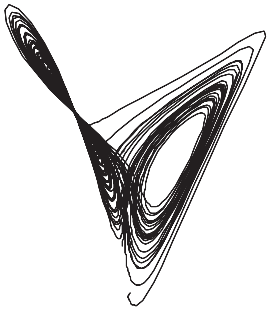

... from September 7, 1998 on, we will have a new telephone number and a new fax number

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Editorial

The idea of the simulation software comparisons was born in 1990 with the first issue of this journal. Since then they have been a regular part of each issue. Many readers took the challenge and solved one or more of the comparisons and documented the solution for publication. Additionally many students at TU Vienna solved at least one comparison during their education in simulation techniques. Therefore in the last eight years a wealth of know-how has been accumulated, which asks for post processing. This has been started last year with the ARGESIM database, where information about the comparison solutions is gathered and evaluated. The first results are summarized in this issue.

We are proud to present in this issue two high-quality essays. One dealing with hybrid systems on a mathematical level by means of differential inclusions, taking also care on existence and uniqueness of solution. The other underlining the importance of state event recognition and corresponding numerical algorithms, from Tycho Brahe to J. Hay.

You will read about intensified co-operation in the European and international simulation area. With this issue we start a regular exchange of information with SIGSIM, the Special Interest Group for Simulation of ACM, and with SCS Europe (see section "Simulation Societies"). In this process it is also planned to offer Simulation News Europe as newsletter for members of SCS Europe.

A few words about the title page: this time we chose a snapshot from a system that allows to explore language through creating a visual interface to a thesaurus. You can try yourself at: http://www.plumbdesign.com/.

We would like to say thank you to all who contributed to this issue.

F. Breitenecker, I. Husinsky

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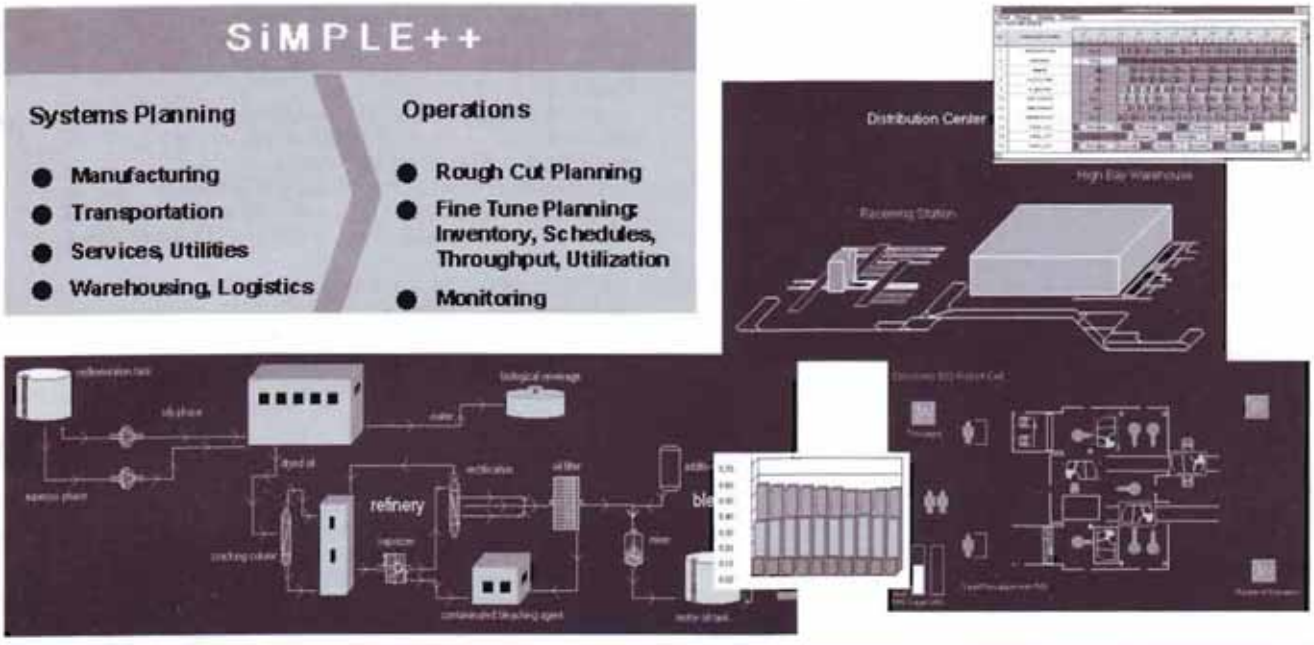

Key Features

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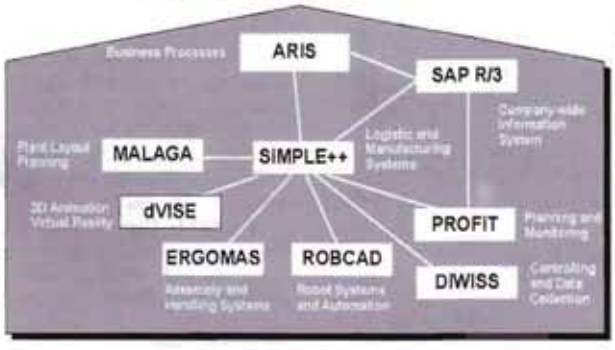
- Application Object Templates

Interfaces & Integration



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Aims and Scope

The journal *Simulation News Europe* (abbreviated SNE) publishes information related to modelling and simulation.

SNE's aims are: to inform about new developments in simulation methodologies, applications and software and hardware for modeling and simulation, to report news from European simulation societies and European simulation events and from international simulation societies and working groups all over the world. SNE is the official membership news journal of EUROSIM.

SNE contains news on EUROSIM, on the EUROSIM societies, on SCS Europe, on SIGSIM/ACM, on other international simulation societies and groups, and on software user groups.

SNE publishes essays dealing with new developments in a particular area and reports on software and hardware developments, new applications and new methodologies and their applications. SNE presents simulation centers and announces simulation events and classes in a calendar of events. The section on industry news contains the latest news available through press releases and announcements. There are book reviews and book news.

A special series on simulation comparisons gives a comprehensive overview on features and developments of simulation software and hardware, including parallelization techniques. These comparisons are also becoming standard benchmarks for simulation programs.

SNE is a printed journal as well as an electronic journal. ARGESIM's WWW server can be found at `http://www.argesim.org/`.

All contributions are selected and may be edited by the editors of the journal.

Declarative, Equation-Based Modeling of Hybrid Systems

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Hybrid Systems

Dynamical systems exhibiting regime switches can be thought of as mixtures between purely continuous and purely discrete systems, and are therefore sometimes referred to as *hybrid systems*. In the past, switching between regimes has often been incorporated into basically continuous models in an *ad hoc* way. A number of proposals to develop a more systematic way of dealing with hybrid systems have been made in recent years, coming from computer science as well as from systems and control theorists and from the simulation community. Alur *et al.* [l] have proposed an automaton-based framework, in which the regimes appear as the nodes of a transition graph and each node has a set of differential equations and transition rules attached to it. Petri nets have been a popular modeling tool for discrete systems and so it is not surprising that there have been proposals to extend Petri nets with continuous dynamics so as to make them represent hybrid systems, see for instance Flaus *et al.* [5]. There have also been proposals to turn continuous modeling tools into formalisms for hybrid systems by adding discrete features, see for instance the work by Mosterman [12] on hybrid bond graphs.

In this paper we consider an equation-based formalism that keeps close to the well-established setting of differential equations. The emphasis will be on mathematical foundations rather than on implementation issues. The exposition must be brief; a more extensive version can be found in [14].

A Relay

Consider a closed dynamical system containing a relay element (cf. [10] for the modeling of systems with relays). After extracting the relay element from the system we are left with an open dynamical system having two external variables, namely the ones that are connected by the relay. Let us call these variables y and u and let us assume for simplicity (more general cases will be included below) that the dynamics of the system that is obtained in this way may be written in a standard input-output form

$$\dot{x} = f(x,u) \quad (1)$$
$$y = h(x,u). \quad (2)$$

After standardization, the relay characteristic may be thought of as a multivalued function that assigns the constant value $u = -1$ to all negative values of y, the values $u \in [-1,1]$ to $y=0$, and the constant value $u = 1$ to positive values of y. This relation may be expressed by means of a propositional formula:

$$\{ y < 0 \text{ and } u = -1 \} \text{ or } \{ y = 0 \text{ and } u \geq -1 \text{ and } u \leq 1 \} \text{ or } \{ y > 0 \text{ and } u = 1 \}. \quad (3)$$

The full dynamics of the relay system can now be described (in one possible interpretation of the relay element) by the equations (1), (2), and (3). One needs to be precise about what this means, that is, one has to define a solution concept (or, stated in a different language, an execution semantics) for expressions of the form (1-3).

Note that the system (1-3) as a whole can also be read as a propositional formula, since the three equations are connected by a logical and, as is always the case in systems of differential equations. Since we are dealing here with a propositional formula that contains derivatives it seems not unnatural to refer to the system (1-3) as a "differential proposition", since equations containing derivatives are usually referred to as differential equations. So we shall be concerned with the semantics of differential propositions.

It should be noted that an alternative interpretation of the relay is obtained by replacing equation (1) by

$$\dot{x} = \tfrac{1}{2}(1-u)f(x,-1) + \tfrac{1}{2}(1+u)f(x,1). \quad (4)$$

The system obtained in this way has the same behavior as the one above as long as we are not on the switching surface (i. e. $y \neq 0$), but it may behave differently on the switching surface. In any case, the system consisting of equations (4), (2) and (3) is still a differential proposition and so the discussion below applies to this form as well.

Semantics of Differential Propositions

Before we can discuss semantics, we have to discuss syntax. We shall consider expressions stated in terms of symbols $x,y,u, \ldots$ that denote continuous variables (taking real values) and symbols $P,Q,R, \ldots$ that denote discrete variables (taking values in some finite set). For each of these symbols, we introduce additional symbols x^+ and x^- denoting lefthand and righthand limit respec-

tively; for symbols denoting continuous variables we also introduce an additional symbol $\dot{x}$ which indicates the derivative. A *term* will be anything of the following types: equations expressed in continuous variables and their derivatives, or in their lefthand and righthand limits; and inequalities expressed in continuous variables or their lefthand and righthand limits. A differential proposition is a combination of such terms by the rules of propositional logic (using `and`, `or`, and `not`; also `if` can be included in the standard interpretation of the propositional calculus, that is, '`if` *p* `then` *q*' means '`not` – *p* `or` *q*').

A *solution* corresponding to a differential proposition is actually a pair consisting of a domain of definition *D* and a vector function of time that assigns values to all symbols in the proposition for all $t \in D$. The domain *D* is required to be open and dense in the real line. The vector function giving the actual trajectory of the solution is piecewise differentiable in the continuous variables and piecewise constant in the discrete variables, where the pieces are determined as the connected components of the domain *D*. Moreover, we require that lefthand and righthand limits of the proposed trajectory exist for all *t*; for instance the function $\sin(1/t)$ defined on $D = (-\infty, 0) \cup (0, \infty)$ is not accepted as a possible trajectory.

By the fact that lefthand and righthand limits are defined everywhere, terms involving such limits can be evaluated at event times, which are by definition time points t that do not belong to the domain *D* of a proposed solution. (So the set of event times may vary from solution to solution.) Since such terms are intended to express properties of events, they are given the default value FALSE for non-event times. Terms of other types do not contain lefthand or righthand limits and therefore cannot be evaluated at event times; at such times, they are assigned the value FALSE. Now, a proposed solution is said to *satisfy* a given differential proposition if the truth value of the proposition (as computed by the rules of Boolean logic) is TRUE for all times *t*. Among all solutions one may distinguish those that hold on to a given mode as long as possible. In this way a precise semantics for differential propositions can be defined.

The setting that has just been described is a generalization of the classical framework due to Filippov [4]. In contrast to the classical formulation, the framework of differential propositions allows jumps in the state variables. Some examples of the use of differential propositions will be given below.

Model Classes

The framework of differential propositions should be considered as a basic format in which possibly discontinuous dynamics can be expressed, not necessarily as the format that the user would prefer. In many cases it will be more convenient from a user's point of view to work in a higher-level language. If a translation from such a language to the language of differential propositions is provided, the semantics described above can still be used. In this way one can build "model classes'" on top of the framework of differential propositions. In such model classes, there may for instance be no need to specify explicitly what happens at event times since this is governed by general rules that form part of the class definition. For this purpose one needs to specify *mode selection rules* that indicate how to select a new mode when a mode change is needed, and *jump rules* that govern discontinuities in state trajectories.

A prime example of a well-defined model class is the class of Hamiltonian systems with geometric inequality constraints. For this class, which can be used to describe mechanical systems with unilateral constraints on the configuration variables, a jump rule has been formulated by Moreau (see [2] for an extensive discussion), whereas for mode selection it suffices to require that a mode should be selected in which all inequality constraints are satisfied. As shown by Lötstedt [9], the search for modes that satisfy this requirement can be carried out by solving one or more *linear complementarity problems* (LCPs). A new (although related) example of a completely defined model class is provided by the class of linear complementarity systems studied in [6]. This class can be used in particular to describe piecewise linear systems.

Existence and Uniqueness of Solutions

So far we have discussed the definition of the notion of solution. Given an unequivocal description of what we mean by a solution, it still remains to be seen whether such solutions exist and are unique for a given initial condition. Even in the case of smooth dynamical systems there are no necessary and sufficient conditions for well-posedness, but strong sufficient conditions are available in the form of the well-known Lipschitz conditions. For hybrid systems, the situation is more complicated due to the interaction of discrete and continuous parts, and examples in which one has nonuniqueness or nonexistence of solutions are much easier to find than in the smooth case. The well-posedness issue has only been studied systematically for certain

model classes. Existence and uniqueness of solutions for mechanical systems with unilateral constraints has been studied by Lötstedt [9], see also [11, 2, 13]. For linear complementarity systems, certain positivity conditions come into play [6, 8].

Examples

Thermostat

A simple thermostat may be described directly in terms of a differential proposition, for instance as follows (θ is a continuous variable denoting temperature, H is a discrete variable indicating whether the heating is on or off):

$\{ \dot{\theta} = f(t,\theta)$ and $[(\theta \leq 20$ and $H =$ on) or $(\theta \geq 19$ and $H =$ off$)]\}$ or $\theta^- = \theta^+$.

The final condition simply specifies that the trajectories of θ should be continuous across events. Note that the above description cannot be fitted into Filippov's framework because the discrete variable H plays a decisive role when an initial value for θ is chosen in the interval between 19 and 20.

Bouncing ball

The differential proposition

$\{ \dot{x} = v$ and $\dot{v} = -9.81$ and $x \geq 0 \}$ or $v^+ = -\alpha v^-$

gives a model for an ideal bouncing ball with restitution coefficient α. Assuming that $0 < \alpha < 1$ and that an initial condition $(x(0),v(0))$ is chosen with $x(0) > 0$, it is not difficult to verify that there is a unique solution defined on $[0, \infty)$ minus a set of event times. The event times have a finite accumulation point, but nevertheless its complement is open and dense as required. Moreover, the trajectory of smaller and smaller bounces followed by the constant value zero after the accumulation of event times does satisfy the requirement of differentiability and of existence of lefthand and righthand limits. Because the lefthand limit of both x and v at the accumulation point of the event times is zero, their righthand limits must be zero as well and so the zero solution on the remaining interval until infinity is the only one.

The ideal diode

In the Modelica document of September 1997 [3], the following model is proposed for the ideal diode:

$0 =$ `if` $u > 0$ `or` $i > 0$ `then` u `else` i.

According to the interpretation of implications in propositional logic, and under the assumption that u and i are restricted to be nonnegative, this formula translates to

$[((u = 0)$ and $(i = 0))$ or $(u = 0)]$ and
$[((u > 0)$ or $(i > 0))$ or $(i = 0)]$.

The right term in this conjunction is tautological whereas the disjunction in the left term has one member subsumed under the other, so that the final interpretation would be $u=0$ (together with the *a priori* restriction $i \geq 0$). This is clearly not what is intended, so that the conclusion must be that Modelica as described in [3] does not interpret implications in the sense of propositional logic. The ideal diode can in terms of differential propositions be formulated as

$u \geq 0$ and $i \geq 0$ and $(u = 0$ or $i = 0)$.

Of course unlike Modelica the framework of differential propositions so far doesn't come with a simulation engine; only for the class of linear complementarity systems mentioned above an implementation has been carried out at the Department of Electrical Engineering, TU Eindhoven.

Looping pendulum

The looping pendulum (a mass point hanging on an inextensible but not rigid wire) belongs to the class of Hamiltonian systems with geometric inequality constraints. It can be compactly specified by just giving the Hamiltonian and the inequality that has to be satisfied (working in Cartesian position and momentum variables, and in units that reduce all constants to 1):

$$H(q,p) = \tfrac{1}{2} p_1^2 + \tfrac{1}{2} p_2^2 + q_2$$
$$q_1^2 + q_2^2 \leq 1$$

There is a systematic procedure to translate data of this form to a differential proposition. Differential equations are derived in the usual manner for constrained mechanical systems (see for instance [7]), introducing a constraint force for every constraint. Inequalities are given by the constraint itself and by the nonnegativity condition on the constraint forces; moreover there is a complementarity constraint which can be stated in the 'or' form. Conditions at event times are obtained by solving certain LCPs.

Conclusions

It has been said that nature consists of relations, not assignments. This adage is, in the case of continuous dynamical systems, the driving force behind the study of implicit systems of differential equations. In the same way it can be argued that in the case of hybrid systems one should allow general `and/or` formulations rather than only `if-then` statements. Of course, this will bring mathematical difficulties, just as it is requires more care to solve an implicit system of differential equations than to solve a set of ODEs. These mathematical difficulties have in no way been fully discussed in this paper. However, it has been suggested that a language of "differential propositions" may be useful as a

tool to formulate, in a declarative and equation-oriented way, the dynamics of hybrid systems. As a basis for simulation, one then needs to develop a theory of existence and uniqueness of solutions for such differential propositions. Results in this direction are available for certain "model classes" that can be built on top of the differential propositions framework. These model classes can also serve to define modeling tools that can greatly reduce the specification load for the user.

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Discontinuous Systems or Ripples in the Ether

P.G. Thomasson
a talk given at the John Lewis Hay Memorial meeting of the United Kingdom Simulation Society
31st October 1996, Salford University

This talk was originally intended to be a technical description of the simulation and behaviour of systems of differential equations containing discontinuities, however as I produced the slides I became aware of an underlying story and given the nature of this meeting I decided to throw away my original material and tell you the story instead. The story is a continuing one that has no definite beginning and has yet to end.

What had dawned on me was that several apparently unrelated themes were coming together and a much more general definition of a discontinuity was in order rather than the narrow mathematical concept I had started with. As a result I took as my definition,

A discontinuity is an event after which things are not the same as they were.

Indeed as we will see, we could be more definite and say that for many discontinuities things are not just different but that things are never the same again.

To start our story we go back over 400 years to 1546-1601 and the time of Tycho Brahe. He was an aristocratic Dane who meticulously collected and recorded accurate data on the changing positions of the planets relative to the fixed stars (the word planet comes from the Greek word meaning a wanderer). He was however devoid of the theoretical or mathematical skills needed to interpret the data. Eighteen months before his death he chanced to meet Johann Kepler, a native of Württemburg, who was everything Tycho was not in that he was a poor, sickly, mathematician. Following Tycho's death he worked on Tycho's legacy for the next twenty years. He abandoned the Copernican theory that the planets moved in circles and hit upon the ellipse as a possible fit. He published his first two laws of planetary motion in 1609, namely that the orbit is an ellipse with the sun at a focus, and then continued with Tycho's data and published his third law in 1619, that the square of the period is proportional to the cube of the mean radius. This represented a major discontinuity in human knowledge, not only were the geometrical details of the planetary orbits now known but predictions of their movements were now possible as well.

Later that century in the year 1642 Galileo died and Newton was born and some twenty three years later in 1665 the outbreak of plague closed the University of Cambridge for two years and during this break Newton conceived the law of gravitation, the laws of motion and the fundamental concepts of the differential calculus. However due to a small difference between his predicted motion of the moon and that observed he did not give the results to the world for another twenty years.

Twenty years later in 1685 Edmund Halley, Christopher Wren and Robert Hooke during discussions about the unsatisfactory nature of Descartes' theory that the planets were swept around the sun by whirlpools in the ether, speculated whether a force "similar to magnetism" and falling off inversely with the square of the distance might not require the planets to travel in elliptical paths. Hooke accepted a wager of 40 shillings if he could prove it within a fortnight. He did not return for the money. Some months later whilst visiting Cambridge Halley put the question to Newton without mentioning the bet, Newton to his astonishment confirmed the conjecture and said that he had the proof amongst his papers from twenty years ago. Under Halley's encouragement Newton published the Principia and Halley established that the comet of 1682 that he had observed was the same one as appeared in 1607 and 1531 and predicted that it would reappear in 1758. It duly did so and was named after Halley who had by then died.

What Newton had solved was the two body problem. He was able to prove that Kepler's laws were a direct consequence of his laws of motion and his theory of gravitation. The observed discrepancies arose from the N-body problem, in that the Solar System consists of not two but N bodies. The N-body problem was to occupy mathematicians for centuries and a series of important advances were made by Henri Poincaré around 1890. He showed that the three body problem, unsolved by mathematicians since Newton 200 years earlier, produced highly complex orbits.

... it may happen that small differences in the initial conditions produce very great ones in the final phenomena. Prediction becomes impossible ...

This was an important concept that was for the most part forgotten over the next one hundred years. The nature of the problem can be seen in Figure 1. This shows the orbits of the inner five planets and the orbit of the small periodic comet Kojima. At the time of writing this

comet is currently making a close approach to Jupiter and as a result its orbit is undergoing a major disruption so that its orbit in the next century will be quite different from its earlier one. Such interactions with the planets have occurred many times over the millennia that it has been orbiting the Sun.

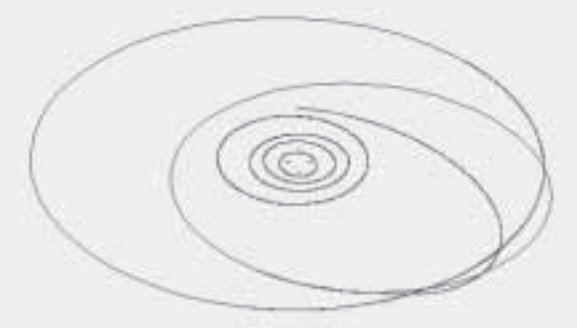


Figure 1: Disruption of the orbit of comet Kojima by Jupiter

If we now return to more earthly matters, in 1963 the meteorologist Edward Lorenz published "Deterministic Nonperiodic Flow" in the Journal of Atmospheric Sciences. His work was at first sight totally unconnected to the motion of the planets. The Lorenz equations were a simplified model of atmospheric convection but they showed great sensitivity to the initial conditions. Lorenz was able to show that there was a link between aperiodicity and unpredictability and that there was in the problem a fine geometrical structure and that order was masquerading as randomness.
The equations themselves are deceptively simple,

$$\frac{d}{dt}x(t) = 10\cdot y(t) - 10\cdot x(t)$$

$$\frac{d}{dt}y(t) = y(t) - x(t)\cdot z(t) + 28\cdot x(t)$$

$$\frac{d}{dt}z(t) = x(t)\cdot y(t) - \frac{8}{3}\cdot z(t)$$

but the solutions are very "noisy" and appear to have random fluctuations.

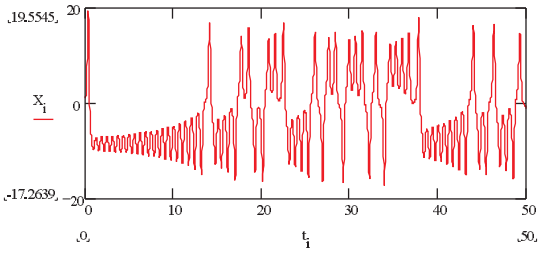


Figure 2: Time history of one of the Lorenz state variables

If the solution is plotted out in three dimensions the following picture, the "Lorenz Attractor" is obtained.

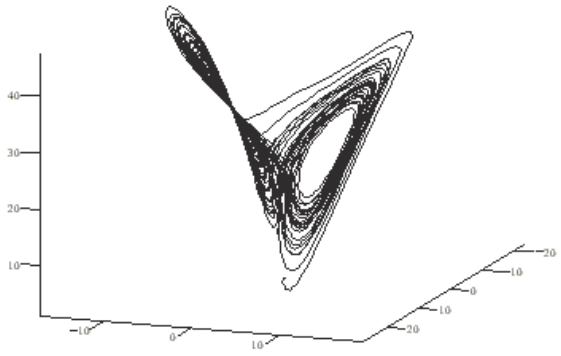


Figure 3: The Lorenz Attractor

This image was to become famous and an emblem of the early explorers of Chaos and as it turns out the similarity to the sensitivity in the three body problem noted by Henri Poincaré is not accidental and much of Poincaré's work has proved to be of great importance in the study of chaos.

Some time later in 1974, another quite unrelated piece of work to do with simulation languages, was reported in The Computer Journal by J.L.Hay, R.E.Crosbie & R.I.Chaplin: *"Integration Routines for Systems with Discontinuities"*. Their paper raised the important idea that we can summarise as:

The continuity assumptions in conventional integration algorithms should not be violated by discontinuities in the derivative evaluation but if they are then simply reducing the integration step size may not solve the problem.

It went on to show that the situation could be rectified by the following strategy:

1. establish discontinuity functions that change sign when the discontinuities are encountered,
2. use the discontinuity function sign change to trigger backtracking code to locate the discontinuity and integrate up to it correctly,
3. restart the integration the other side of the discontinuity with new initial conditions, and governing equations.

At the time of publication many in the simulation fraternity thought that it was the solution of a "Non-Problem" and that the slight error in the integration following passage through a discontinuity was negligible. Had the work of Poincaré and Lorenz been known to them at that time the true significance of the idea would have been better appreciated.

Returning to the developments in chaos, in 1980 Ueda published a paper on the steady state chaotic behaviour of Duffing's equation. This is a linear second order system with a non linear stiffness,

$$\ddot{x} + a\dot{x} + bx + cx^3 = D\sin\omega t$$

The behaviour of this equation was extensively studied by Duffing in 1918 but it was only recently that quite large regimes of chaos have been discovered, as they have also been found for the non-linear damping second order system known as Van der Pol's equation.

In 1982 Michael Thompson published *"Chaotic dynamics of an impact oscillator"* in Physics Review. This is a linear second order system with discontinuities and even though it is linear the presence of the discontinuities produces chaotic behaviour.

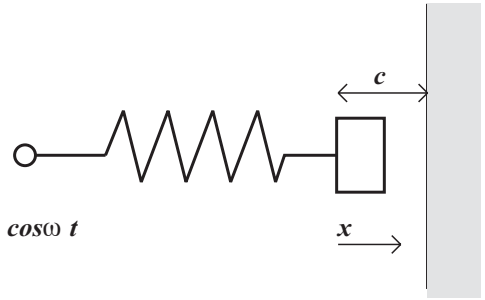


Figure 4: Impact oscillator

Meanwhile returning to the simulation world, two important events occurred in 1984

- ESL (the European space agency Simulation Language) was issued, it incorporated an implementation of the Hay, Crosbie & Chaplin discontinuity algorithm.
- ACSL (the Advanced Continuous Simulation Language) added the discontinuity algorithm to its repertoire.

At this point at around 1987 the present author entered the picture. I developed a state transition model for discontinuous systems and used the new ACSL SCHEDULE & DISCRETE statements to implement it. This approach identified five stages in analysing and implementing a model with discontinuities. The particular problem at the time was to analyse the effect of the end stop and slew rate limiting discontinuities of a small electric actuator on the flight control behaviour of a catapult launched unmanned aircraft that was unstable about all three axes. The governing equations were,

$$\ddot{\delta} + 2\omega\zeta\dot{\delta} + \omega^2\delta = \omega^2\delta_d$$

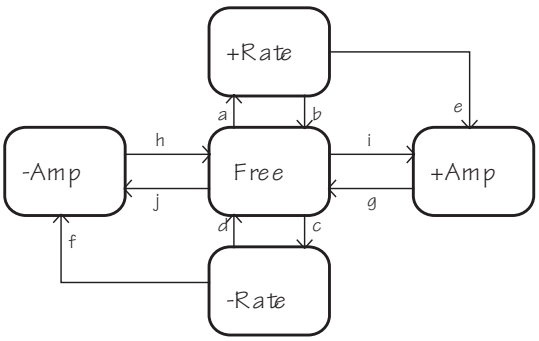
ω = natural frequency of the actuator

ζ = actuator damping ratio

$$\delta_{min} \le \delta \le \delta_{max} \quad , \quad \dot{\delta}_{min} \le \dot{\delta} \le \dot{\delta}_{max}$$

Briefly the stages were,

Stage 1: Identify the continuous regimes and the allowable transition paths between them



Stage 2: Establish the governing equations of each regime

Free $\ddot{\delta} + 2\omega\zeta\dot{\delta} + \omega^2\delta = \omega^2\delta_d$

Amp $\dot{\delta} = 0$

Rate $\delta = 0$ or

$$a = \omega^2(\delta_d - \delta) + 2\omega\zeta v$$

$$\dot{v} = K_r a$$

$$\dot{\delta} = K_a v$$

Stage 3: Establish the transition criteria for each transition path i.e. the discontinuity functions.

Path	Transition	Criterion	Action
a	free to +rate	$v \ge \dot{\delta}_{max}$	set K's
b	+rate to free	$a < 0$	set K's
c	free to -rate	$v \le -\dot{\delta}_{max}$	set K's
d	-rate to free	$a > 0$	set K's
e	+rate to +amp	$\delta \ge \delta_{max}$	set K's, v=0
f	-rate to -amp	$\delta \le -\delta_{max}$	set K's, v=0
g	+amp to free	$a < 0$	set K's
h	-amp to free	$a > 0$	set K's
i	free to +amp	$\delta \ge \delta_{max}$	set K's, v=0
j	free to -amp	$\delta \le \delta_{max}$	set K's, v=0

Stage 4: Establish the actions required following each transition

Regime	Set Kr	Set Ka	Set v
free	1	1	
+rate	0	1	
-rate	0	1	
+amplitude	0	0	0
-amplitude	0	0	0

Stage 5: Code the problem

- ACSL use SCHEDULE plus DISCRETE blocks
- ESL use WHEN plus procedural code

This approach worked very well and the aircraft successfully completed its first flight and has flown many times since and is still in operation.

Some time later in 1988 a Cranfield PhD student, Raj Joshi had problems with the simulation of an electro-optical tracker system that included gear boxes with backlash in the gears.

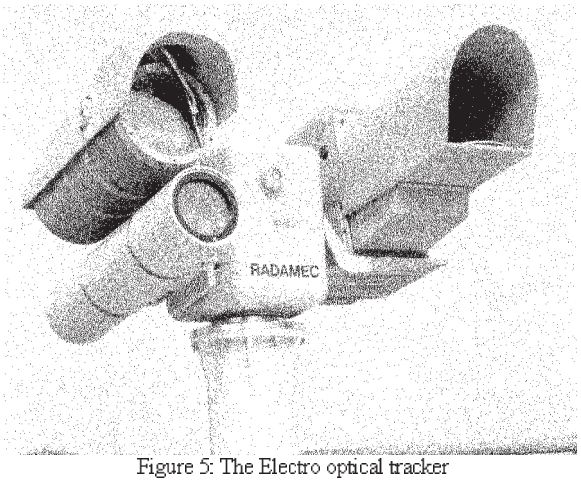


Figure 5: The Electro optical tracker

He used the author's method with ACSL to model the backlash but sometimes got random noisy "chattering" behaviour even when he used deterministic inputs.

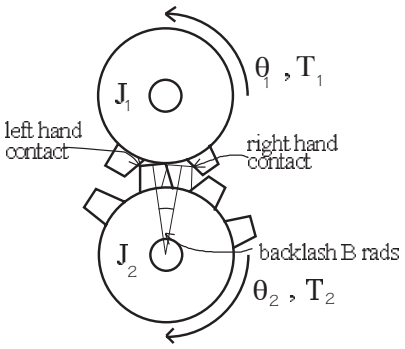


Figure 6: The Gear backlash model.

In 1990 I attended a UKSS meeting at witch C.J. Budd gave a presentation on "*Chaos and Dynamics*". He described the impact oscillator problem and showed the Poincaré Section of the chaotic attractor. As a result I returned to the gear backlash problem for further investigation since it struck me that it was very similar to the impact oscillator and could be capable of chaotic behaviour. As an initial exercise I first programmed the impact oscillator problem as described by Budd but using my discontinuity method and the ACSL implementation of the Hay, Crosbie & Chaplin algorithm. It worked fine and gave the same Poincaré section results as Budd's, but without having to evaluate the exact solution as he had done. Hence it suggested that the Hay, Crosbie & Chaplin algorithm could be useful for more complex cases where exact solutions were not possible.

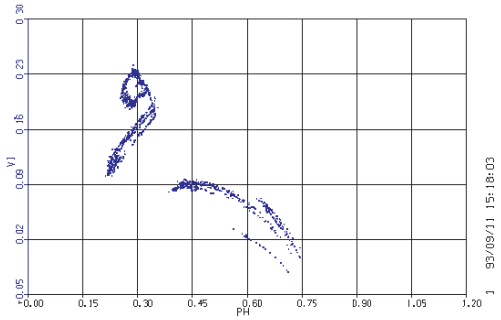


Figure 7: ACSL Poincaré section of the impact oscillator

By 1994 further investigation had revealed that the gear backlash problem was also capable of chaotic behaviour pointing to the conclusion that Joshi's inexplicable results were probably due to chaos, a fact no one involved appreciated at the time. At present studies continue at Cranfield with ACSL and its implementation of the Hay, Crosbie & Chaplin algorithm, in particular with studies into undercarriage dynamics and the effect of comet out gassing on space craft rendezvous.

And so to the moral of this story. It is simply,

that we generate ripples in the ether that reverberate long after we have gone and they can wash up on many a strange and distant shore.

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EUROSIM – the Federation of European Simulation Societies

News

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. Full membership and observer membership are available.

At present EUROSIM has ten full members and two 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 (U.K.). AES – Asociación Española de Simulación (Spain) and PSCS – Polish Society for Computer Simulation (Poland) are observer members.

The EUROSIM Congress is arranged every three years in Europe. EUROSIM'98 took place in Helsinki, April 14-17, 1998. The 4th EUROSIM congress will take place in Delft, The Netherlands, June 26-30, 2001.

EUROSIM is governed by a **Board** consisting of one representative of each member society, plus the organizer of the last EUROSIM Congress (past president) and the organizer of the coming EUROSIM Congress (president).

At the EUROSIM'98 Congress the Board elected new officers for a three year period beginning on July 1, 1998: L. Dekker (DBSS) – president, K. Juslin (SIMS) – past president, A. Javor (HSS) – secretary, Y. Hamam (FRANCOSIM) – treasurer. The Polish Society for Computer Simulation (PSCS) has been accepted as observer member in EUROSIM.

Further information can be found on the EUROSIM WWW Server:

http://www.eurosim.org/

Simulation Practice and Theory

Simulation Practice and Theory (SIMPRA) is EUROSIM's scientific journal, published by Elsevier Science B.V. It publishes high quality contributions on modelling and simulation.

Alerting and Awareness Services

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The following is the most recent delivery from Contents Direct for the journal Simulation Practice and Theory.:

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Colajanni, M.
pp.: 369-385

An airport passenger terminal simulator: A
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pp.: 387-396

Modeling and quantitative analysis of discrete
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Gruer, P.
pp.: 397-411

Modeling problems of hybrid event dynamic
systems
Wen, Chuanyuan
pp.: 413-422
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F. Breitenecker

ASIM

ASIM (*Arbeitsgemeinschaft Simulation*) is the association for simulation in the German speaking area. ASIM was founded in 1981 and has now about 680 individual members.

ASIM'98
12. Symposium Simulationstechnik
Zürich, September 15 - 18, 1998

ASIM'98 will be hosted by ETH Zürich and University Zürich, from September 15 to 18, 1998. Local organiser is the *Institut für Werkzeugmaschinen und Fertigung* of ETH Zürich. All kinds of modelling and simulation aspects will be addressed.

Preliminary Program:

Tuesday, Sept. 15, 1998: tutorials, user group meetings, welcome cocktail
Wednesday, Sept. 16, 1998: invited lectures, parallel sessions, *Praxisforum: "Steuer- und Regelsysteme im Kraftfahrzeug"*, ASIM *Mitgliederversammlung*, reception
Thursday, Sept. 17, 1998: invited lectures, parallel sessions, poster session, social event
Friday, Sept. 18, 1998: parallel sessions, meetings of ASIM working groups

An exhibition of simulation software and hardware accompanies the symposium.

Invited Papers:
Dr. Maier, Robert Bosch AG: *Simulation in der Zusammenarbeit Zulieferer/Hersteller*
Prof. Nadja Thalmann, Uni Genf: *Virtuelle Menschen, virtuelle Welten, was kann man damit ?*
Prof. Paul Embrechts, ETH Zürich: *Risk-Management und Simulation*
Prof. Wilhelm Hummeltenberg, Uni Hamburg: *Simulation for Business and Competitive Intelligence and Excellence*
Prof. Heinrich Brändli, ETH Zürich: *Simulationsansätze im Verkehr*

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Co-operation ASIM – SCS Europe

On March 27th, 1998 representatives from ASIM (Bausch-Gall, Breitenecker, Kampe, Möller) and representatives from SCS Europe (Kerckhoffs, Lehmann, Rimane) met in Munich to discuss common issues, as book series, conferences and other chances for a fruitful co-operation.

One of the main results of this meeting was to suggest to the ASIM board and to the board of SCS Europe that the book series of ASIM and of SCS Europe are published jointly from 1999 on. The aim is to bring together the major European publishing efforts in the area of modelling and simulation and to support one series, where all interested persons will publish and look for advanced publications in simulation.

The books could be marketed and sold together to the benefits of both, SCS and ASIM members, with less costs for overhead than today (and partly for other societies, e.g. EUROSIM).

It was suggested
- to join the ASIM series *Fortschritte in der Simulationstechnik*, Vieweg Verlag, and the SCS series *Frontiers in Simulation* to one series.
  In future this will be the series to publish monographs, status reports of the ASIM *Fachgruppen*, basic books of a more general interest.
- to join the ASIM series *Fortschrittsberichte Simulation / ARGESIM Reports* and the SCS series *Advances in Simulation.*
  This series is intended to publish e.g. dissertations, manuals, classroom notes and other material.

It is planned to have a common editorial board. Publishing languages will be German, English and French. The books will be printed in the SCS European Publishing House.

The ASIM board already accepted this suggestion. The subject will be discussed at the SCS board meeting during the ESM conference in Manchester.

All other publications, like *ASIM Nachrichten*, *ASIM Mitteilungen*, and SCS publications, like conference proceedings, manuals, etc. will remain unchanged.

Further items of the co-operation are: a) The ASIM 2000 Symposium and the ESS 2000 Conference will be arranged together in Hamburg. b) SCS intends to promote SNE also as membership journal for the European SCS members.

From 1999 on together with SCS series "Advances/Frontiers in Simulation"

ASIM - Buchreihen / ASIM Book Series

Reihe/Series **Fortschritte in der Simulationstechnik**

VIEWEG Verlag, Wiesbaden, Deutschland
erhältlich im Fachbuchhandel / available at book stores

kürzlich erschienen / appeared recently:

- R. Grützner (Hrsg.); Modellierung und Simulation im Umweltbereich
- A. Kuhn, S. Wenzel (Hrsg.); Simulationstechnik 11. Symp. Dortmund, 1997

Schwerpunkte / Topics:

- Statusberichte über Simulation in den ASIM Fachgruppen / Status reports
- Allgemeine Monographien / General monographies
- Proceedings der ASIM Tagungen / Proceedings of the ASIM conferences

Reihe/Series **Fortschrittsberichte Simulation**

ARGESIM, Wien, Österreich; erhältlich bei ASIM / available at ASIM

kürzlich erschienen / appeared recently:

- J. Plank; State Events in Continuous Modelling and Simulation - Concepts, Implementation and New Methodology
- P. Acel; Methode zur Durchführung betrieblicher Simulationen - Effiziente Optimierung der diskreten Simulation
- M. Kinder; Stochastische Simulation biotechnischer Prozesse - Entwurf von Filtern und Regiern
- M. Lingl; Hybrid Modelling Approach in Discrete, Continuous, and Combined Simulation (geplant für Ende 1998 / to appear at the end of the year)

Schwerpunkte / Topics:

- Spezielle Monographien (Dissertationen, ...) / Special monographies (PhD-thesis, ...)
- Erweiterte Berichte der ASIM Fachgruppentreffen / ASIM Workshop proceedings
- Handbücher für Simulationssprachen / User Guides for simulation languages

Preis / Price: DM 40.- (ASIM-Mitglieder DM 30.-) + Versandkosten

Andere Reihen / other Series

kürzlich erschienen / appeared recently:

- A. Kuhn, M. Rabe (Hrsg.); Simulation in Produktion und Logistik
- K. Mertens, M. Rabe (Hrsg.); Erfahrungen aus der Zukunft

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Ab 1999 zusammen mit den SCS-Reihen "Advances/Frontiers in Simulation"

ARGESIM REPORT

Board Meeting

The Board met on April 24, 1998 in Mainz. The Board thanked again Dr. Wenzel and Prof. Kuhn for their organization of the last year's ASIM symposium.

Main subjects of the meeting were: preparation of the conference in Zürich and the status of the book series. It was decided to organize a so-called "*Praxisforum"* at the Zürich conference. The *Praxisforum* will focus on simulation in Automotive and will be held on Wednesday, September 17th at the Zürich conference. The *Praxisforum* will be organized by Ewald Hessel, the speaker of the *Fachgruppe* "*Simulation Technischer Systeme*". Speakers will come from car manufacturers, suppliers and from universities. For a more detailed program see *ASIM Nachrichten*.

The ASIM Board accepted the suggestion that from 1999 on the ASIM and the SCS book series will be published jointly, and the co-operation plan with SCS in general.

The next ASIM Board meeting will take place on September 15, 1998. Please contact the speaker or vice-speaker if there are any special subjects to be discussed.

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`admin@asim-gi.org` (for adminstration)

ASIM Meetings to come

September 15-18, 1998: ASIM'98, *12. Symposium Simulationstechnik*, the annual ASIM conference, Zurich, Switzerland.

March 1-2, 1999: Meeting of FG 5 "*Simulation Technischer Systeme*" and FG 2 "*Simulationssoftware und -hardware*" at RWTH Aachen.

March 8-10, 1999: Seventh symposium "Simulation for managerial decision support – new tools and approaches in practice" in Braunlage.

September 21-24, 1999: ASIM '99 *13. Symposium Simulationstechnik*, Weimar.

April 2000: Meeting of the *Fachgruppe "Simulation in Biologie, Medizin und Ökologie"*.

September 2000: ASIM'2000 will be held at Universität Hamburg together with ESS 2000.

Working Groups (Fachgruppen FG)

"Verteilte Systeme und parallele Prozesse" (FG 1)

Speaker: Dr.-Ing. Peter Schwarz, Fraunhofer-Institut IIS/EAS, Zeunerstr. 38, D-01069 Dresden Tel: +49-351 4640 730, Fax: +49-351 4640 703, email: schwarz@eas.iis.fhg.de

"Simulationssoftware und -hardware" (FG 2)

On March 2, 1998, the working group met for a half-day seminar at University of Magdeburg, at the beginning of the conference SV'98 - Simulation and Visualisation, organised by P. Lorenz and co-workers.

At this meeting (about 30 participants) the working group discussed specific trends and open questions in the development of simulation environments, whereby specialist gave an overview on specific items and intensive discussions tried to view the topic from all sides:

i. WWW-based simulation, Simulation in WWW (P. Lorenz; Univ. Magdeburg)
ii. Combined and object-oriented simulation technique and user-customized simulation environments (B. Schmidt, Passau)
iii. Convergence or divergence of continuous and discrete simulation techniques (F. Breitenecker)
iv. Spreadsheet-based modelling and simulation (Th. Schriber, Univ. Michigan)
v. SLX – an alternative approach for discrete modelling and simulation and for implementation of application-oriented simulators (Th. Schulze, TU Dresden)

In the 3rd and 4th topic it became clear, that the classical definition of simulation must be extended, because methods from soft computing and analytical-symbolical methods on the one side, and easy-to-use tools like spreadsheets on the other side, change the demands essentially.

The 5th contribution showed an old contradiction in simulation technique: object-oriented, flexible (dynamic) and modern, but slow, versus classical, static, "old-fashioned", but fast.

The most intensive discussion resulted from the 1st and 2nd topic. While P. Lorenz underlined the advantages and the necessity of using WWW in modelling and simulation not only for representation, but also for application, distributed simulation, etc, on the contrary B. Schmidt formulated the sentence "Do we really need that – except for advertising ?" – consequently proofing that possible benefits are achieved also by e. g. server-client concepts, etc. These very different views of the protagonists (see following figure) were discussed in detail, also after the end of the meeting – to be continued at the SV'98 conference.

The meeting ended – later than expected because of the intensive discussions – with administrative affairs of the working group. F. Breitenecker (prel. speaker together with D. Möller since re-organisation of the group) gave an overview on the development of the group and sketched possible activities of the group, in order to take account of the new demands in simulation technique. Afterwards elections of speaker and vice speaker took place. F. Breitenecker was elected as speaker, and Th. Schulze as vice speaker. Mr. Schulze will take more care on the discrete world and on non-classical methods, as e. g. used in traffic simulation (Mr. Schulze is also vice-speaker of the working group "*Simulation von Verkehrssystemen*"). Furthermore it was decided to install an advisory board, where representatives of developers and distributors are asked to inform ASIM members about developments, trends, etc.

The working group is co-operating with ARGESIM in evaluation and documentation of the ARGESIM Comparisons of Simulation Software and Simulation Techniques since two years. In the beginning of this year the co-operation was extended by the co-organisation of the "*Seminare aus Modellbildung und Simulation*" at Vienna University of Technology. There ARGESIM runs a series on simulation software seminars – 48 seminars since 1990. The working group supports seminars of general interest for ASIM members, giving support with announcements and administration.

The first seminar in the co-operation was the "MATLAB / SIMULINK Seminar" on March 12, 1998. W. Kleinert (Computing Services, Vienna University of Technology), F. Breitenecker (ARGESIM / ASIM) and H. Stahl (Scientific Computers) could welcome about 150 (!) participants (see following pictures).

The seminar gave an overview on the broad variety of MATLAB, SIMULINK, the Toolboxes and Blocksets, from mathematics to hardware-in-the-loop applications. The seminar was also a forum for MATLAB users, who discussed problems, open questions, and certain demands on the developer or distributor.

One of the highlights of the seminar was the contribution by E. Neuwirth (Inst. of Statistics, University Vienna; at the right in the picture above), who explained the projection of results of elections and of the changing behaviour of voters by means of MATLAB programs – successfully applied at several elections in Austria and presented live on TV.

Speaker: Prof. Dr. Felix Breitenecker, TU Wien, Abt. Simulationstechnik, Wiedner Hauptstraße 8-10, A-1040 Wien, Tel: +43-1 58801 5374, Fax: +43-1 5056849, email: Felix.Breitenecker@tuwien.ac.at

Vice-speaker: Dr. Thomas Schulze, Univ. Magdeburg, Inst. f. Techn. Informationssysteme, Universitätsplatz 2, D-39106 Magdeburg, Tel: +49-391 67-12017, email: tom@isg.cs.uni-magdeburg.de

"Simulation und künstliche Intelligenz" (FG 3)

Speaker: Prof. Dr.-Ing. Helena Szczerbicka, Universität Bremen, Rechnerarchitektur und Modellierung, Fachbereich 3 - Informatik, Postfach 33 04 40, D-28334 Bremen, Tel: +49-421 218 7389 or 7390, Fax +49-421 2187385, email: helena@informatik.uni-bremen.de
Vice-speaker: Dr. Thomas Uthmann, Johannes-Gutenberg-Universität Mainz, Institut für Informatik, Staudingerweg 9, D-55099 Mainz, Tel: +49-6131 39-3610, Fax +49-6131 39-3534, email: uthmann@informatik.uni-mainz.de

"Simulation in Medizin, Biologie und Ökologie" (FG 4)

Speaker: Prof. Dr.-Ing. Dietmar P.F. Möller, TU Clausthal, Institut für Informatik, Erzstraße 1, D-38678 Clausthal-Zellerfeld, Tel: +49-5323 72 2402, 2504, Fax: +49-5323 72 3572, email: moeller@informatik.tu-clausthal.de
Vice-speaker: Prof. Dr. Otto Richter, TU Braunschweig, Institut für Geographie und Geoökologie, Langer Kamp 19c, D-38106 Braunschweig, Tel: +49-531 391 5627, Fax: +49-531 391 8170

"Simulation technischer Systeme" (FG 5)

This year's spring meeting was organized at FH Heidelberg, perfectly hosted by Prof. Schmidt and his crew. More than 60 participants came to the lovely town at the Neckar.

The program included on Monday reports about simulation at FH Heidelberg (several speakers), a talk about simulation of hydraulic systems (P. Beater) and a talk about simulation in car industry (D. Hoetzer).

Members met on Monday evening to elect speaker and vice speaker. Ewald Hessel was elected as new speaker of the working group, Achim Wohnhaas as vice speaker. Ingrid Bausch-Gall thanked all who helped her with her work during the last year and gave all her best wishes to the newly elected speaker and vice speaker. Mr. Hessel thanked Mrs. Bausch-Gall for the work she did to make this working group successful. A detailed report can be found in *ASIM Nachrichten*.

On Monday evening we visited a students restaurant for dinner, interesting technical discussions, but also to drink wine and sing songs together !!

Tuesday morning followed so-called "*Arbeitsgespräche*" in smaller groups. Subjects were simulation in electronics (Gall, Hessel), simulation of hydraulic systems (Beater), simulation in education (Schmidt) and simulation in control applications (Rake, Schneider).

After lunch we visited the ABB research lab in Heidelberg. The report of this meeting appeared as *ASIM Mitteilungen Nr. 59.*

The next meeting will take place on March 1st and 2nd, 1999 at RWTH Aachen, hosted by Prof. Rake.

The working group will organize a "*Praxisforum*" at the Zurich Conference. For more details see *ASIM Nachrichten*, which is mailed with this issue of SNE.

Speaker: Ewald Hessel, Hella KG Hueck&Co., Abt. EL-R, Werk II, Beckumer Straße, D-59552 Lippstadt, Tel: +49-2941 38 8572, Fax: +49-2941 38 8427, email: hessel@hella.de
Vice-Speaker: Dr. Achim Wohnhaas, FKFS, Simulation u.Rechnertechnik, Pfaffenwaldring 12, D-70569 Stuttgart, Tel: +49-711 685 5626, Fax: +49-711 685 5710, email: wohnhaas@fkfs.uni-stuttgart.de

"Simulation in Produktion und Logistik" (FG 6)

The biannual Working Group Conference of the ASIM Working Group "Simulation in Production and Logistics" took place on February 16 - 17, 1998 in Berlin, Germany. About 190 participants with a high percentage of people from industry visited the conference. The conference proceedings (ISBN 3-00-002439-5) can be ordered from M. Rabe, Fraunhofer IPK, Berlin (email: Markus.Rabe@ipk.fhg.de, Tel: +49-30-39006 248).

The next working group meeting is held on June 24th, 1998 in Dortmund, Germany. Topics are the organization of the 9th Working Group Conference, planned in spring 2000, and the presentation of the Demonstration Center "Simulation in Production and Logistics" which was established as a Fraunhofer cooperation of nine Fraunhofer Institutes and made their business to support and propagate simulation technology in production and logistics.

For a more detailed report about the activities of this working group see also *ASIM Nachrichten.*

Speaker: Prof. Dr.-Ing. A. Kuhn, Fraunhofer-Institut für Materialfluß und Logistik, Joseph-von-Fraunhofer-Straße 2-4, D-44227 Dortmund, Tel: +49-231 9743 132, Fax: +49-231 9743 234
Vice-speaker: Prof.Dipl.Ing. Adolf Reinhardt, Universität Gesamthochschule Kassel, Fachbereich 15, IPL, Kurt-Wolters-Str. 3, D-34125 Kassel, Tel.: +49-561 804 2693, Fax: +49-561 804 2697, email: fps@hrz.uni-kassel.de

For detailed information about working group activities please refer to `http://www.asim-pl.uni-kassel.de` or contact: Mrs. Dr.-Ing. Sigrid Wenzel, Fraunhofer-Institut für Materialfluß und Logistik, Joseph-von-Fraunhofer-Straße 2-4, D-44227 Dortmund, email: wenzel@iml.fhg.de.

"Simulation in der Betriebswirtschaft" (FG 7)

Speaker: Prof. Dr. W. Hummeltenberg, University of Hamburg, Institute for Computer Science in Business Administration, Max-Brauer-Allee 60, D-22765 Hamburg. Tel.: +49-40-4123-40 23, Fax: +49-40-4123-64 41, email: wi@mba.uni-hamburg.de.
Vice-speaker: Prof. Dr. Biethahn, Georg-August-University of Göttingen, Platz der Göttinger Sieben 5, D-37073 Göttingen.

"Simulation von Verkehrssystemen" (FG 8)

Speaker: Dipl.Ing.Andre Graber, Drusbergstr. 39, CH-8703 Erlenbach, Tel: +41-1-9120640, Fax: +41-1-9120641, email: a.graber@bluewin.ch
Vice-speaker: Dr. Thomas Schulze, Univ. Magdeburg, Inst. f. Techn.

Informationssysteme, Universitätsplatz 2, D-39106 Magdeburg, Tel: +49-391 67-12017, email: tom@isg.cs.uni-magdeburg.de

"Simulation in Umweltanwendungen" (FG 9)

On March 29th to 31st, 1998 the 8th Workshop: "Tools for Environmental Modelling and Simulation" of the Working Group FG 9 took place in the small town Witzenhausen, nearby Kassel in Germany at the University of Kassel.

At the evening of March 29th, the day of arrival of participants, a supper gave an opportunity to first individual contacts and conversations. The main program started on March 30th and finished on the afternoon of March 31st. There were 13 speakers and about 30 participants.

Main topics of this workshop were:
1. Basic concepts and tools for modelling and simulation,
2. Coupling of simulation systems with environmental information systems and documentation systems of models,
3. Methods and algorithms for environmental modelling and simulation: fuzzy, neuronal nets, wavelets,
4. Application of simulation in the environment: environmental oriented production control, air pollution, modelling and analysis of ecosystems.

The program consisted of the following papers.

The papers of G. Karigl (TU Vienna): "Growth and use of natural resources: modelling and simulation" and of J. Ortmann (University of Rostock): "A general approach to individual oriented modelling of population dynamics in ecological systems" cover the first main topic.

J. Wittmann (University of Rostock) has presented a paper with the title "A systems architecture for computation of spatio-temporal models" and R. Hoch (University of Kassel) spoke about "ECOBAS-MIF: documentation exemplified by a multi-model study". The last two papers reported about actual research problems in the field of system coupling and systems for ecological model documentations.

The 3rd main topic was covered by the following 6 papers. T. Clemen (University of Kiel): "A wavelet based approach for validation of ecological simulation models". G. Moebus (University Otto-v.-Guericke, Magdeburg): "Forecast based on fuzzy inductive reasoning for control of a sewerage plant". H. Unger (University of Rostock): "Approaches for modelling of individuals with different social characteristics". P. Wernecke (Agrarian Ecological Institute, Halle-Wittenberg):"Simulation tool CaDiMo for modelling of virtual stocks of plants".

L. Weyrauch; B. Page (University of Hamburg): "Distributed event-oriented simulation of air pollution based on a particle approach".

To the main topic number four we can attach the papers of A. Tuma; T. Kriwald (University of Bremen): "Environmental protection oriented production control". A. Gnauck (BTU Cottbus): "Modelling and simulation of aquatic ecological systems using MATLAB". C. Reick; P. Johanssen; B. Page (University of Hamburg): "Forecasting of plankton using neuronal nets".

Most of the papers represented new aspects and approaches to solve existing complex environmental problems. All papers will be published by Metropolis Verlag, Marburg in the series "*Umweltinformatik aktuell*".

Next year, the 9th workshop will probably be held in Dresden.

Further copies of the "state of the art report" on environmental modelling and simulation are available from the speaker of the working group. The full title is: R.Grützner (ed.): *Modellierung und Simulation im Umweltbereich*. Wiesbaden: Friedrich Vieweg Verlag. 1997.

For detailed information see the WWW pages of the working group: `http://www.informatik.uni-rostock.de/FB/Praktik/Mosi/ak5/ak_info.html` or contact the speakers.

Speaker: Prof.Dr.habil. Rolf Grützner, University of Rostock, Dept. of Computer Science, WG Modeling and Simulation, Albert-Einstein-Str.21, D-18059 Rostock, Tel: +49-381 4983369, Fax: +49 381 4983426, email: gruet@informatik. uni-rostock.de
Vice Speakers: Dr. Hubert B. Keller, Research Center Karlsruhe GmbH, Institute of Applied Informatics, P.O. 3640, D-76021 Karlsruhe, Tel.:+ 49 7247 825756, Fax.: + 49-7247 825730, email: keller@iai.fzk.de
Dr. Jochen Wittmann, University of Rostock, Dept. of Computer Science, Chair: Modelling and Simulation, Albert-Einstein-Str. 21, D-18059 Rostock, Tel.: +49-381 4983368, Fax.: +49-381 4983426, email: wittmann@informatik.uni-rostock.de

Ingrid Bausch-Gall, Felix Breitenecker

European Control Conference ECC 99
August 31 - September 3, 1999
Karlsruhe, Germany

The 5th European Control Conference ECC'99 will take place from August 31st to September 3rd, 1999, at the Congress and Exhibition Center of Karlsruhe in the South of Germany. The ECC is organized every two years and aims at stimulating contacts between specialists active in academic research and industrial development and application in the area of systems and control and to promote scientific exchange within the European Community and between Europe and other continents. Previous conferences were held in Grenoble, Groningen, Rome and Brussels, each featuring over 800 participants from all over the world.

The scope of the conference includes all aspects of systems and control ranging from fundamental research to all kinds of engineering applications and related established and advanced technologies. It is a new policy of the organizers of the ECC to strengthen the involvement

of practical applications in industry to the mutual benefit of both academia and industry. To this end the Conference promotes topics of high practical relevance to industry by sector oriented Industry Packages, where practical applications in continuous und manufacturing processes will be discussed with emphasis on cost/profit aspects. The scientific program includes plenary papers, regular and invited papers, tutorial workshops, mini courses and round tables.

Plenary lectures will prospectively be given by K. Åström (S), M. Blanke (DK); S. Campbell (USA); M. Grimble (UK); B. Krogh (USA); J. Levine (F); I. Mareels (AUS); G. Schmidt (D); D. Seborg (USA). Technical visits to nearby companies and social events will be arranged.

Scientists from academic research and engineers from industrial development and application are encouraged to participate, submit papers for presentation and to organize invited sessions. The **deadline** for draft paper submission and invited session proposals is **October 1, 1998**.

For more information please visit the ECC'99 internet page http://ecc99.uni-duisburg.de or contact the general chair
Prof. Dr.-Ing. Dr.h.c. mult. Paul M. Frank, Gerhard-Mercator-Universität-GH Duisburg, FG Meß- u. Regelungstechnik, Bismarckstr. 81, BB, D-47048 Duisburg, Phone: +49-203-379-3386, Fax: +49-203-379-2928, email: chair@ecc99.uni-duisburg.de
or the Conference Secretariat: VDI/VDE-Gesellschaft Meß- und Automatisierungstechnik (GMA), POB 10 11 39; D-40002 Düsseldorf, Tel.: +49 211 6214-224 -226 or -227, Fax: +49 211 6214-161, email: gma@vdi.de

AES

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email: gironsi@dia.ucm.es

CROSSIM

CROSSIM (The Croatian Society for Simulation Modelling) was founded in 1992 in Zagreb. *CROSSIM* is a non-profit society with the following main goals: promotion of knowledge, methods and techniques of simulation; establishment of professional standards in simulation; development of education and training in simulation; organization of professional meetings and publishing in the field; cooperation with similar domestic and international institutions. From April 1997 *CROSSIM* is a full member of *EUROSIM*.

Membership

CROSSIM currently has 64 individual members. The annual membership fee is equivalent of 8 German marks for regular members, and 2 German marks for students.

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Activities

- Co-organizing the 20th International Conference *"Information Technology Interfaces" ITI '98*, to be held in Pula, Croatia, from June 16-19, 1998. The conference has traditionally a strong modelling and simulation session.
  Information about the conference can be found on the Web address: http://www.srce.hr/iti/.
- Regularly organizing a simulation seminar held at the Faculty of Economics, University of Zagreb.
- Work on scientific projects in discrete and continuos simulation, and applications of simulation in such diverse fields as engineering, economy, medicine, ecology etc.
- Publication of papers in international and domestic journals and conference proceedings.
- Preparing publication of a booklet about the CROSSIM society.
- Preparing the CROSSIM society Web site.
- The first WWW site in Croatian devoted to simulation was developed at the Faculty of Electrical Engineering and Computing. Its address is:
  http://www.rasip.fer.hr/nastava/mis/.

V. Ceric

CSSS

General Information

CSSS (The Czech and Slovak Simulation Society) has about 75 members in 2 groups connected to the Czech and Slovak national scientific and technical societies. 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 to its members about modelling and simulation activities in Europe, informing the members about publishing in the field of modelling and simulation. Since 1992 CSSS is a full member of EUROSIM

Steering Committee

J. Stefan, Technical University Ostrava (Chairman);
M. Alexik, University of Zilina (Vice Chairman);
J. Snorek, Czech Technical University Prague;
J. Lauber, Economy University Prague;
E. Kindler, Czech Technical University Prague;
Z. Rabova, Technical University Brno;
M. Sujansky, Technical University Kosice;
J. Luhan, Res. Institut TESTCOM Prague (secretary),
P. Menhart, Slovak Techn. University, Bratislava;
V. Stoffova, University of Nitra.

Past Events

The 32nd International Conference on "Modelling and Simulation of Systems" (MOSIS'98) was very successfully held on May 5-7, 1998 in the Moravian town Bystrice pod Hostinem, Czech republic. 85 participants from the Czech and Slovak republics and 20 participants from Germany, Latvia and Poland attended the workshop and 94 papers were presented. The conference took place in the hill Saint Hostin where there is an old holy shrine. The Moravian Archbishop Jan Graubner gave a talk at the beginning of the conference. In the evening of the first conference day the Moravian folk group "Rosava" performed typical Slovanian songs and dances. The members of CSSS hope that this is a good place to prepare MOSIS in the next years.

5 members of CSSS attended the EUROSIM'98 Congress in Helsinki with the financial support of CSSS, 3 of them are doctoral students. This is the way how CSSS plans to support in the future our successful members.

On May 28-29 the 5th International Symposium "ZEL'98" took place in Zilina, Slovak republic. 93 participants from Czech and Slovak republics and 75 from Germany, Austria, Switzerland, Hungaria, The Netherlands, Poland and Russia attended the symposium. 29 papers and 21 posters were presented; 11 papers were connected with modelling and simulation. The symposium was held commemorating the 150th anniversary of Slovak railways and the 45th anniversary of founding the University of Zilina. The rector of the University of Zilina and the general director of Slovak railways attended the symposium.

Coming Events

The 13th International Conference on "Process Control and Simulation" (**ASRTP'98**) will take place on September 8-11, 1998 in Kosice, Slovak republic. Main topics: Measurement and Monitoring Systems, Modelling and Simulation, Information Technologies, Real Time Process Control and Management, Artificial Intelligence. The ASRTP conferences have a more than 20 years old tradition with a high reputation in control systems theory, modelling and simulation and its industrial applications. The chairperson of the International program committee is Prof. Dr. Ing. D. Malindzak, Technical University of Kosice, dept. of Management and Control Engineering, 042 00 Kosice, Slovak republic, email: asrtp98@ccsun.tuke.sk

The 20th International workshop "**Advanced Simulation of Systems**" will be held on September 15-17, 1998, in the Moravian town Krnov, Czech republic. Chairperson of the workshop is Dr. Ing. Zdenka Rabova, TU FEI Brno, Bozetechova 2, Czech republic.

The scientific conference with international participation "**Electronic Computers and Informatics'98**" with a section on Modelling and Simulation, will be held October 8-9, 1998 in Herlany, Slovak republic. General chair of the conference is Prof. Ing. Milan Jelsina, Technical university Kosice, Slovak republic. Organization chair is Dr. Jan Baca (bacaj@tuke.sk). Herlany is a small spa 30 km from Kosice with a special attraction, a big geyser.

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M. Alexik

DBSS

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 co-operation with the other members and is affiliated with SCS International and IMACS.

DBSS Membership

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:

I. Dfl. 75,- individual member or Dfl. 150,- institutional member, which means that you will receive the newsletter Simulation News Europe three times a year.

II. Dfl. 150,- individual member or Dfl. 250,- institutional member, which means that you will receive the Journal Simulation Practice and Theory eight times a year, and the newsletter Simulation News Europe three times a year. 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.

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

Dutch Benelux Simulation Society
Mrs. Marja Dekker-Genemans
Noordeindseweg 61
2651 LE Berkel en Rodenrijs, The Netherlands
Tel: + 31-10 51 12714
Fax: +31-10 51 13883
email: dekker@cp.tn.tudelft.nl

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

The Steering Committee exists of the following members:

A.W. Heemink (TU Delft)	Chairman
L. Dekker	Vice-Chairman
J.C. Zuidervaart (TU Delft)	Treasurer
M.J. Dekker-Genemans	Secretary
W. Smit (AKZO NOBEL)	Member
Th.L. van Stijn (Rijkswaterstaat/RIKZ)	Member

Coming Events

- In co-operation with HPAC (High Performance Applied Computing Centre) in Delft, the DBSS will organise this year a one day symposium about the theme "visualisation". This symposium will take place in week 40 (September 28 - October 2, 1998). During this symposium HPAC will officially inaugurate its virtual workbench. As soon as the programme and the exact date are available, the information will be sent to the members of the DBSS. Others who are interested to receive the programme, are kindly requested to contact the secretary by email.

- A second symposium will take place October 14, 1998, around the theme "Neural Networks" focussed on the topic "water management". This symposium wil be organised by TechnoTrans b.v. in Rotterdam in co-operation with the DBSS. Participation for DBSS members is possible for a reduced fee. The programme will be mailed to the members of the DBSS. Others who are interested to receive the programme are kindly requested to contact TechnoTrans b.v.: tel: +31 10 234 10 82, fax: +31 10 234 11 72, email: technotrans@per.nl.

- In Helsinki, April 1998, the DBSS has definitely been appointed as the organiser of the 4th EUROSIM congress in 2001. The congress will take place in Delft, The Netherlands, June 26-30, 2001.
  It is the intention of the DBSS to involve as much as possible the member societies and other simulation societies in preparing the scientific contents of the congress.
  A first step is that in June a questionnaire will be mailed to several people within and outside EUROSIM. We hope to receive a good response.
  In the next issues of SNE, after evaluation of the questionnaires, we will communicate further details.

In Helsinki, the vice chairman of the DBSS (L. Dekker) has been appointed as President of EUROSIM for the period July 1, 1998 - June 30, 2001.

Marja Dekker-Genemans

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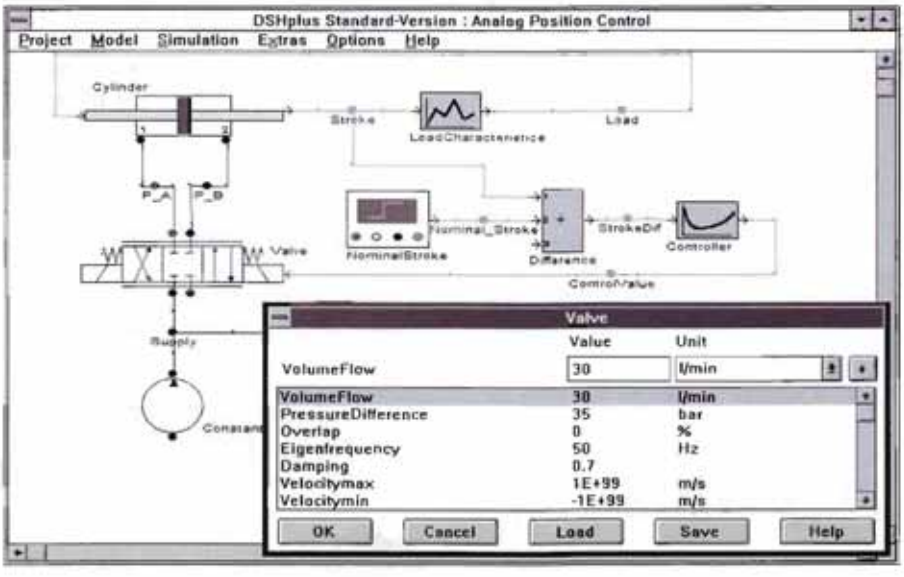

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FRANCOSIM

FRANCOSIM was created in 1991 and aims to the promotion of simulation and research in industry and academic fields. It has members from large French companies and members of Belgian and French universities.

FRANCOSIM operates two poles:
- Modelling & simulation of continuous systems
- Modelling & simulation of discrete event systems

Modeling & simulation of discrete event systems

A large community of researchers interested in discrete event simulation exists in France. Application areas are varied and include: hospitals, harbours, transportation systems, computers and industrial systems. Manufacturing systems are probably the main area of interest of FRANCOSIM members from the discrete side. Simulation is used and studied both by academic institutions and by industrial companies.

Although simulation is a key method, many researchers are interested in other types of tools for system modelling: Petri Nets, queueing networks, for example, constitute the topic of many research or application work. To improve the necessary synergy between industrial and academic people in the area of system modeling, the series of conferences "MOSIM" (Modeling and simulation) has been initiated after the success of a first conference on modeling and simulation in production management in Clermont Ferrand (with the support of the AFCET and the French CNRS through the GDR automatique). The first MOSIM conference in Rouen was international and French speaking, in order to improve the relationships between the specialists of French speaking countries (many participants coming from France, Belgium, Switzerland, Canada, North Africa, etc.). The proceedings were published by Hermes and a special issue of the scientific journal JESA was devoted to this event. The next MOSIM conference will be held in Annecy next year, with the support of EUROSIM and SCSI and we look forward to a very fruitful event. MOSIM is scheduled every 2 years.

FRANCOSIM, and its international partner societies of EUROSIM, represent a good framework for new initiatives and for members to go further.

Contact: Prof. Henri Pierreval, IFMA, Campus des Cezeaux, BP 265, F-63175 Aubiere, Cedex, France. Tel. +33-4 73 28 81 06, Fax. +33-4 73 28 81 00, email pierreva@ifma.fr

Modelling & simulation of continuous systems

This pole has been working for several years and has already organized 3 workshops (2AO92, 2AO94, 2AO96) which grouped industrials and academics in the field of modelling and simulation of continuous systems. It has also produced a document for the evaluation of modelling and simulation software which was published in the Eurosim 1995 Congress in Vienna. The pole is presently reorienting its work towards the organisation of one day workshops on specific subjects. It is also currently organising a one day workshop on diagnostics and fault detection. It will run the next academic year the BioMedSim'99 and the ModSim'99 conferences described below.

BioMedSim'99
1st Conference on Modelling and Simulation in Biology, Medicine and Biomedical Engineering. 20-22 April 1999, ESIEE Noisy-le-Grand, France

BioMedSim'99 is the first of a series of conferences to be held once every 2 years. 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 organisers expect that this series of conferences will offer researchers and developers in both fields an opportunity to meet, exchange information and establish contact. For more information on this workshop, please consult the following address:
http://www.esiee.fr/~hamamy/bioconf.html

ModSim'99
Workshop on Modelling and Simulation Methods, 20-22 April 1999, ESIEE Noisy-le-Grand, France

This workshop is intended to be an opportunity to bring together scientists and practitioners in order to present and to discuss recent advances in the field of Modeling and Simulation. The workshop is oriented towards applications. Innovative modeling techniques should be presented in combination with their impact to the solution of real world applications. For more information on this workshop, please consult the following address:
http://www.esiee.fr/~hamamy/confmodsim.html

Important dates:
Please note that the dates have been changed.
The dates are:

Deadline for extended abstracts: October 31st, 1998
Notification of acceptance: November 30th, 1998
Deadline for final papers: January 15th, 1999
Conference & workshop: April 20-22, 1999

Pole and Conference contact :
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email: lorsim@lorsim.be

Y. Hamam

HSS

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, demonstrations, round table discussions and conferences.

Activities

Last year demonstrations of applications of artificial intelligence controlled simulation have been performed in various fields for their specific subject matter expert audiences. This year an interdisciplinary workshop and demonstration is planned in the last quarter of this year. It is intended to present and demonstrate the principles and application of the AI controlled CASSANDRA 3.0 simulation system. Those colleagues who are interested in participating at this event are kindly requested to contact the address given below via email or otherwise.

Contact Address

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email: javor@goliat.eik.bme.hu

András Jávor

ISCS

General Information

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

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

Giuseppe Iazeolla	chairman
Mario Savastano	vice-chairman
Vincenzo Grassi	treasurer
Vittorio Cortellessa	secretary
Pasquale Daponte	committee member
Franco Maceri	retiring chairman

Membership

At present ISCS counts 132 members: 6 institutional, 4 honorary, 120 regular and 2 affiliate. Charges per annum are Lit. 30,000 for regular and affiliate members and Lit. 400,000 for institutional members.

Contact Address

For further information or application for membership, please contact:

ISCS, c/o Dipartimento Ingegneria Informatica
Università di Roma "Tor Vergata"
Via di Tor Vergata, I-00133 Roma, Italy
Phone: +39 6 7259.7380 -.7381
Fax: +39 6 7259.7460
email: {grassi,cortelle}@info.utovrm.it
http://remlab.dis.unina.it/iscs/iscs_hp.htm

Activities

On December 16, 1997 the annual meeting of ISCS members was held in Napoli. This meeting, besides representing an interesting forum to discuss and promote the activities of the society, was the occasion to elect the Steering Committee for the period 1998-2000. The following persons have been elected:
G. Iazeolla, V. Grassi, V. Cortellessa (University of Rome "Torvergata"), M. Savastano (University of Naples), P. Daponte (University of Salerno).

On February 12, 1998 the first meeting of the Steering Committee was held in Rome, were the administrative offices have been distributed. Furthermore, the following additional duties have been assigned: EUROSIM board member - Giuseppe Iazeolla; EUROSIM board proxy - Mario Savastano; ISCS representative in foreign simulation societies - Pasquale Daponte; ISCS proxy in foreign simulation societies - Vittorio Cortellessa.

The names and related administrative offices of the new Committee are listed above. In this meeting the 1998 annual conference of ISCS has also been scheduled: it will be held in Naples on December 15, 1998.

An ISCS web page has been recently realized, whose address is
http://remlab.dis.unina.it/iscs/iscs_hp.htm.

Vittorio Cortellessa

PSCS

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 uni- versities, research institutes and industry in Poland with common interests in a variety of methods of computer simulations and its applications. At present PSCS counts about 162 members. The affairs of the PSCS are directed by the board of second cadence consisting of the following persons:

Roman Bogacz - President
Leon Bobrowski - Vice President
Romuald Kotowski - Vice President
Zygmunt Strzyzakowski - Tresaurer
Zenon Sosnowski - Secretary
Edward Kolodzinski
Bogdan Lesyng
Andrzej Tylikowski

Activities

The main activities of the Polish Society for Computer Simulation are annual conferences known as "PSCS Workshops on Simulation in Research and Development". The third PSCS Workshop was organised in 1996 by Prof. Leon Bobrowski in Wigry and there were about 80 participants. The fourth PSCS Workshop was organised in 1997 by Prof. E. Kolodzinski in Jelenia Gora.

Coming Events

The **fifth PSCS Workshop on Simulation in Research and Development** will be organised in Jelenia Gora on 7-9 October 1998 by Prof.Tylikowski, email: ptsk98@simr.pw.edu.pl.
PSCS will participate in the organisation of the European Simulation Multiconference **ESM'99** which will be held in Warsaw on June 1-4, 1999 .
Contact persons: Prof. Helena Szczerbicka (esm99@informatik.uni-bremen.de), Philippe Geril (philippe.geril@rug.ac.be), Prof. Leon Bobrowski (leon.bobrowski@ibib.waw.pl).

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Z. Sosnowski

SIMS

General information

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' matters are taken care of by a board, the ombudsman and the treasurer. SIMS' board has eight members – two from each country. The annual meeting takes place in connection with the conferences. Usually the board meets a second time per year. The bylaws are written in Swedish and have recently been proposed updated.

How to join SIMS?

From 1996 the basic membership is free. You may register as a member by sending a mail with personalia to the address

sims@ecy.sintef.no

As a member you will receive invitation to the conferences and other information related to simulation. You will also get a discounted conference fee on the SIMS conferences. Individual subscriptions for a discounted price to *Simulation News Europe* and *Simulation Practice and Theory* are available.

For more information visit the Internet address **http://www.itk.ntnu.no/SINTEF/sims/sims.html**

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Torleif Iversen

SLOSIM

The Slovenian Society for Simulation and Modelling (SLOSIM) has currently 85 members, both from Slovenian universities and from industrial companies. SLOSIM was founded in 1994 and became a full member of EUROSIM in 1996.

Recent Events

SLOSIM is a co-operative society in the organisation of the traditional Electrotechnical and Computer Science Conference ERK 98 in Portoroz, Slovenia, on the Adriatic coast (September 24-26, 1998) and is responsible for modelling and simulation sessions. So modellers and simulationists are kindly invited to send a camera ready paper before July 20 to:

Sasa Divjak
Faculty of Comput. and Inform. Science
Trzaska 25, 1001 Ljubljana, Slovenia

A Call for papers has been already sent to our members. More information can be found on http://www.ieee.si/erk98/ and http://www.tse-trade.si/erk98/

On April 23, there was a regular group presentation meeting at the University of Maribor, Department: Faculty of Organizational Sciences (in Kranj) where Laboratory of Cybernetics and Decision Support Systems was presented (see also presentation of simulation centres, page 55). This was the first presented group which deals with discrete event modelling and simulation. Its activities are focused on the modelling of business and production systems and their validation.

At this occasion there was also the SLOSIM board meeting. The discussion was focused on the current problems in EUROSIM (conflict between ASIM and the new president Dekker, …) as well as on the preparation of the elections of new members of the SLOSIM board, which will take place in autumn this year. The general opinion was that the work of the board was successful. In order to assure continuity the majority of the board can stay for a new 4-years period.

All members are kindly invited to propose candidates for a new SLOSIM board. Particularly more interest would be appreciated from Maribor region.

On April 13, I participated in the EUROSIM board meeting in Helsinki during the 3rd EUROSIM congress. The Slovene Ministry of Research and Technology covered a part of the expenses for my participation in the EUROSIM Board meeting. It covers also the expenses for SNE and SIMPRA for our members (as a regular membership fee). For this support we express to our Ministry our warmest thanks.

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slosim@fe.uni-lj.si

B. Zupancic

UKSIM

General Information

The UK Simulation Society has about 80 members throughout the UK from both universities and industry. It is active in all areas of simulation and holds a biennial conference as well as regular smaller meetings and seminars.

Fourth United Kingdom Simulation Society Conference

See announcement below.

Membership

Membership of the UK Simulation Society is very good value at only £20 per year including a subscription to Simulation News Europe. For more information, contact the Membership Secretary,

Dr. Gwyn Jones
Dept of Computing and Information Systems
London Guildhall University
100 Minories
London EC3N 1JY
Tel: +44 171 320 1716
Fax: +44 171 320 1717
email: gjones@lgu.ac.uk

Gary J. Gray

Fourth United Kingdom Simulation Society Conference
UK Sim 99

St Catherine's College, Cambridge, England

7th-9th April 1999

Initial Announcement and First Call for Papers

Papers are invited on any aspect of simulation to be presented at a three day event to be held in Cambridge, England. The conference venue is St Catherine's College Cambridge. Founded in 1473, St Catherine's College is beautifully located in the heart of Cambridge, surrounded by many other well-known colleges. 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.

Abstracts (two pages of A4 without 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, languages, tools and techniques. Models and modelling tools. Data/object bases. Analysis and statistica1 tools. Simulators and simulation hardware, training simulators. Integration of simulation with concurrent engineering, integrated design and simulation systems. AI in simulation. Parallel and distributed simulation. Neural networks.

Simulation applications include: aerospace; electronic circuits and systems; computer networks; business; management; finance; economics; leisure; 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 also welcome, especially EUROSIM member countries.

The registration cost is 160 pounds sterling for members of EUROSIM Societies. This includes proceedings. Accommodation including all meals, (including Conference dinner) and refreshments, tea/coffee is 65 pounds sterling per day for double occupancy or 75 pounds per day for single occupancy.

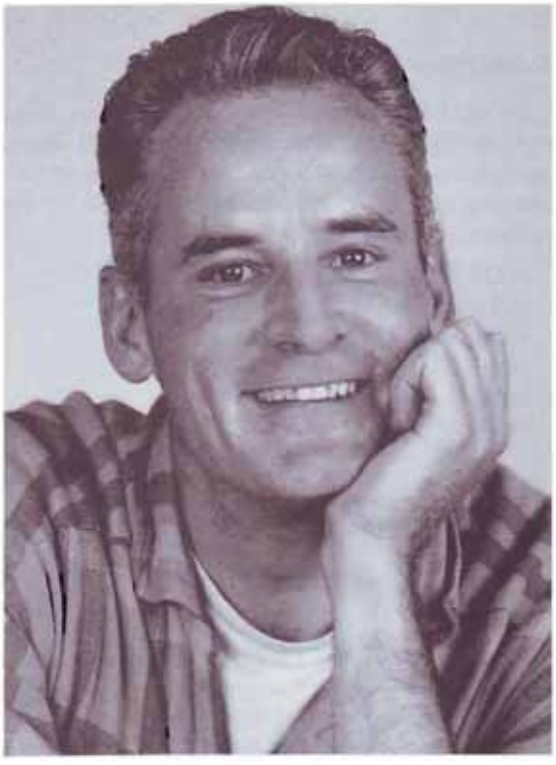
Abstracts/submissions/proposals to the Conference Chair from whom further information is available.

Deadlines:

Abstract (four copies. 2 pages of A4): 1st November 1998.
Notice of provisional acceptance: 17th December 1998.
Camera ready copy and registration fee: 1st February 1999.

Conference Chair:

Russell Cheng
Canterbury Business School
The University
Canterbury, Kent, CT2 7PE, UK.
Tel: +44 1227 823665
Fax: +44 1227 761187
Email: R.C.H.Cheng@ukc.ac.uk



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Simulation Societies

SIGSIM

General Information

The Special Interest Group for Simulation (SIGSIM) is an international professional organization in the area of modeling and computer simulation. The organization's members represent an extremely cross-disciplinary set of professions where modeling and simulation are applied. SIGSIM is actively involved in promoting technical advances in the field and supporting educational activities that expand the use of M&S in engineering, scientific, and management fields.

Regular Activities

SIGSIM is a cosponsor of the Winter Simulation Conference (WSC) and the Parallel and Distributed Simulation Workshop (PADS). WSC 1998 will be held in Washington DC, USA, December 13-16. PADS 1998 will be held in Banff, Alberta, Canada, May 26-29.

SIGSIM publishes a quarterly newsletter entitled *Simulation Digest*. One issue of this newsletter is a reprint of the most recent PADS proceedings. The organization also maintains a web page at http://www.acm.org/sigsim where current news, links to conferences, electronic publications, and special activities are maintained.

Special Activities

SIGSIM is currently in the process of creating a Web-Based Distinguished Lectureship Series. This consists of audio and video recordings of presentations by and interviews with some of the most prominent people in the field. The multimedia presentations will be accessible to SIGSIM members via the web page listed above.

Contact Addresses

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Orlando, Florida 32817 USA
smithr@magicnet.net

Ernest Page, SIGSIM Vice Chair
MITRE Corporation
7525 Colshire Drive
McLean, Virginia 22102 USA
epage@mitre.org

Membership

SIGSIM has approximately 750 members distributed among 50 countries around the world. Annual membership fees are $45, or $22 when accompanied by membership in ACM. Additional membership information is available from:

ACM European Service Centre
108 Cowley Road
Oxford, OX4 1JF, UK
+44-1865-382-338
acm_europe@acm.org
http://www.acm.org/sigsim

Roger Smith

SCS Europe

The SCS European Office (in close co-operation with the SCS European Council) continues to organize high-quality international scientific conferences on computer simulation and related fields. For many of our conferences both written Proceedings and CD-ROMs are available, which also can be ordered afterwards.

In the recent past ECEC98 (the 5th European Concurrent Engineering Conference) has been held in Erlangen-Nuremberg (Germany), April 26-29. The aim of ECEC98 was to provide European researchers with a forum where they can discuss the latest developments linked to Concurrent Engineering. The event was sponsored by Daimler-Benz and attended by 60 participants. The Proceedings (315 pages covering 46 papers) have been edited by dr. Uwe Baake (Daimler-Benz) and dr. Richard Zobel (University of Manchester). The conference was generally considered to be of high quality. ECEC99 (the 6th European Concurrent Engineering Conference) is scheduled to be organized in April 1999 in Erlangen (Germany). Our next conference in the Euromedia series will also be organized to be held in April 1999 in Munich (Germany).

In the following we summarize the forthcoming SCS events in 1998.

1. ESS98 (10th European Simulation Symposium & Exhibition) Nottingham, UK, October 26-28, 1998.

General Chair & Program Chair: Andrzej Bargiela (Nottingham, UK) General Program Co-Chair: Eugene Kerckhoffs (Delft, the Netherlands).

This conference focuses on simulation in industry. The major topics are: Simulation Methodologies; Simulation in Sciences; Engineering Systems Simulation; Simulation in Industry and Services; Simulation in Business and Finance; Simulation and Artificial Intelligence; Human Centered Simulation. Special care will be spent to exhibitions showing the latest developments in simulation and related software.

In addition to the yearly events in the ESM and ESS series, the SCS European Office decided to support the organization of smaller dedicated Workshops. Two events are planned:

2. International Workshop on "Advanced Simulation (including visualization and animation) and AI, Supporting Production Process Development in the Factory of the Future". Bucharest, Romania, August 23-25, 1998 (local organization: The Bucharest Research Institute for Informatics).

General Chairs: Florin-Gheorghe Filip (Research Institute for Informatics, Bucharest, Romania) and Ghislain Vansteenkiste (University of Ghent, Belgium). General Program Chairs: Carmen-Veronica Bobeanu (Research Institute for Informatics, Bucharest, Romania) and Eugene Kerckhoffs (Delft University of Technology, the Netherlands).

The Workshop intends to contribute to the dissemination of scientific and technological results of using advanced modelling and simulation as well as AI-techniques in industrial design and manufacturing. Three different tracks are planned to cover recent progress in modelling enterprises in general, production process planning and control, and simulation and AI in the factory of the future, encompassing methodological approaches, methods, tools and applications.

3. International Workshop on "Modelling and Simulation within a Maritime Environment". Riga, Latvia, September 6 - 8, 1998 (local organization: LSS: The Latvian Simulation Society)

The workshop will deal with various aspects of modelling and simulation for maritime applications. It is aimed to discuss the role of simulation in increasing efficiency of maritime operations, and to share already existing experiences in that area. The list of conference topics includes (but is not limited to) modelling and simulation activities along the following main lines: Container Terminals, Harbour Management, In-Harbour Traffic Control, Maritime Traffic Control, Multimodal Transportation, Naval Architecture, Naval Training Equipment, Navigation Line Management, Safety in Maritime Environment, Ship Building.

For more details on all above conferences, please contact:

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Coupure Links 653
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Phone: +32.9.233 77 90; Fax: +32.9.223 49 41
email: philippe.geril@rug.ac.be
or look to our Website:
http://hobbes.rug.ac.be/~scs

SCS European Publishing House being a part of the SCS European Office, the SCS European Publishing House publishes high-quality scientific books on computer simulation and related fields in the series "Advances in Simulation" and "Frontiers in Simulation" (editors-in-chief: Eugene Kerckhoffs, Axel Lehmann, Henri Pierreval, Richard Zobel). For more information, please contact:

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P. Geril, E.J.H. Kerckhoffs, R. Rimane
Executive Directors SCS European Office

International Societies

SCS

The Winter Simulation Conference:
The Premier Forum on Simulation Practice and Theory

General Chairs: James R. Wilson, Department of Industrial Engineering, North Carolina State University, 2401 Stinson Drive, Riddick Labs 328, Raleigh, NC 27695-7906, U.S.A.
John S. Carson II, AutoSimulations, 1355 Terrell Mill Rd, Bldg 1470, Suite 200, Marietta, GA 30067-9482, U.S.A.
Program Chair: Mani S. Manivannan, Emery World Airlines, 2701 NW Vaughan, Suite 460, Portland, OR 97210, U.S.A.

Introduction: The Winter Simulation Conference (WSC) is the premier international forum for disseminating recent advances in the field of system simulation, with the principal focus being discrete-event simulation and combined discrete-continuous simulation. In addition to a technical program of unsurpassed scope and quality, WSC provides the central meeting place for simulation practitioners, researchers, and vendors drawn from all disciplines and from the industrial, governmental, and academic sectors. From another perspective, the Winter Simulation Conferencere presents

a remarkable collaborative effort which has been led entirely by volunteers for nearly three decades, resulting in a unique, long-standing cooperative arrangement among eight major professional organizations. In this article all these aspects of WSC are discussed, with particular emphasis on highlights of WSC '98 to be held December 13-16, 1998, in Washington, DC.

Overview of the Conference: The Winter Simulation Conference features tracks devoted to leading-edge developments in modeling methodology, analysis methodology, manufacturing applications, military applications, and general applications. Moreover, WSC offers an invaluable educational opportunity for novices and experts alike, with a large segment of each program devoted to introductory tutorials, advanced tutorials, and state-of-the-art reviews that are carefully designed to address the needs of simulation professionals at all levels of expertise and that are presented by prominent individuals in the field. Issued to each registrant at the beginning of the conference, the *Proceedings of the Winter Simulation Conference* contains complete documentation on the technical program.

Of particular interest to virtually all attendees are the software/modelware tutorials as well as the exhibits by software and hardware vendors covering the full spectrum of commercial simulation products and services. Rounding out the attractions of WSC are meetings of several professional societies and users' groups along with social events which give attendees many opportunities to get acquainted and to become involved in the ongoing activities of the international simulation community.

Highlights of WSC '98: WSC '98 will be held December 13-16, 1998, at the Grand Hyatt Hotel in Washington, DC, where the conference returns every three years. This year's theme will be "Simulation in the 21st Century" to stimulate thinking about the future of simulation in the coming millennium. The conference will have a special minitrack of presentations on leading edge technologies that may have a significant effect on simulation in the coming years.

The conference will feature application tracks on manufacturing, transportation and logistics, military applications, and general applications. Vendors will give sessions on the new and special features of their software, and the exhibits area will have displays by all of the leading simulation software vendors. The special Sunday afternoon sessions for vendor-sponsored training and education started in 1997 will continue in 1998.

For new and experienced users interested in learning more about simulation, there are the introductory and advanced tutorial tracks. For those interested in the latest research, there are tracks on modeling and analysis methodology. For Ph.D. students, the conference offers the INFORMS/CS-sponsored Ph.D.-student colloquium and poster session. In total, there will be eleven tracks, including five applications tracks.

The Grand Hyatt Hotel, the site of this year's conference, is located about five blocks from the Washington Mall and the Smithsonian Institution. The hotel is one block from a metro station for convenient access to the airport as well as restaurants and sites around the Washington area. A number of restaurants are conveniently located in the hotel and across the street from the hotel. The exhibits area and all meeting rooms are close together in the hotel on the two conference levels just below the lobby. The hotel has a spectacular lobby with secluded seating for informal get-togethers and discussions.

Plan now for Future WSCs: To participate in future WSCs as a speaker, panelist, exhibitor, session chair, or as a member of the conference committee, interested readers should start planning now. The 1999 Winter Simulation Conference will travel west to Phoenix, Arizona.

For additional information on WSC '99, contact Dave Sturrock, the WSC '99 general chair (Systems Modeling Corp.; 504 Beaver Street; Sewickley, PA 15090, U.S.A.; telephone: +1-412-741-3727; fax: +1-412-741-5635; e-mail: DSturrock@sm.com), or Jerry Evans, the WSC '99 program chair (Univ. of Louisville; Dept. of Industrial Engineering; Louisville, KY 40292, U.S.A.; telephone: +1-502-852-0143; fax: +1-502-852-5633; e-mail: gwevan01@ulkyvm.louisville.edu).

Conclusion: Further advances in system simulation will require coordinated improvements in education, methodology, and software and hardware development together with innovative, intelligent applications of simulation technology. By providing a common, broadly based forum for the great diversity of interests and orientations among the members of its sponsoring organizations, the Winter Simulation Conference will continue to serve as a catalyst for the interactions between simulation professionals in academia, government, and industry that are essential to future progress of the field. With the preservation and extension of its long-standing traditions, WSC should also provide a model for other conferences that are based on collaboration among several large professional societies. For more information, please see the Winter Simulation Conference web site at `http://www.wintersim.org`.

References: Andradottir, S., Healy, K. J., Withers, D. H., and Nelson, B. L., eds. 1997. Proceedings of the 1997 Winter Simulation Conference, Piscataway, New Jersey:Institute of Electrical and Electronics Engineers, 1452+xxx pp. Also available on CD-ROM.

Swain, J. J., Goldsman, D., Crain, R. C., and Wilson, J. R., eds. 1992. Proceedings of the 1992 Winter Simulation Conference, Piscataway, New Jersey:Institute of Electrical and Electronics Engineers, 1410+xxx pp.

IMACS

3rd MATHMOD Vienna

3rd IMACS Symposium on Mathematical Modelling
February 2-4, 2000 in Vienna (Austria)

The international symposium on **Mathematical Modelling** will take place during February 2-4, 2000 at Technical University Vienna.

Scientists and engineers using or developing models or interested in the development or application of various modelling tools will find an opportunity to present ideas, methods and results and discuss their experiences or problems with experts of various areas of specialization.

The scope of the conference 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 with respect to time etc.). Comparison of modelling approaches, model simplification, modelling uncertainties and the impact of items such as these on the problem solution, 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.

Presentations of software and a book exhibition will be organized.

Deadline for submission of extended abstracts (1 - 2 pages in triplicate) is May 15, 1999.

Organizer: Division for Mathematics of Control and Simulation (E114/5) at Technical University Vienna.
Chair of IPC: Univ.Prof. Dr. Inge Troch.

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Web site:
http://simtech.tuwien.ac.at/3rdMATHMOD

INFORMS

Call for Nominations for the INFORMS College on Simulation Distinguished Service Award

To recognize individuals who have provided long-standing, exceptional service to the simulation community, the Institute for Operations Research and the Management Sciences (INFORMS) College on Simulation has established its Distinguished Service Award, which may be given to at most one person annually. Sustained service to the simulation community should extend over a period of 15 to 20 years or longer and be acquitted with distinction. The concept of service for this award does not include teaching or research contributions. Areas of volunteer service include but are not limited to:

1. elected offices in simulation societies;
2. editorial responsibilities for simulation such as department editor, area editor, and editor-in-chief;
3. conference responsibilities involving simulation such as program chair, proceedings editor, general chair, and being a member of the organizing or program committee;
4. appointed positions for simulation-related activities such as serving on committees and being a newsletter editor;
5. undertakings and actions that promote simulation in the "larger community".

Nominations for the Distinguished Service Award can be made by anyone and are made by sending a letter of nomination to the chair of the award selection committee by September 1, 1998. Letters of nomination should identify the nominee's areas of exceptional service, detailing the activities for which the nominee is believed to deserve this award. The nominee's current vita must be included with the nomination letter. The individual or individuals making the nomination have the primary responsibility for justifying why the nominee should receive this award. If given, the award will be presented Monday, December 14, 1998, during the opening session of the 1998 Winter Simulation Conference in Washington, D.C., U.S.A. Nominations should be sent to the Chair of the Selection Committee:

Professor Thomas J. Schriber
School of Business, The University of Michigan
701 Tappan Street
Ann Arbor Michigan 48109-1234 USA
Internet: schriber@umich.edu
Fax: +1-734-936-8716, Voice: +1-734-764-1398

LSS

The Latvian Simulation Society is organising, in co-operation with the Society for Computer Simulation International (SCSI), the international workshop "**Modelling and Simulation within a Maritime Environment**" (September 6 - 8, 1998, Riga, Latvia).

Information and contact address:
Prof. Yuri Merkuryev
email: merkur@itl.rtu.lv,
Tel.: +371-7089514, Fax: +371-7820094
or visit the Website: http://hobbes.rug.ac.be/~scs/conf/ew98riga/index.html

Comparisons of Simulation Software and Simulation Techniques

Overview – Summary – Evaluation Part I

The contribution gives an overview on ARGESIM's Comparisons of Simulation Software and Simulation Techniques, summarises the development of these comparisons since the beginning in 1990, describes the evaluation by means of a database and sketches the WWW presentation and WWW evaluation of the comparisons. This first part concentrates on an overview, on the development, on the database evaluation and gives as example the WWW evaluation of a continuous comparison. The second part in the next issue of SNE will give some statistics on solutions and simulators, and will concentrate on evaluation and WWW representations of the discrete and general comparisons.

Definition, Aims and Scope

ARGESIM is featuring a series on *Comparisons of Simulation Software and Simulation Techniques*. Definitions, solutions, overviews and evaluations are published in the journal *Simulation News Europe*. The series started in 1990, the first comparison was defined in SNE 0, November 1990.

Well-known types of comparisons are the so-called benchmarks and the feature tables.

Comparisons of benchmark type (like PHYSBE)

- allow deep insight into special features,
- work with relatively large specific models,
- but are difficult to reproduce.

Comparisons with feature tables

- indicate with "yes" or "no" the availability of a certain feature of the language,
- give a concentrated overview on features,
- are based on general features and not on specific model types,
- but give no information on the features themselves.

The *ARGESIM Comparisons* were initiated as a compromise between these two types of comparisons. Based on simple, easily comprehensible models special features of modelling and experimentation within simulation languages, also with respect to an application area, are compared. These comparisons

- are based on simple, but significant models,
- are testing up to three features,
- and they are easy to reproduce.

Features are, for instance: modelling technique, event handling, numerical integration, steady-state calculation, distribution fitting, parameter sweep, output analysis, animation, complex logic strategies, submodels, macros, statistical features etc.

Additionally they take into account different modelling approaches and experiment techniques: not only the simulator's features used in a specific solution are discussed, but also the approach or technique is qualified.

Twelve comparisons have been defined up to now, alternatively comparisons with continuous and discrete systems, and a special comparison (see table 1):

SNE	Comparison											
	C1	C2	C3	C4	C5	C6	C7	CP 1	C8	C9	C10	C11
0	Def/1											
1	5	Def										
2	4	4	Def									
3	4	3	3	Def								
4	1	5	5	2	Def							
5	4	-	1	1	2							
6	-	2	-	2	1	Def						
7	1	2	1	2	-	1	Def					
8	-	1	-	-	-	1	3					
9	-	-	-	-	-	2	3					
10	1	2	-	-	-	1	2	Def/1				
11	2	2	1	-	1	-	-	2				
12	1	-	1	-	-	-	2	3				
13	-	-	-	-	-	-	3	1				
14	3	-	1	-	-	-	2	-				
15	-	-	1	-	1	-	-	-				
16	1	-	-	-	-	-	1	-	Def/1			
17	-	-	1	-	1	-	1	1	1	Def/1		
18	-	-	-	-	-	-	2	2	-	-	Def/1	
19	-	-	-	-	-	-	-	1	1	1	3	
20	-	-	-	-	-	-	1	-	1	1	2	
21	-	1	-	1	-	1	5	-	-	-	2	
22	1	-	1	-	1	-	5	-	1	-	-	Def/1
23	-	2	-	-	-	-	-	-	-	2	-	1
Total	28	24	16	8	7	6	30	11	5	5	8	2

Table 1: Definitions and Solutions of ARGESIM Comparisons in SNE

Comparison ***C1 Lithium-Cluster Dynamics under Electron Bombardment***, SNE 0, November 1990, deals with a stiff system. This comparison tests features for integration of stiff systems, for parameter variation, and for steady state calculation.

Comparison ***C2 Flexible Assembly System***, SNE 2, March 1991, for discrete simulators, compares features for submodel structures, control strategies, and optimisation of process parameters.

Comparison ***C3 Analysis of a Generalized Class-E Amplifier***, SNE 2, July 1991, focuses on simulation of electronic circuits, requiring table functions, eigenvalue analysis, and complex experiments.

Comparison ***C4 Dining Philosophers I***, SNE 3, November 1991) is more general, involving not only simulation but also different modelling techniques like Petri nets, etc.

Comparison ***C5 Two State Model***, SNE 4, March 1992, primarily addresses simulation tools with very high accuracy (checking integration and state event handling).

Comparison ***C6 Emergency Department – Follow-up Treatment***, SNE 6, November 1992, addresses discrete simulation languages and tests features for modelling, concepts of availability, and complex control strategies.

Comparison ***C7 Constrained Pendulum,*** SNE 7, March 1993, checks features for model comparison, state events, and for boundary value problems.

Comparison ***CP1 Parallel Simulation Techniques***, SNE 10, March 1994, deals with the benefits of distributed and parallel computation for simulation tasks. Three test examples have been chosen to investigate the types of parallelisation techniques.

Comparison ***C8 Canal-and-Lock System***, SNE 16, March 1996, checks features for modelling complex logic control and variance capabilities.

Comparison ***C9 Fuzzy Control of a Two Tank System***, SNE 17, July 1996, asks for implementation and / or modules for fuzzy control.

Comparison ***C10 Dining Philosophers II,*** SNE 18, November 1996, reviews discrete simulators with respect to simultaneous (concurrent) access to resources and with respect to deadlocks.

Comparison ***C11 SCARA Robot***, SNE 22, March 1998, deals with the handling of implicit systems.

All readers of *Simulation News Europe* are and have been invited to simulate the model(s) with a tool of their choice and to sent in a report, containing a short description of the language, the model description, and the results of the tasks.

Development of the Comparisons

Up to now 150 solutions to the 12 comparisons have been sent in, with about 65 languages or tools (see table 1).

As any kind of simulationists were invited to take the challenge of preparing a solution, the authors of solutions came from different backgrounds, whereby four groups can be classified as follows:

i. Solutions sent in by simulation specialists from universities or research laboratories, who are using and who are specialised in a specific commercial simulator or freeware simulator.
ii. Solutions from universities or research laboratories presenting their in-house simulator, which has been developed there.
iii. Solutions coming directly from the developers and / or distributors of a commercial simulator.
iv. Solutions done by the staff of ARGESIM or / and within student project groups.
Especially in the last time some solutions were done by ARGESIM. The reason is that distributors or developers sent us their software to be tested with the comparisons.

Sometimes it was not so easy for us to publish the solution immediately. We had to contact the authors and ask for corrections or changes. The reasons were:

i. *Solution too long.* In order to have the same conditions for all solutions, we have to insist on the limit of 1 page. Sometimes we could shorten the solution ourselves, sometimes we had to contact the authors.
ii. *Solution not complete.* In some solutions one or more tasks were not done, although the simulator offered features for these tasks. We asked the authors for correction.
iii. *Solution of advertising type.* Only few solutions were more advertising the simulator than solving the tasks. We had to ask for a new solution.
iv. *Solution referring to others.* Sometimes people sent a second solution with e. g. a different approach for a specific task – referring to previous solutions with respect to other tasks. As each solution has to be an independent one, we had to ask for the other details, too.
v. *Solution solving other tasks.* Some authors sent also comments or solved other tasks, or "changed" the definition. In this case we either asked the authors to send the missing details, or we published the material as *Comparison Comment*.
vi. *Solution based on a different view of the definition.* It also happened that a *Comparison Definition* was misunderstood (especially in the early comparisons). So solutions differed because of different assumptions. We decided to publish also this variety, commenting the different views in the explanations to the classifying criteria.

In order to prevent misunderstandings in the *Comparison Definition*, we published a solution together with the definition, with all aspects the comparison authors had in mind (usually provided by the comparison authors themselves), starting with CP1 in SNE 10.

Summary and Evaluation of the Comparisons

The solutions sent in represent a considerable know-how in simulation techniques. From the very beginning we had in mind to summarise and to evaluate the solutions.

A first try was a very early overview on *Comparison Solutions* to *C2 Flexible Assembly System*, published in SNE 4. Unfortunately the author of the *Comparison Definition* could not continue this summary.

In SNE 6 a "Preliminary Summary of Results" for C1 *Lithium Cluster Dynamics* was published. This summary was the first step towards a classification and standardised evaluation of the comparisons.

The basic idea was to formulate some criteria for each task and for the modelling technique, and for each criterion some classifications.

Table 2 shows part of the evaluation table for task b and task c of comparison C1. Task b asked for a variation of a model parameter and for a logarithmic plot of the results, task c checked features for the calculation of the steady state in this model. Table 2 indicates that task b was evaluated by means of the two criteria PARAMETER VARIATION and LOG., while task c was checked by means of one criterion (STEADY STATE CALCULATION).

The table then gives "answers" to these criteria – e.g. for the criterion PARAMETER VARIATION up to six "answers", for criterion LOG. only two, and for the criterion STEADY STATE CALCULATION of task c three possible "answers".

The biggest problem is and was, how to continue these evaluations with reasonable effort.

A solution to the problem of maintenance and continuation of the comparison evaluations came with SNE 11, when SNE and EUROSIM went to Internet (first on a gopher server), and with SNE 13, when the EUROSIM / ARGESIM WWW server was introduced.

The server was intended to document in steps

i. the *Comparison Definition*,
ii. the *Comparison Sample Solution*,
iii. a table of sent in *Comparison Solutions*,
iv. the documented *Comparison Solutions* (pdf format),
v. and the *Comparison Evaluation*.

It was relatively easy to realize the first three steps. But already the third step indicated that for data maintenance a database was an absolute need. Consequently we developed from 1995 on the ARGESIM database, which takes care of any kind of data from SNE, EUROSIM and ARGESIM. The database interfaces to the WWW server, where e.g. the table of contents of each SNE, the calendar of events, etc. are automatically updated (in general, in parallel to the printed version, SNE is going towards a WWW journal, where this database is also necessary).

The input into the database is as follows: At first the *Comparison Definition* is stored in the database, fig. 1 shows a snapshot of the database form for the *Comparison Definition*. The attributes of each definition are: Comparison Number * Comparison Title * Starting SNE * Definition Authors * Link to Comparison Sample Solution * Formulation of task a, task b, task c * Criteria and classification for task a, task b, task c * Criteria and Classification for model description * Methodology.

Figure 1 shows the contents of the definition form for comparison C7 *Constrained Pendulum*. Most of the attributes are self-explaining. It is evident that for each task two criteria are chosen, and for the classification of model description, structure or general features three criteria are used. The classification is roughly formulated at the right of the form, giving the classification and sometimes certain classification items in advance, e. g.:

Algorithm: optimisation / iteration / loop / manually ...

LANGUAGE	PARAMETER VARIATION	LOG.	STEADY STATE CALCULATION
ACSL	manual variation at runtime	standard	trim-command, iteration
DESIRE	parameter loop in model description	manual	not given
DYNAST	manual variation in model description	standard	long-term simulation in time domain
ESACAP	parameter loop in model description	standard	long-term simulation in time domain
ESL	parameter loop in model description	standard	trim-command, iteration
EXTEND	manual variation in graphic model description	standard	long-term simulation in time domain
FSIMUL	parameter loop in graphic model description	standard	long-term simulation in time domain
HYBSYS	parameter loop at runtime	standard	trim-command, iteration

Table 2

Additionally the classification item **Methodology** has been added, which has to be explained in more detail in the following.

Before the implementation of the evaluation in the database and in the WWW interface some principle questions had to be solved, e. g.:

- How long should a comparison run (in order to have up-to-date solutions, which can be compared) ?
- Should more than one solution with the same simulator be accepted, how much have the solutions to differ ?
- Does it make sense to repeat a solution with a newer version of the simulator (many simulators have developed powerful environments, which increase the features essentially) ?

After discussions and careful analysis of the solutions sent in up to now, it was decided

- to continue a comparison, and not to stop after a certain period – in order to keep the number of comparisons low and to keep a continuation of the evaluation,
- to accept new solutions with an up-to-date version of a simulator, which was used in an older solution – in order to show the development of the simulators,
- and to accept more than one solution with a certain simulator, if they differ in the approach – in order to show the very broad variety of methodological approaches to a certain simulation task.

In order to distinguish between versions of simulators and types of methodological approaches two new attributes were introduced, **Version** and **Methodology**.

When an issue of SNE is ready to print, the *Comparison Solutions* published in this issue are stored in the database by means of the *Comparison Solution* form, shown in fig. 2. This form is structured in the same manner as the form for the *Comparison Definition*, it represents the individual data for characterising the *Comparison Solution*. In the upper part of the form details (attributes) on the solution are given:
Comparison Number * Simulator * Simulator used * Simulator Version * SNE no. * Page no in SNE * Author(s) of *Comparison Solution*

The left part of the form (fig. 2) repeats the classification criteria from the *Comparison Definition* (**Criteria**). In the right part the classification items are inserted (**Classification wrt Criteria**), whereby the classification is prepared by the author(s) of the *Comparison Definition*.

The new classification **Methodology** plays a key role in the evaluation: it not only allows to distinguish between different methodological approaches, it reflects also the development in the simulator environment, and it can reflect the incorporation of simulation technique into new methodologies and other areas.

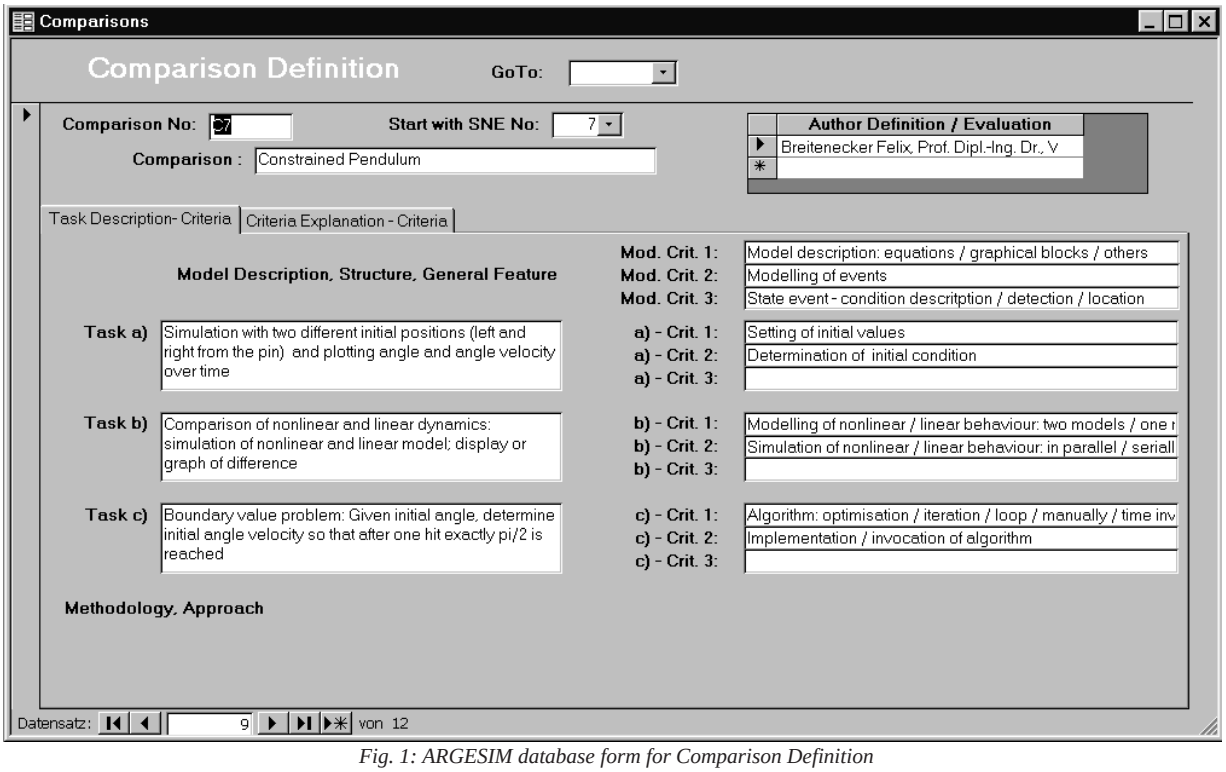

Fig. 1: ARGESIM database form for Comparison Definition

It is a very difficult task to find the most applicable classification item. In most cases the methodological classification is related to the method of the modelling approach. The newer comparisons are defined with respect to this new "overall" classification, for the old comparisons it is and was very difficult to find the appropriate items. It has to be mentioned that the evaluation is dynamic: if incoming solutions show up new aspects, the classification items may be changed.

In case of comparison C7 *Constrained Pendulum* the methodological classification reflects the model structure with respect to state events, at present twelve items are used (fig.3).

Tests have shown that indication of the classification items is not sufficient for the understanding of the particular evaluation. Therefore criteria explanations support the documentation of the criteria classification: The form for *Comparison Definition* (fig. 1), usually in the "**Task Description – Criteria** mode" showing at the left the tasks and at the right the criteria, can be switched into the "**Criteria Explanation – Criteria** mode", showing at the right the criteria and at the left explanations and comments for the choice of the criteria.

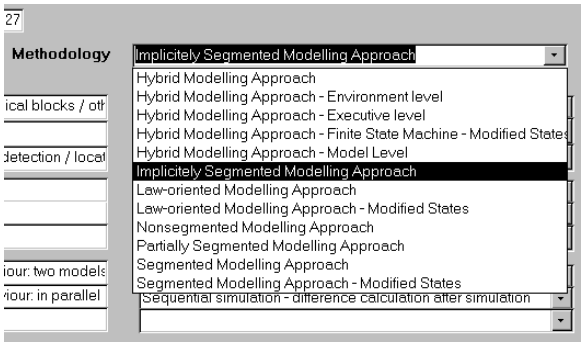

Fig. 3: Methodological classification items for comparison C7

WWW Representation

The comparisons are documented on the ARGESIM WWW server, http://www.argesim.org/comparisons/

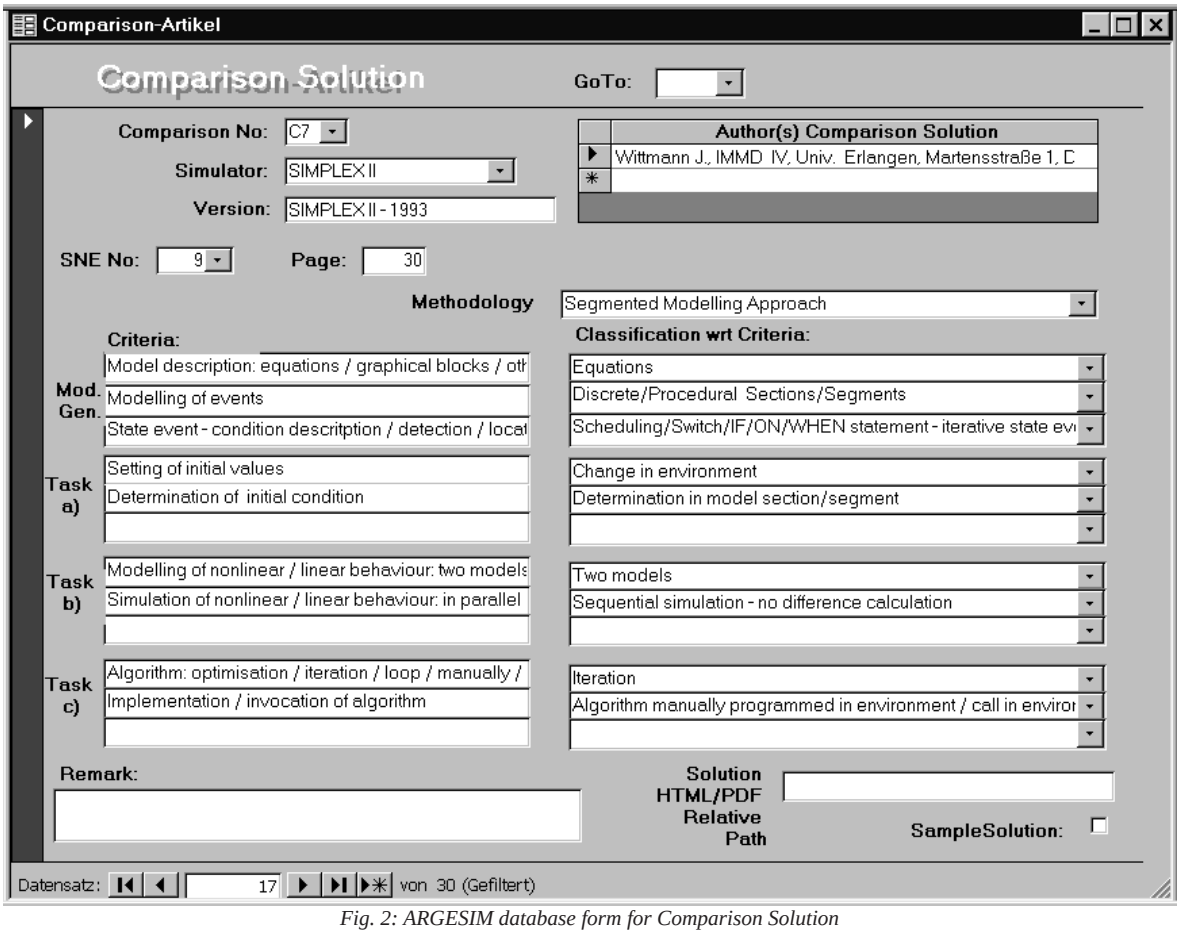

Fig. 2: ARGESIM database form for Comparison Solution

Comparison Definition, *Comparison Sample Solutions* and *Comparison Solutions* (in pdf-format) are taken directly from the SNE issue. The table of *Comparison Solutions* and the *Comparison Evaluation* is automatically updated from the database.

For some solutions, especially for the solutions prepared by ARGESIM, also model source and experiment sources are available and can be downloaded.

Documentation and representation were implemented step by step, and definition, sample solution, some specific solutions and the table of solutions became available 1995 - 1997 (e. g. table of *Comparison Solutions* for C7 *Constrained Pendulum*, see fig. 4). Also some of the *Comparison Solutions* are available in pdf format, especially the newer ones. In the WWW-table of solutions documented solutions are linked, and the sample solution is marked (fig. 4).

In the beginning of 1998 the interface for the evaluation between database and WWW server has been implemented, and classification and evaluation of the comparisons is still going on.

In general the database export updates data for: ARGESIM / EUROSIM Calendar of Events * SNE Table of Contents * SNE Book Reviews * SNE Essays, Simulation Centers, Software Developments * ARGESIM *Comparison Solutions* * *ARGESIM Comparison Evaluation.*

The classifications stored in the database are automatically read into the WWW server, whereby the classification is grouped with respect to the items or with respect to simulators.

This kind of grouping evaluation is able to generate automatically evaluation tables – as given manually in the evaluation of C1 *Lithium Cluster Dynamics*, see table 2). Furthermore it sorts and groups by language, comparison type, SNE issue, etc. Main intention is to show the various classification items with respect to simulators and vice versa.

The introductory page of the evaluation (fig. 5) gives an overview on the tasks, on the criteria, and allows to switch

Simulation Language	Location
DESIRE/X	SNE 8 p, 28
SIMUL_R	SNE 8 p, 29
ACSL - SampleSolution	SNE 8 p, 30
STEM	SNE 9 p, 26
SimuSolv	SNE 9 p, 27
SIMPLEX II	SNE 9 p, 30
PSIMOS	SNE 10 p, 35
ACSL	SNE 10 p, 36

Fig. 4: WWW Table of Comparison Solutions to Comparison C7

to the **Criteria Explanation** if necessary. Furthermore, one may switch to **Sorted by Programs**, if one is interested in the evaluation of a specific simulator (resulting after language selection in an appropriate representation, fig. 6 – and mirroring exactly the data of the Comparison Solution stored in the database in fig. 2). Continuing with **Sorted by Programs** the server offers the evaluation for the methodological approach, for the general (modelling) criteria and for the task criteria.

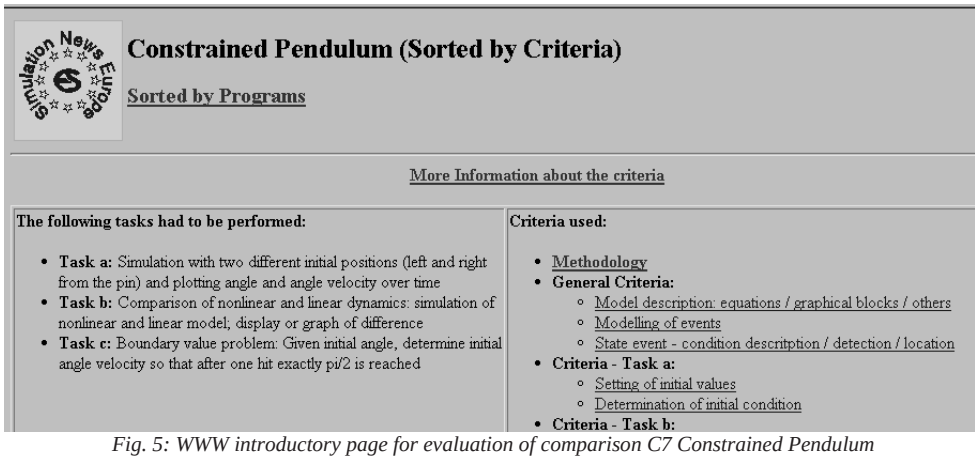

Fig. 5: WWW introductory page for evaluation of comparison C7 Constrained Pendulum

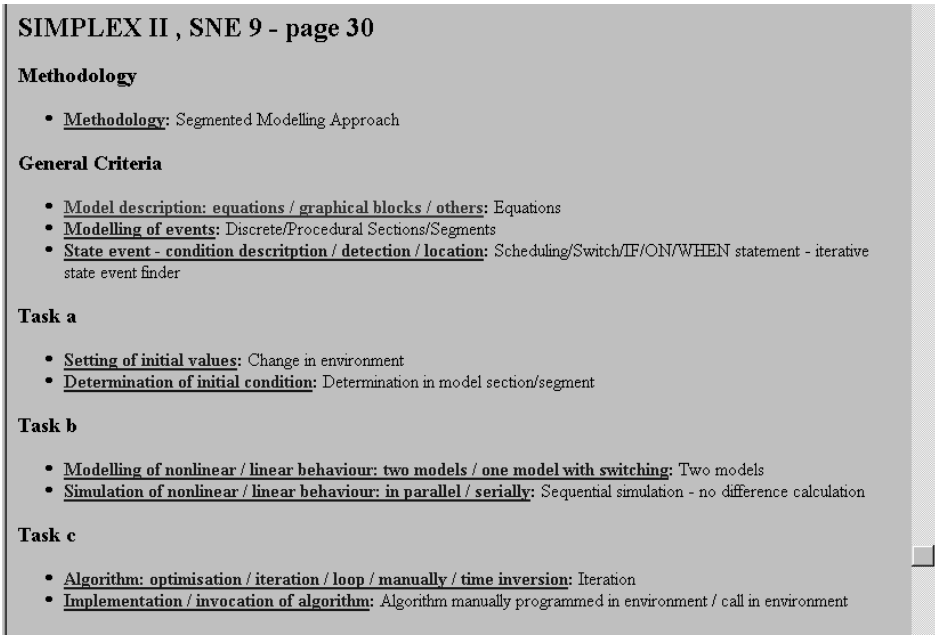

Fig. 6: Evaluation and classification for specific solution of comparison C7 Constrained Pendulum – see database form in fig. 2

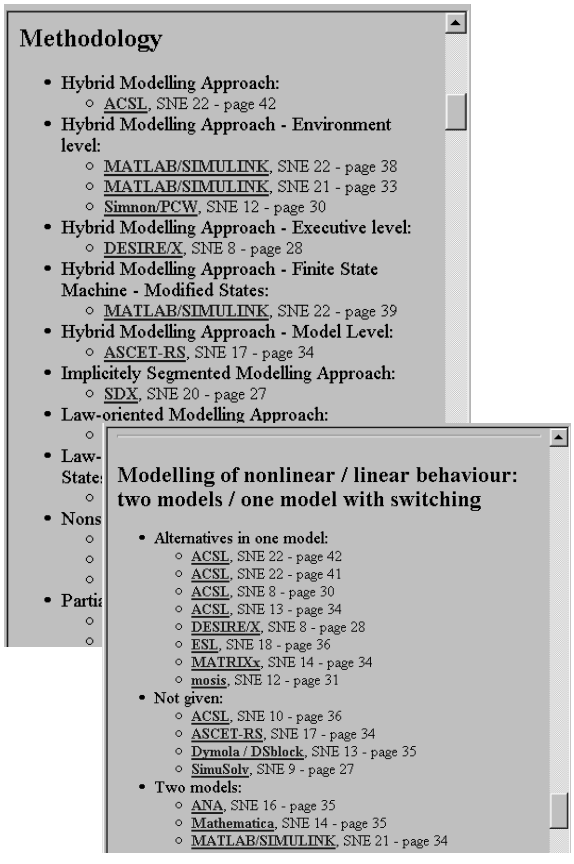

Fig.7: WWW Evaluation of Comparison C7 Constrained Pendulum – Sorted by Criteria

Figure 7 shows some details from the evaluation sorted by criteria, where in the methodological classification the context to the list in fig. 3 is evident.

Comparison C1 *Lithium Cluster Dynamics*, C2 *Flexible Assembly System*, C7 *Constrained Pendulum* and C11 *SCARA Robot* are completely evaluated, we hope to finish the classification and evaluation of the other comparisons until end of the year 1998.

Three aspects must be mentioned with respect to validity and correctness of the evaluation:

i. The classification items are dynamic, they have to be, in order to continue the evaluation at an up-to-date level.
ii. The classification items for a solution are not absolute or exclusive: another solution (with the same simulator) may use another feature for a certain task, yielding another classification item.
iii. If a part (of a task) is not solved, the classification "not given" is used. This classification item not necessarily indicates that the simulator used in this solution does not support this feature – it only says that the author of the solution gave no information.

Analysis of the relations between the comparisons has shown that the *Comparison Solutions* show some context in evaluation criteria.

Consequently it is intended to extend the evaluation within a comparison by a search machine checking the classification items from all comparisons, so that results may be used for comparative studies, courses, etc. That makes it e.g. necessary to uniform the criteria and the classification items, which is a very difficult task (planned for 1999).

I would like to thank all co-workers from ARGESIM who are involved in this project, in database implementation and comparison evaluation.

F. Breitenecker, ARGESIM/SIMTECH, Dept. Simulation Techniques, Vienna University of Technology, email: Felix.Breitenecker@tuwien.ac.at

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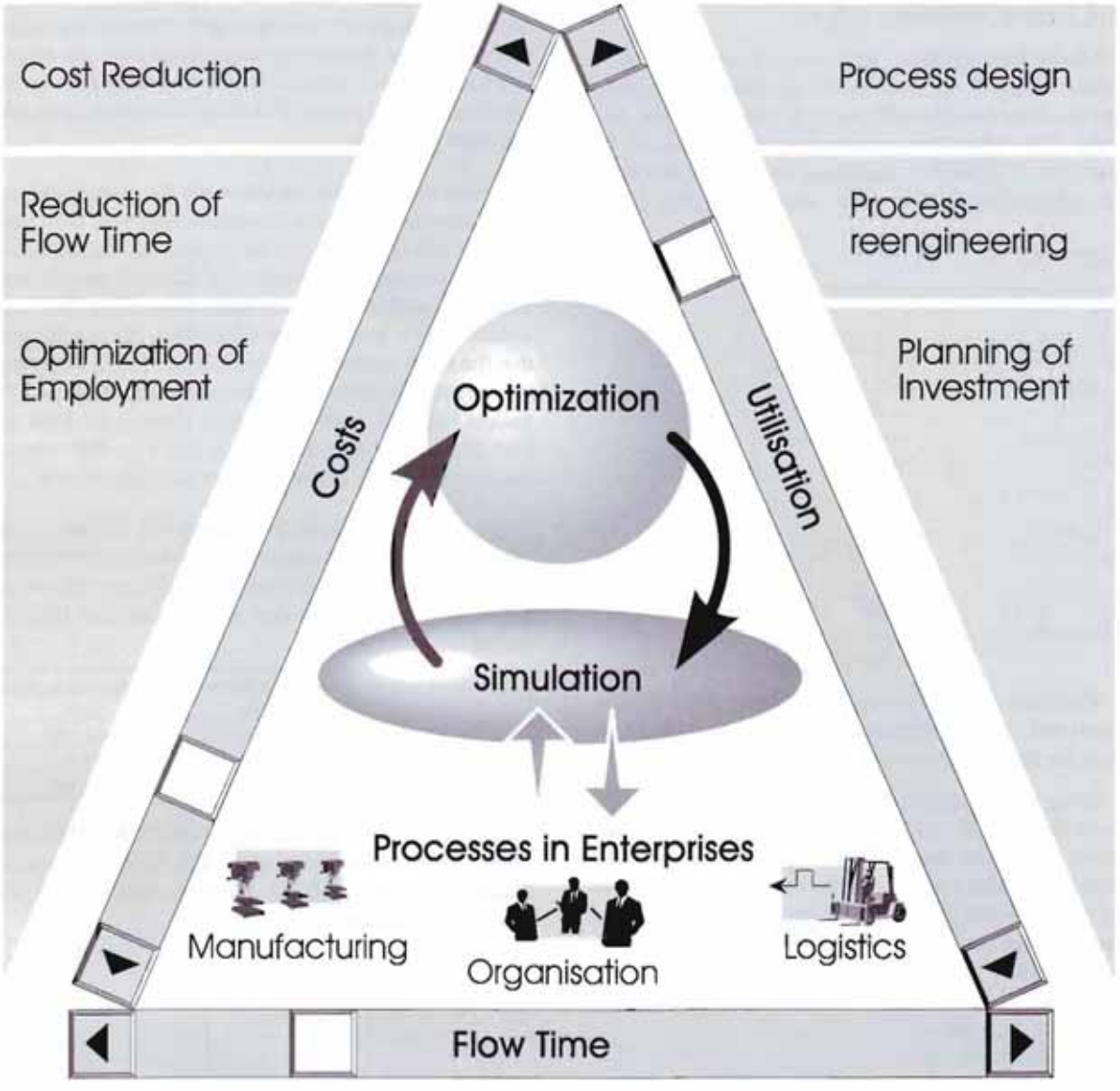

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Comparison 2 – MicroSaint

Application/Process-oriented Modeling Approach

Micro Saint is a process-oriented general purpose discrete simulator with a graphical user interface. Micro Saint Release 2 Build Y with Action View and Opt Quest under MS Windows 95 was used to solve this comparison. The basis for modelling are *tasks*, which are passed by *entities*. *Tasks* offer free definition of *Release Condition* and *Time Distribution* as well as *Beginning*, *Launch*, and *Ending Effect*.

Model Description: The model was created using 8 almost identical submodels (**A**...), each representing one machine and the belt running parallel to the machine. The submodels (rectangles) are connected by *tasks* (round symbols) modelling the belt between the machines or the shifting parts, respectively (fig. 1).

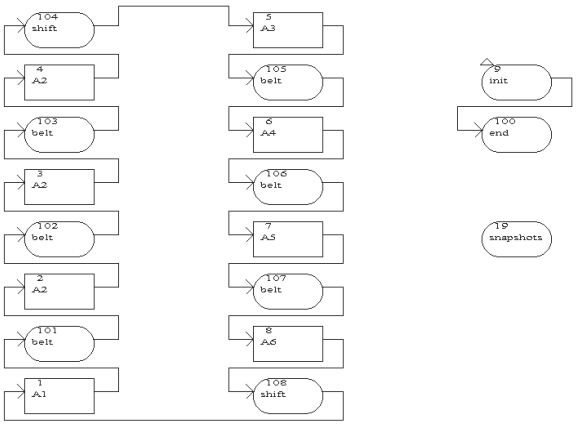

Fig. 1: Model layout

The three *tasks* on the right side control the initialisation and the termination of the model and the snapshots for the data collection.

Every submodel (fig. 2) consists of 9 *tasks* which represent the belts (**B**...), the shifting parts (**S**...), and the machines (**A**...). The decisions are made locally, both the decision whether a part should be shifted to a machine or not (based on the availability of the machine and on the status of the part; first shifting part) and the decision which part may move on at the second shifting part according to the given priority rules. The working times of the *tasks* are stored and calculated locally as well.

The pallets are represented as the *entities* of the system and are "created" as empty pallets at time *t=0*. A variable field (`status`) holds the information whether there is a part on a pallet and which procedures this part, if present, has already undergone.

As time unit seconds were chosen, so the model runs from time 0 to time 36000, logging data of every part leaving the system from the 7200th second on.

The simulation times vary significantly with the number of the pallets, being roughly linearly dependent on this number. So the two runs with 20 and with 40 pallets together took approximately the same time as the third run with 60 pallets. For every 20 pallets the model ran nearly an hour.

These long calculation times are the reason why sophisticated optimisation strategies (which the OptQuest module offers) could not be applied to this solution, simply because the evaluation of different possibilities was not possible with reasonable time effort. But even without such methods the simulation clearly showed that the version with 20 pallets is by far the best, managing the same number of processed parts as with 40 or 60 pallets but with a lower average throughput time per part. Manual investigations show that 17 pallets also result in 1440 parts, but with lower throughput time.

It is clear that these 1440 parts are the maximum number of parts the system can process in 480 minutes because of the three stations **A2**, which are the bottleneck. Any greater number would indicate that the model was wrong!

number of pallets	Number of processed parts	Average throughput time
20	1440	401.160
40	1440	537.942
60	1440	619.860

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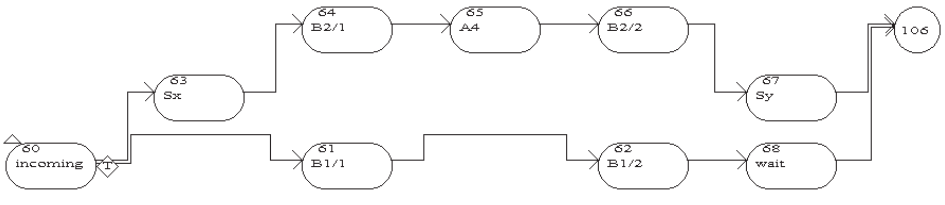

Fig. 2: Submodel for machine A4

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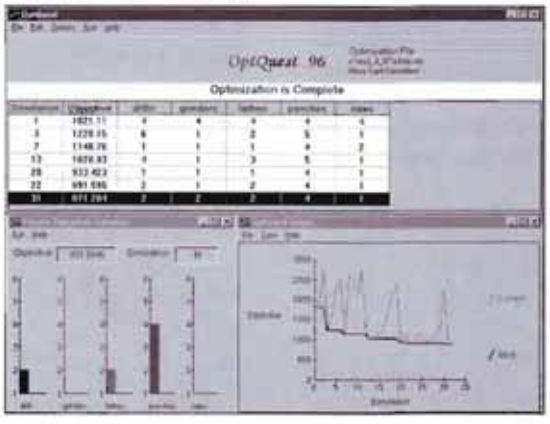

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Comparison 2 – MicroSaint
Process-oriented Modeling Approach

MicroSaint is a process-oriented general purpose discrete simulator with a graphical user interface. Micro Saint Release 2 Build Y with Action View and Opt Quest under MS Windows 95 was used to solve this comparison. The basis for modelling are *tasks*, which are passed by *entities*. *Tasks* offer free definition of *Release Condition* and *Time Distribution* as well as *Beginning*, *Launch*, and *Ending Effect*.

Model Description: The model was built using one submodel (**Ax**) for the eight machines and the belts running parallel to the machines and one additional *task* for the belts or the shifting parts between the machines, respectively (fig. 1). The control for the flow is programmed in user functions.

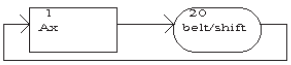
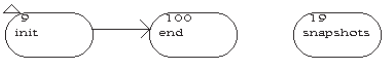


Fig. 1: Model layout



The three *tasks* on the bottom control the initialisation and the termination of the model and the snapshots for the data collection.

The submodel (fig. 2) consists of 9 *tasks* which represent the belts (**B**...), the shifting parts (**S**...), and the machines (**Ax**). Some kind of "central control unit" is modelled by a set of functions. These functions are called in the *tasks* and in the *decision*, giving the working times of the *tasks*, making the decisions whether a certain part should be shifted to a machine or not, and executing the effects of the machines.

The pallets are represented as the *entities* of the system and are "created" as empty pallets at time *t=0*. A variable field (`status`) holds the information whether there is a part on a pallet and which procedures this part, if present, has already undergone. Another variable counting from 1 to 8 tells for every pallet at which machine it actually is, as all of the eight machines are modelled by the same subsystem.

As time unit seconds were chosen, so the model runs from time 0 to time 36000, logging data of every part leaving the system from the 7200th second on. In these 480 minutes, a maximum number of 1440 parts can be expected to be processed, because the three stations A2 cannot process more than three parts per minute.

The simulation times vary significantly with the number of the pallets, being roughly linearly dependent on this number. So the two runs with 20 and with 40 pallets together took approximately the same time as the third run with 60 pallets. For 20 pallets the model ran about ten minutes (on a Pentium 166). Although in this model the same number of events has to be processed as if there were a separate submodel for each machine, the simulation was much faster. Decreasing the number of *tasks* speeds up the simulation significantly, because less description code has to be interpreted (MicroSaint is an interpretative system).

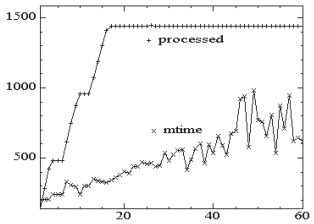


Fig. 3: Experiment results

Figure 3 shows the number of processed parts and the corresponding throughput times for 1 to 60 pallets. This loop was processed fast enough, so that also Micro Saint's optimising module OptQuest could be used in order to determine the optimal number of pallets: the optimisation method based on genetic algorithms resulted in 17 pallets – which corresponds to results in fig. 3. The following table gives these results in more detail.

number of pallets	Number of processed parts	Average throughput time
17 (optimum)	1440	340.04
20	1440	401.16
40	1440	537.94
60	1440	619.86

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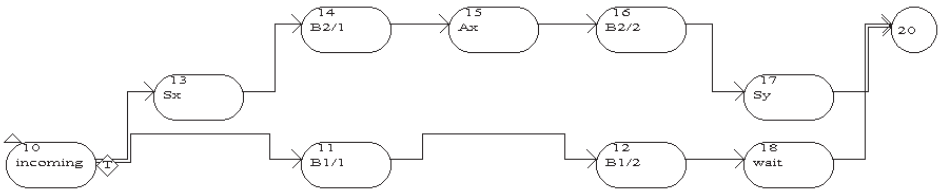


Fig. 2: Submodel for a machine

Comparison 9 – ACSL
Fuzzy Control Programmed at Model Level

ACSL is a classical continuous CSSL-type simulator. Models may be defined by means of equations in **ACSL Model** or graphically by means of blocks in the **Graphic Modeller**. ACSL models are compiled, using FORTRAN. Simple experiments may be done in ACSL's runtime interpreter, experiments of any kind may be done in **AMATH**, an environment of matrix language type. Although ACSL offers no direct support for fuzzy systems, any type of FORTRAN code may be embedded, thus providing the means for programming a fuzzy controller – mainly table lookups and matrix operations. For this solution ACSL 11.4.1 / AMATH 1.2 was used.

Model Description: The model equations (ODEs) in the **`derivative section`** in the following (abbreviated) ACSL model describe the continuous plant. The sampled data control is implemented in the **`discrete section controller`**, sampling data each `ts` seconds. In this `discrete section` any kind of discrete control may be implemented – in this case a discrete fuzzy control. First fuzzification is done by evaluating the table functions `nlx1`, ... describing the membership functions (defined in the **`initial section`**). Interference is simply programmed in nested loops, which determine `min` or `max`, resp, using the rules (defined in a matrix `rule`). Defuzzification is done by explicit programming of the centre of gravity in a loop.

```
initial
 constant x10=0, x20=0, tend=1000, p=1.5, .
 constant rule= 9, 8, 8, 5, 1, .........
 table nlx1, 1, 4 / 0., 35., 40.0,  70.0,
 table p1x1, 1, 6 / 0., 35.,    ..........
derivative
 if (x2 .lt. 16) then r = r1 else r = r2
 ax2   = exp(0.43*dlog(abs(x2)))
 f =0.06624*v1*sqrt(abs(x1-x2))*sign(x1-x2)
 x1= integ ( 0.067 * u - f, x10)
 x2= integ ( f - 0.0605*r*v2*ax2,x20)
 ex2   = x2s - x2; end
discrete controller                    Fuzzification
 interval ts = 1.
 fx1(1)=nlx1(x1); fx1(2)=p1x1(x1); ....
 do label2 i =1,5                      Interference
do label2 j=1,5
   fu(rule(i,j))=max(fu(rule(i,j)),
     min(fex2(6-i),fx1(j)))
 label2..continue
 do label3 i=1,8                       Defuzzification
sx=(fu(i)+0.25*fu(i+1))/(fu(i)+fu(i+1))
  off=(i-1)*1.25
  iy = iy + fu(i)*(sx-(sx*sx)/2.)+fu(i+1)
   *((1.25-sx)-(1.25-sx)*(1.25-sx)/2.)
  ixy = ixy + fu(i)*(sx*off+sx*sx*  .....
 label3..continue
u=ixy/iy; end;
```

This kind of implementation makes use of some ACSL operators, but it's mainly FORTRAN code, and in defuzzification it is depending on the type of membership functions (triangle membership function for FC1) because of the analytical computation of the centre of gravity. In case of singletons (FC2) the code becomes much easier:

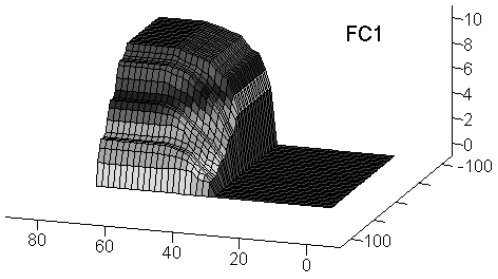
```
do label3 i=1,9
  u=u+(i-1)*1.25*fu(i); sfu=sfu+fu(i)
label3..continue
u=u/sfu
```

Weighting rules (FC3) are implemented easily by multiplying in the interference with a weighting matrix:

```
fu(rule(i,j))=max(fu(.....)*weight(i,j))
```

It is clear, that this kind of "manual" implementation is not very comfortable, but i) it is a very slim code without any overhead, ii) it is very fast, and iii) singletons and other discontinuous membership functions can be used without problems.

Results. ***Task a)*** tests the performance of the implementation by computing and visualising the 3-dimensional surface of the fuzzy controller FC1 and FC2, resp. on a 41 x 41 grid. The surface is plotted in AMATH (see fig.) by a standard command, the data are computed in a "dummy" ACSL model consisting only of initial and discrete section, evaluating in a loop the discrete section. Times for computation on a Pentium 166, 32 MB, are ta_{FC1}=0.98 and ta_{FC2}=0.91. As these times differ due to inaccurate measurement etc., the ratio 1.07 is not really significant.



Task b, c. Simulation of the whole system (task b) with FC1 and FC2 (see fig. at bottom) result in tb_{FC1}=2.68 and tb_{FC2}= 2.61, resp. (ratio ~ 1.02). Weighting rules neither change the results nor the computation times essentially (tc_{FC3}=2.68).

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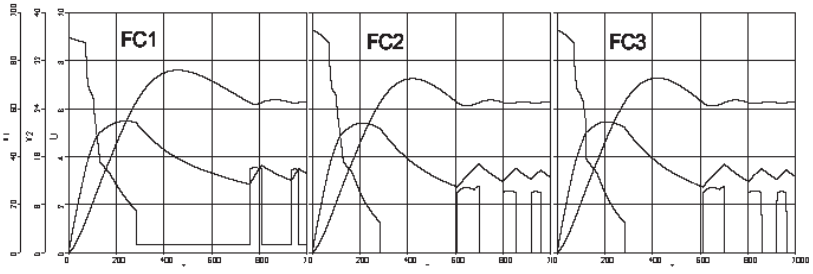


Comparison 9 – ACSL

Fuzzy Control Programmed at Environment Level

ACSL is a classical continuous CSSL-type simulator. Models may be defined by equations in **ACSL Model** (or graphically in the **Graphic Modeller**) and are compiled (on a FORTRAN base). ACSL's power was increased in 1996 by **AMATH**, an interpretative environment of matrix language-type with graphical features. With AMATH e.g. complex experiment control and hybrid modelling can be implemented comfortably. ACSL Model and AMATH offer no direct support for fuzzy control. But as AMATH is a matrix-type environment, fuzzy control (fuzzification, interference, and defuzzification) can be implemented simply (as well as a toolbox could be implemented easily).

Model Description: The model under consideration is a sampled data system. Each `ts` seconds data are sampled, and the new control u is calculated by means of fuzzy control. In a classical implementation approach, the data sampling interrupts the "continuous" solution of the system governing ODEs at model level. The approach in this solution (with ACSL Model 11.4.1, AMATH 1.2) controls data sampling with calculation of the fuzzy control in the environment level (calling the model in a loop (`start`), as shown in the following "main" m-file and ACSL model file:

AMATH main

```
rule=[9 8 8 5 1; 8 7 6 4 1; .....
x1=zeros(1,1001);x2=zeros(1,1001);.....
load(@file='c9amath.prx',@format='model')
x1(1)=0;x2(1)=0;ex2(1)=25; TEND=1;
for t=1:1000
  fx=fuzzify([x1(t) ex2(t)]);
  fu=interf(fx, rule, weight);
  u(t)=defuzzy(fu, 1);
  X10=x1(t); X20=x2(t); U=u(t);
  !!start
  x1(t+1)=X1;x2(t+1)=X2;ex2(t+1)=25-X2;
end
```

ACSL model file

```
model c9amath
if ( x2.lt.16.0 ) then r=1.2 else r=1
 ax2   = exp(0.43*dlog(abs(x2)))
 f =0.06624*v1*sqrt(abs(x1-x2))*sign(x1-x2)
 x1 = integ (0.067 * u - f, x10)
 x2 = integ (f - 0.0605* r * v2 * ax2, x20)
end
```

The m-file `fuzzify` evaluates the input membership functions, `interf` performs the interference by matrix manipulations (in case of FC3 simply by multiplying with the matrix `weight`), and `defuzzy` calculates the control u by means of the center of gravity (in case of FC1 by calculating the centre of gravity by the analytical formula, and in case of FC2 by a simple weighted sum):

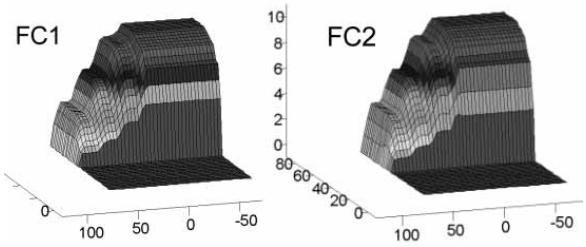
AMATH Fuzzification

```
function fx=fuzzify(x)
nlx1=[0 35 40 70; 1 1 0 0];
p1x1=[0 35 40 45 50 70; .......
fx(1,1)=interp1(nlx1(1,:),nlx1(2,:),x(1));
fx(1,2)=interp1(p1x1(1,:),p1x1(2,:),....
return; end
```

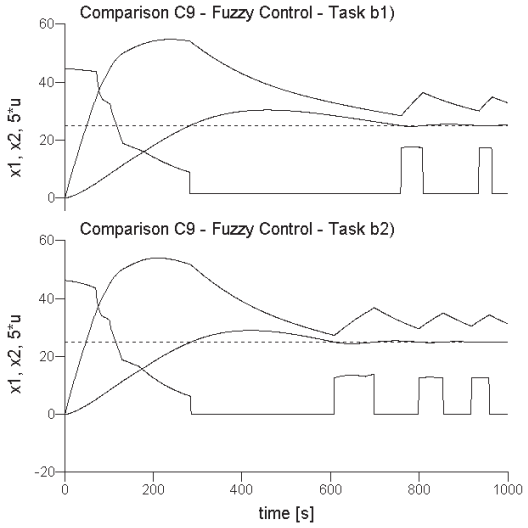
AMATH Interference

```
function fu=interf(fx,rule,weight)
fu=zeros(1,9);
for i =1:5; for j=1:5
fu(rule(i,j))=max(fu(rule(i,j)),
   min(fx(1,j),fx(2,6-i))*weight(i,j));
   end; end; return; end;
```

Results. ***Task a)*** A simple m-file calls in a nested loop 41 x 41 times the calculation of the fuzzy control, and a standard command plots the fuzzy control surface: Computation times on a Pentium 166, 32 MB, are ta_{FC1}= 680 and ta_{FC2}=677 sec., resp. Due to the interpretative calculation these times are relatively high; they are mainly consumed in loops and function evaluations, so that difference between FC1 and FC2 does not really matter (giving ration ~1).



Task b, c). Simulation of the whole system (using the main m-file) with FC1, FC2 and FC3 result in tb_{FC1}= 420 s, tb_{FC2}= 410 , and tc_{FC3}=411 sec., resp.; As results with FC2 and FC3 do not differ significantly, only figures for FC1 and FC2 are given below.



Remark: The sampled data nature and control of the overall system raises the question how important the continuous modelling of the plant really is. For investigation, the "continuous" plant model in ACSL (integrated with stepsize *h*=0.001, RK4) was replaced by a simple Euler step (stepsize *h*=1) in the AMATH m-file. As result, the relative difference in x_2 lies in a bandwidth of a relative error of 4×10^{-5}. Simulation times do not change essentially !!

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Comparison 11 – DYMOLA

Classical mechanical approach

Automatic-symbolical and numerical inversion

DYMOLA (Dynamic Modelling Laboratory) is an object-oriented simulation environment for the modeling, simulation and visualisation of continuous processes. Besides the classical textual model definition, Dymola provides an editor for graphical model editing together with comfortable possibilities to reuse objects by means of (graphical) libraries. Model details can be given by ODE's and DAE's in the Dymola's object-oriented modelling language; for simulation either Dymola's simulator Dymosim can be used, or other commercial simulators (e.g. ACSL, SIMULINK).

Model Description (Task a): One of the main characteristics of Dymola is the law-oriented model description allowing the formulation of DAE models. This description can be manipulated symbolically depending on certain options. In this solution the textual mode of Dymola is used, defining the equations of motion in DAE form in a Dymola class, instanced once:

```
model class components
  parameter L1=0.4, L2=0.3, L3=0.3, ...
  constant m1=8, m2=6, m3A=2.5, ...
  local M(3,3), b(3), q(3), dq(3), ...
  cut torq1(T1) torq2(T2) torq3(T3) ...
  M=[th1+2*th2*cos(q(2))+th3, ...;
  b=[T1+th2*(2*dq(1)*dq(2)+dq(2)**2)* ...
  q=[q1;q2;q3]; dq=[dq1;dq2;dq3]
  dq=der(q)
  M*der(dq)=b
end
```

Dymola is able to transform these equations to explicit form by symbolically inverting the mass matrix, resulting in an explicit system. Another method is provided by a numerical inversion of the mass matrix by means of an iterative algorithm, resulting in a pseudo-explicit system. Depending on options, Dymola translates the system into both forms (as a third form, a pure implicit description is possible).

Point to Point Control (Task b): As three motors and three controls are required, two classes are defined: one describing the equations to specify a motor, one defining a control. Then the three instances of each class are connected with the instance of the components class, e.g.:

```
model class drive
  ...
  cut torque (T)
end
model scara
  submodel(drive) d1 d2 d3
  submodel(components) robot
  connect d1:torque at robot:torque1
  connect d2:torque at robot:torque2
  ...
end
```

The bounds for the voltages and the currents are considered by **if**-statements:

```
U=if abs(P*(qdach-q)-D*qd-Umax)0 then
  Umaxreg else P*(qdach-q)-D*qd-Umax
```

For simulation Dymosim is used. Dymola translates each **if** and **when** statement into a state event. Therefore the bounds for the current are formulated with state events in each target simulator. Dymosim handles state events by means of built-in features of the integration algorithms DASSL (used here) and LSODER. Unfortunately, Dymosim does not use the DASSL algorithm for direct integration of implicit equations (third method).

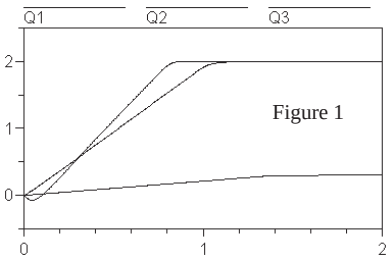

Figure 1

Of course numerical inversion of the implicit system takes more time than the integration of the explicit system; the relation is shown in the table below.

Figure 1 shows the graphs of the three joint positions.

Model description	Norm. CPU-time
Task b) explicit – symbolic inversion	1 (1.32s at P120)
Task b) pseudo-explicit – numerical inversion	1.69
Task c) explicit – symbolic inversion	1.43
Task c) pseudo-explicit – numerical inversion	2.27

Obstacle avoidance (Task c): For the collision avoidance a new class that observes and controls each state variable is implemented. The two instances (one for each state) check the distance between the obstacle and the tool-tip of the robot, and apply either the emergency maximum voltages and set the target positions for the state-variables to the current position, or reset the target positions to the original values bounding the voltages to their regular-mode-interval. Below a part of this description is shown, which is translated into a state event in Dymosim:

```
Xcrit=if abs(Xtip-Xobs)Xobs+Dcrit) then
true else false
Umax=if Xcrit and (q3-Hobs) then
Umaxmax else Umaxreg
q1dach=if Xcrit and (q3-Hobs) then
      q1 else q1target
```

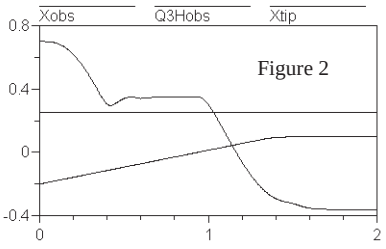

Figure 2

Figure 2 illustrates the behaviour of the tool-tip in this situation: it does not cross the critical region as long as the end-effector has not cleared the obstacle's height. This implementation of obstacle avoidance increases simulation time by a factor 1.43 (see table).

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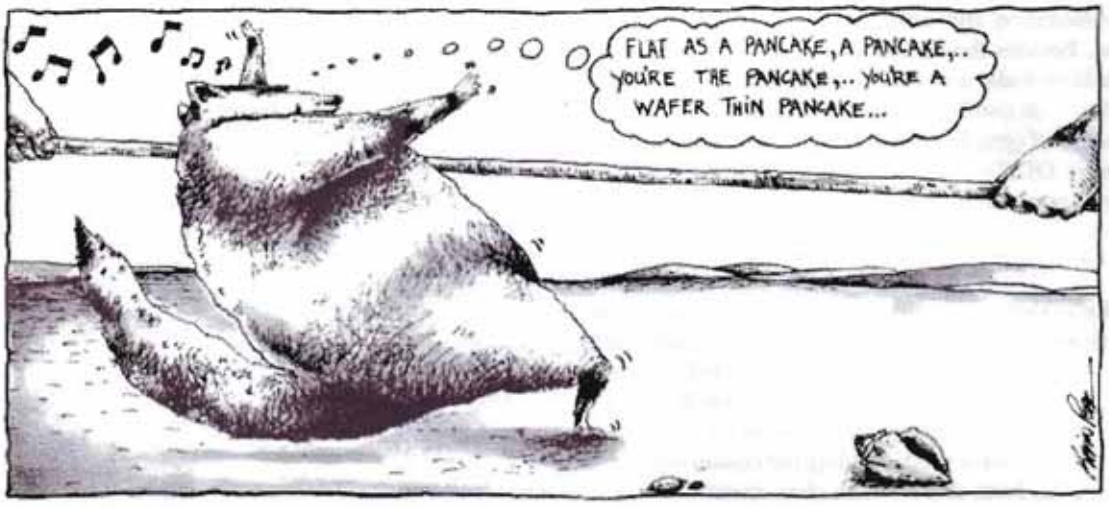

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Book Reviews

Mathematics of Climate Modeling
Valentin P. Dymnikov, Aleksander N. Filatov
Birkhäuser, Boston, 1997
ISBN 0-8176-3915-2, 264 pages

This publication is dedicated to a new branch of climate theory. The foundation of this branch is the investigation of climate models by the methods of quality theory of partial differential equations. The book starts with a detailed introduction to the general theory of nonlinear dissipative dynamical systems, whereby the main focus is given to the theory of invariant measure concentrated on the attractor. Then the investigations are extended to the theory of nonautonomous nonlinear dissipative systems and some relations between autonomous and nonautonomous systems are established.

The following chapters of the book contain a detailed analysis of climate models of different complexity from barotropic models to models based on the full system of hydro-thermo-dynamics equations. This analysis includes existence theorems and proofs for attractors and invariant manifolds. Furthermore general theorems on approximations for the infinite-dimensional dissipative systems are discussed. These theorems lead to numerical investigations of the structure of attractors generated by the barotropic equations on the sphere. The concept of quasistationary regimes of the atmosphere circulation is introduced through the analysis of situations when the invariant measure is concentrated in the neighborhood of the stationary points. Then the results are derived for the two-layer baroclinic model which is an intermediate stage between barotropic and general primitive baroclinic equations. Also the numeric of the characteristics of the attractor of two-layer baroclinic model for different regimes of the atmospheric circulation are investigated.

The last chapters are dedicated to the problems of identification and classification. It starts with the study of the attractor of the ideal climate model by the series of observed data. The existing methods for the reliable estimate of the dimension of the attractor require such long data series that they are practically not applicable. Therefore new methods are described connecting the attractor dimension with the chaotic behavior of the trajectory and the number of statistically independent degrees of freedom. Furthermore the concept of the atmospheric circulation regime is formalized and the regimes are classified. Finally the recent theory of the dissipative systems generated by the primitive equations of the thermo-hydro-dynamics of the atmosphere and the ocean is described. The results are connected with the existence and uniqueness theorems in general for the models of atmospheric and oceanic circulation.

In summary the book gives a detailed insight into the study of climate models based on the quality theory of partial differential equations and nonlinear dynamical systems. The book is oriented to specialists in applied and numerical mathematics and geophysical hydrodynamics.

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Modelling and Control in Solid Mechanics
A.M. Khludnev, The Russian Academy of Sciences, Novosibirsk, Russia
J. Sokolowski, Université Henri Poincaré Nancy I
Birkhäuser 1997, 384 pages, ISBN 3-7643-5238-8

A wide range of mathematical models of the mechanics of deformable bodies are boundary value problems. Some examples are boundary value problems concerning plates and shells, crack theory and elasto-plastic bodies. A lot of these problems impose inequality type constraints on the solution (bodies may not penetrate each other). This book analyses that kind of mathematical problems.

Applications of these mathematical models are in all areas of the engineering sciences.

The first chapter gives an introduction to the mathematical tools that are used, especially the calculus of variations and the mathematical models of elastic bodies (linear elastic bodies and shallow shells and models of contact problems). Chapter two covers contact problems of elastic bodies with different kinds of other bodies (rigid or elastic). Dynamic problems are also covered. In chapter three the most widespread models of plasticity are presented. The most widespread of these models are flow model and the Hencky model. The fourth chapter discusses various optimal control problems. The last chapter discusses the application of sensitivity analysis of nonlinear problems to the discussed problems.

Some of the issues discussed in the chapters are: proof of the solvability of the various boundary value problems and analysis of qualitative characteristics of the solution. The book gives an overview over the field and presents some new mathematical methods developed by the authors.

The emphasis of the book is on the theoretical mathematical treatment of the presented problems. In

this it is very thorough. The absence of practical examples makes it a very dry read for the not very theoretically inclined reader.

The book is intended for postgraduates, scientists and engineers.

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Modelling and Simulation of Complex Systems – Methods, Techniques and Tools
Y. Monsef
SCS European Publishing House
ISBN 1-56555-118-4, 296 + xii p.

This is a quite surprising book on modelling and simulation. It not only introduces concepts, methods and tools, it also gives a "philosophical" background by employing the epistemological culture that the modelling and simulation files cover. It is a book giving a broad overview and at the same time a book for people interested in some special aspects of modelling and simulation. The author really combines these two aspects by bridging the gap between general published books in this area and books dealing with a specific method or a specific tool.

A general theme in this book is the View of the World and the corresponding paradigms, reviewed in detail from the discrete area, from the continuous area and from the combined area.

The first chapter introduces the basic terminology, the second chapter deals with methodological aspects and develops structures methods as well as the object-oriented paradigm. Chapter 3 shows the structured approach in a simulation project.

The next three chapters deal with world views; *The Discrete View*, *Continuous System Modelling*, and *Combined and Mixed System Modelling*.

In the following chapters modern development and new methods are discussed: *Qualitative and Knowledge-Based Modelling Systems, Human Interaction with Complex Systems, Variable Structure and Autonomous Systems; Automatic Model Generation, Parallel and Distributed Simulation of Complex Systems, User Interactive Computer Simulation and Training, Quality Assurance in Modelling and Simulation*.

It is the author's aim to make an understanding for the methods behind, and to enhance the practical use of tools and techniques in modelling and simulation by trying to bridge the gap between theoretical concepts and practical issues. It can be underlined that the author fulfils this aim, and the book can be considered at the same time as a useful manual for those interested in some specific systems, and as state-of -the-art book for those with general interest.

The book can be highly recommended for all people involved in modelling and simulation. The large number of references is very helpful, e.g. in research for finding information and in application for gaining information about applications. As each chapter , and the exercises at the end of each chapter recommend the book for courses, lectures etc. - every simulationist will benefit from this book.

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Felix.Breitenecker@tuwien.ac.at

Mathematik mit MATLAB **(in German)**
Franz Bachmann, Hans Rudolf Schärer, Louis-Sepp Willimann
vdf Hochschulverlag AG an der ETH Zürich
ISBN 3 7281 2308 0, 294 + xiv p.

The book includes a CD-ROM containing solutions of all exercises and a demo version of MATLAB. This book was published in 1996 and is based on MATLAB 4.2. Since the latest version of MATLAB is 5.2 one might consider this book to be out of date but as neither basic MATLAB nor basic mathematics change much this book is of interest!

The main attraction of the book is the combination of MATLAB with 'real world' exercises. It is neither a course on MATLAB nor a collection of pure mathematics exercises but shows how interesting and also challenging mathematical problems can be solved with MATLAB.

Chapter one provides a brief introduction to MATLAB by which it opens this book for beginners.

Chapter two concentrates on MATLAB basics (vectors, matrices, scripts, functions, and polynomials). The authors choose a 'learning by doing' approach, so there is not much theory but the reader is guided by a series of well chosen examples.

The next chapters are designated to particular fields of application: Graphics, Linear Algebra, Analysis, and 'Real World' Applications.

The chapter on graphics stretches from standard x-y plot over surfaces in three dimensional space to strange attractors. The chapter on linear algebra deals with matrix calculus as well as with mappings and intersection of lines and planes. Some of the highlights in the chapter on analysis are: roots of polynomials, solution of

systems of equations, various algorithms for differential equations, interpolation and approximation.

Finally the chapter Applications provides a highly interesting collection of examples from the fields of electrical engineering, mechanics, dynamics, physics, pattern recognition and others.

The last chapter presents the listings of one solution for each of the given problems. These solutions can also be loaded from the enclosed CD-ROM.

The book closes with an index of all used MATLAB commands and important keywords.
WWW-support at: http://vdf.ethz.ch

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Fluid Power Systems – Ninth Bath International Fluid Power Workshop
C. R. Burrows, K. A. Edge (eds.). John Wiley & Sons
ISBN 0-471-97126, xiv + 458 pages.

This book is a collection of the contribution to the 9th Bath International Fluid Power Workshop. As usual in these series of Proceedings a written discussion accompanies each paper, which sometimes is very helpful for the reader in order to estimate the relevance of the contribution.

The general theme of this 9th workshop is "Fluid Power Systems" and a big majority of the contributions makes use of modelling and simulation, as well as many papers have control as the main or at least secondary theme. The contributions are grouped with respect to applications, e. g. fuzzy control, distributed control, potential of water hydraulic systems, valves, neural nets. Some contributions deal with the use and integration of software packages, where e. g. ADAMS, ANSYS, MATLAB and Bathfp (developed at Bath University for hydraulic circuit analysis) are discussed.

The editors have put emphasis on a certain context of the papers, by selecting and grouping of the papers and by an introductory contribution, showing developments and trends and discussing the contributions. Consequently this book is not only a Proceedings volume, it can be recommended as a review of the state-of-the-art in fluid power systems, with main emphasis on control, modelling and simulation.

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Einführung in partielle Differentialgleichungen für Ingenieure, Chemiker und Naturwissenschaftler
(in German)
Hungerbühler N.
vdf Hochschulverlag AG/ETH Zürich, 1997
ISBN 3-7281-2303-X, 218 + x pages

This book gives a comprehensive introduction into PDEs. The author deals with the classical equations (wave equation, etc) as well as with classical approaches for solutions. A relatively small part is dedicated to numerical algorithms for the solution of PDEs. A more detailed review in German can be found in the *ASIM Nachrichten*, July 1998.

Simulation in Produktion und Logistik **(in German)**
A. Kuhn, M. Rabe (Hrsg.)
Springer-Verlag, ISBN 3-540-63854-7, 200 + xvi p.

The aim of this book on case studies on simulation applications in production systems is to stimulate the use of the tool modelling and simulation in enterprises, etc. The editors underline that benefits of modelling and simulation can be shown at the best by means of successful applications, and therefore they have collected case studies in six areas, from assembly to organisation. The 19 case studies are based on different approaches and make use of different simulators, so that the reader gets a very broad overview, and a possible user finds criteria for a suitable approach and for the choice of a simulator. A detailed review in German can be found in *ASIM Nachrichten*, July 1998.

Erfahrungen aus der Zukunft **(in German)**
K. Mertins, M. Rabe (eds)
IPK - Berlin, Eigenverlag
ISBN 3-00-002439-5, 440 + xii p.

This book is the Proceedings volume of the 8th *ASIM-Fachtagung* on "*Simulation in Produktion und Logistik*", held in February 1998 in Berlin. The title is taken from the theme of the opening session of the Berlin Demonstration Centre for Production and Logistics, where simulation was emphasised as the tool of the future. The volume groups the 44 selected contributions with respect to application areas, and many from the contributions are coming from industry. The book summarises a state-of-the-art in this area of modelling and simulation, with special emphasis on applications. A more detailed review can be found in the *ASIM Nachrichten* July, 1998.

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***Regelungstechnik und Simulation* (in German)**
A. Makarov
Vieweg Verlag, ISBN 3-528-15278-8, 264 + viii p.

The book is the second edition of a successful book on control theory and simulation in German language. The book includes all necessary basic information to start a successful simulation and can be used for educational purposes as well as for persons working in industry, without control education,who need this information in their daily work. The book is available for DM 89,00, including a disk with basic simulation software. A more detailed book review can be found in German language in the *ASIM Nachrichten.*

Ingrid Bausch-Gall
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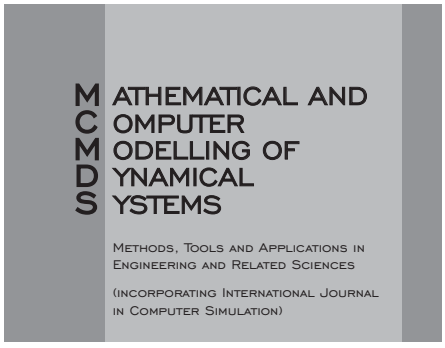
News on Books and Journals

"Mathematical Modelling of Systems" becomes "Mathematical and Computer Modelling of Dynamical Systems"

Mathematical modelling is one of the most important tools for an engineer or scientist in solving real-world problems. The journal *Mathematical Modelling of Systems* has successfully provided an international forum for the presentation of new ideas and for the exchange of experience and knowledge through descriptions of specific applications. Experience gained over the last years shows that a good presentation allows transfer of ideas and methods from theory to practice or between various areas of application.



Experience also shows that computational aspects of modelling are becoming more and more important, not only in terms of model based simulation but also in the very process of modelling. Modern modelling tools may include features based on artificial intelligence or expert systems, methods which can assist the modeller in developing a useful model. Moreover, simulation tools are frequently used for modelling purposes. Modelling tools therefore have a proper place in the scope of *Mathematical Modelling of Systems*, since for the real-world systems of today modelling tools and mathematical techniques are both important.

In the context of today's applications different software tools have to be used in parallel – e.g. modelling and simulation environments and tools for engineering system analysis and design (e.g. for the design of controllers). At present, software specialists are needed to make such environments "talk" to each other. Therefore it is important to consider either a unification of tools such as these and/or the design of bridges between various tools.

In considering how to take care of needs such as these the Editorial Board of MMoS has decided to allow proper weight to be given to computer aspects in modelling issues and to modify the scope of the journal so that these ideas become more transparent. This will also be expressed by the new journal title *Mathematical and Computer Modelling of Dynamical Systems* which includes "modelling" as the basic scope, "computers" as the (computational) tools and "dynamical systems" as field of interest.

The scope of *Mathematical and Computer Modelling of Dynamical Systems* is such that, in addition to papers dealing with various methodological aspects of modelling, modelling ideas and specific applications, papers are welcome which relate the use of simulation and simulation tools to real-world modelling problems or, present work on the relationship between computational/simulation methods, the underlying mathematical formulation and the modelling problem itself.

Ordering Information:
Swets & Zeitlinger Publishers
P.O.Box 825
NL-2160 SZ Lisse, The Netherlands
email: orders@swets.nl

Detailed Scope, Author's Instruction:
Univ.Prof. Dr. Inge Troch
Technische Universitaet Wien
Wiedner Hauptstr. 8-10
A-1040 Wien, Austria
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I. Troch

Presentation of Simulation Centers

Laboratory of Cybernetics and Decision Support Systems, University of Maribor Faculty of Organizational Sciences

Research at the Laboratory of Cybernetics and Decision Support Systems is focused on the modelling of business and production systems and their validation. Models of business process are designed by the principles of system dynamics and the production process as discrete event simulation. The goal of the current research project is to develop and to evaluate an integral simulation system for decision making support for pedagogic purpose as well as for real use.

The basic concept of business simulation modelling is the connection of production, financial and information flows. We analyse the influence of actions, activities, market impacts, organisation structure, and action time delays on the efficiency of the business system through the determination of the system structure. This approach provides a unique framework for integrating the functional areas of management – marketing, production, accounting, research and development and capital investment. The simulation model packed in user-friendly business simulator enables decision-makers to experience different business scenarios. The consequences of these scenarios are understood in a risk-free environment before any business actions are taken.

The system behaviour is studied on the model, which enables reasoning on consequences of the chosen strategy. The multiple criteria methods of the simulation scenario choice for the decision support were used. Presently, the most intensive research efforts are spent on the combination of simulation methods and expert systems. The simulation system consists of commercially available packages as for example: Powersim, ProModel, GPSS, Group Systems, Expert Choice, etc. It is organised in several modules: basic model that represents the production process, program for the scenario formulation, program for the analysis of the simulation results, and program for the normative analysis. The simulation scenarios are made of two subsets: a subset of input that anticipate the impact of the environment (exogenous scenarios), and a subset of management choice of alternative (endogenous scenarios).

The evaluation criteria and business goals are gained by methods of group decision support systems (GDSS) in connection with the method of analytical hierarchy process (AHP) Group decision support systems enable participant's creative, independent and anonymous estimation of decision variable. On this way the decision-makers should creatively participate in modelling of business policy.

Several business simulators, which simulate the different business aspect, were developed in past years and installed on the laboratory's computer network. Since the models are running in a form of simulator, it is very easy for participants involved in simulation experiments to test business decisions on a model. The objective of using business simulators is to develop decision-maker's ability in applying their business knowledge in the real world. Due to the large amount of data and certain complexity of decision making problems, a connection between the decision expert system DEX and AHP method has been established. Users have the opportunity to participate actively in the decision process in spite of a large number of different business scenarios. Researches showed (with the group of students) very small correlation between the rank of individual variants (scenarios) based on the subjective estimation of a business politics and the rank of simulation results ranked both in terms of scenarios and multiple criteria evaluation by the same experts. We also compared the multiple criteria simulation decision problem to the AHP method and DEX. As expected, the results of the evaluation were similar although DEX allowed us to make a synthesis of heterogeneous expertise and rules while AHP enabled a different analysis in terms of a hierarchy problem definition.

The method was also tested in the medium size factory in order to improve operation planing and reengineering process. The simulation model was used to test feasibility of heuristic operation planing and to define bottlenecks in production process. In order to gain better understanding of the decision processes, in case of the reengineering of production process, additional cognitive information to decision-makers were introduced. Real process was recorded by video camera and stored in personal computer. Animation of the simulated process synchronised with the video of the real process was projected in the meeting room. On this way, validation of the model and confidence of the participants in evaluation of the chosen solution was achieved. On the base of current and future demand the production performance are prepared and simulated. A preliminary result was satisfactory.

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1998 International Conference on Web-Based Modeling and Simulation Conference Report

January 1998 marks the date of the first conference exploring "web-based modeling and simulation". We held the conference at the Catamaran Resort Hotel in San Diego from January 11-14. Prof. David Hill (Blaise Pascal University, France) and I were the General Chairs, and Roger Smith (STAC, Inc.) served as the Program Chair. The conference was three days, long and we had about 80 attendees from all over the world. We were especially pleased with the turnout from Europe and Asia.

The topic of "web-based modeling and simulation" is a fairly new one, even though the technology of the web is now several years old. If we ask ourselves "how can the web relate to simulation?" then we find ourselves knee-deep in distributed model repositories, Java/CGI scripts for both client and server-side execution, and forms-based browser interfaces for simulation programs. There were many topics of interest. One of our novel achievements was the creation of a CD-ROM with full multimedia proceedings. The CD-ROM, along with the hardbound proceedings, is available through the Society for Computer Simulation International in San Diego. Moreover, we maintained full-content proceedings on the web. Look at http://www.cise.ufl.edu/~fishwick/webconf.html for an indepth-look at these proceedings.

One highlight of the conference was Dr. Ernie Page's (epage@mitre.org) panel on the conference theme. The panel title was "The Modeling Methodological Impacts of Web-Based Simulation". While each panelist discussed issues regarding the future of the integration of the web with our discipline, the most lively topic was one of ensuring quality control over simulation models and results within the context of a fairly chaotic world wide web. I have since written a short article on some of these issues (http://www.cise.ufl.edu/~fishwick/tr/tr98-001.html), and Ernie is spearheading a journal article comprehensively outlining the broader issues based on all views of the panelists. There is no question that many issues remain on how to best infiltrate the web with simulation models, code and input/output. It is clear that we must continue getting together in this forum to better understand the role of simulation in the web, so that we can at least try to address the controversial topics.

Please consider becoming part of next year's conference in San Francisco. The address is http://cpsi4.dibe.unige.it/~websim/webconf.html. The lineup is as follows: Agostino Bruzzone (University of Genoa) and Adelinde Uhrmacher (University of Ulm) will be General Chairs. Ernest Page (The MITRE Corporation) will be the Program Chair, and Hessam Sarjoughian (University of Arizona) and Lorenzo Motta (University of Genoa) will focus on the CD and web dissemination of the interactive, multimedia proceedings. Judging from the turnout this past January, and from the web-based modeling and simulation sessions held recently as part of the Winter Simulation Conference, this area seems ripe for future research and for new applications software.

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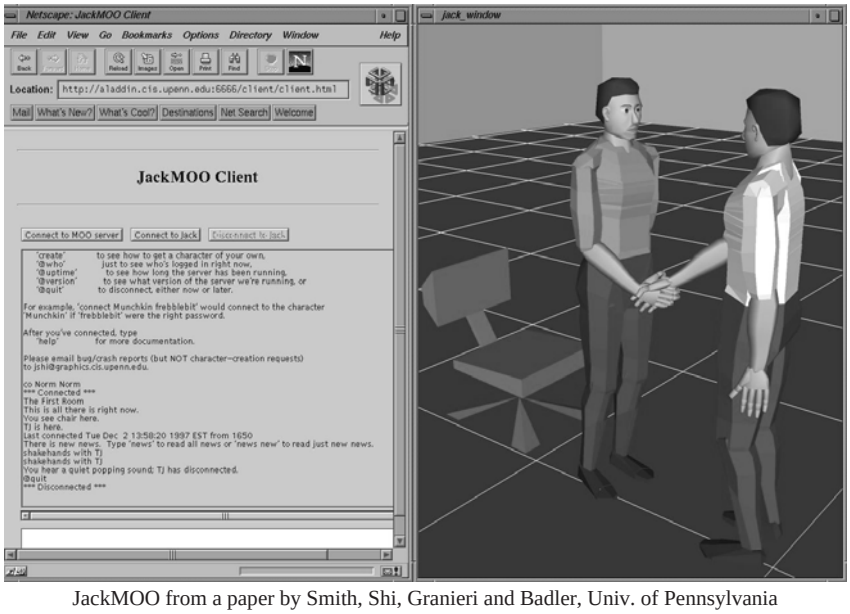
http://www.cise.ufl.edu/~fishwick



JackMOO from a paper by Smith, Shi, Granieri and Badler, Univ. of Pennsylvania

Transaction Oriented Simulation within MATLAB: The MATLAB-GPSS Toolbox

In spite of the rich functionality provided by MATLAB and its toolboxes for many scientific and technical computation purposes, there is hardly any support of discrete event simulation methods within the entire MATLAB environment.

The MATLAB-GPSS Toolbox is one step towards filling this lack. It introduces a GPSS-like transaction oriented simulation method into MATLAB, and besides it is an example realization of a general concept for embedding discrete event methods in interactive/interpretative computing environments.

Brief Introduction

The traditional way for combining MATLAB based computations and discrete event simulations is to establish a data coupling between MATLAB and an external simulation system (mostly via ASCII files). But this approach has two characteristic disadvantages: the user has to work in different environments, and the MATLAB facilities can only be used "around" the simulation, i.e. for data pre- and post-processing. Conversely, embedding simulations into sophisticated computations (e.g. optimizations) is often very difficult or even impossible.

The MATLAB-GPSS Toolbox is based upon a completely different approach. It provides a transaction oriented modeling language, which is derived from the popular GPSS language ([1]), and an appropriate simulation engine (scheduler) *within* MATLAB. The toolbox design is aligned to meet the following requirements:

- The modelling language should be as conform as possible to GPSS and MATLAB.
- Easy integration of pure MATLAB statements into the model description.
- Easy integration of simulation runs into superior MATLAB based algorithms.
- Interactive way of working during modelling and simulation.

Realization

Because a GPSS-like model description is done in a declarative manner (i.e. non-procedural, fig. 1), it cannot be executed straight forward by the MATLAB interpreter, and has to be transformed to an internal model representation (computing model). Therefore, an entire simulation consists of a model generation and execution process, which can be managed by means of three interface routines (fig. 2).

```
% A simple single server model
GENERATE     (ERLANG(0.6,1),[],5)
stem         (AC,1)              % MATLAB stem plot
QUEUE        ('ServerQ')
SEIZE        ('Server')
DEPART       ('ServerQ')
ADVANCE      (1.5,0.5)
RELEASE      ('Server')
TERMINATE    (1)
```

Fig. 1: MATLAB-GPSS Model Description

```
>> % model generation & initialization
>> init ('model_name');
>> % simulation execution
>> [outputs]=schedule('model_name',tc_start,inputs);
>> % get statistical report
>> [Q,F,S,...] = report;
```

Fig. 2: MATLAB model generation & execution routines

For the model generation the toolbox provides two alternative methods. The first one is a translator routine that reads a model description from file and builds up the computing model in the MATLAB workspace. This method is very similar to conventional compiler based approaches (fig. 1, fig. 2). The second method permits a truly interactive model generation. For that, the toolbox provides for each model command a separate MATLAB function, which implements the specific generation and calculation aspects of the command. In this case the init routine provides a special model generation prompt. During the interactive generation phase model commands can be entered at this prompt, and only the generation parts are executed to build up the computing model, gradually.

Conclusions: The recent version of the MATLAB-GPSS Toolbox is a M-coded prototype implementation. Therefore, the model execution speed is very slow compared with conventional discrete simulators. For better performance it is necessary to link the runtime system as compiled code. But already the prototype is quite useful, especially for educational purposes and for applications which are dependent on a very close integration of discrete simulation and MATLAB. Further information about the MATLAB-GPSS Toolbox and its development can be found in [2,3,4]. If there is a certain interest in the simulation community the authors will compile a toolbox release for the public domain.

References

[1] T. J. Schriber. *An Introduction to Simulation using GPSS/H.* John Wiley and Sons, 1991.

[2] T. Pawletta, S. Pawletta, W. Drewelow. Transaction oriented simulation in interactive SCEs. In P. Lorenz, B. Preim, editors, *Simulation and Visualization*, pp. 181-194, SCS Int. Publishing House, 1998. (in German)

[3] T. Pawletta, W. Drewelow, S. Pawletta. Discrete event simulation in interactive scientific and technical computing environments. *12th European Simulation Multiconference*, Manchester, 1998. (in publishing)

[4] MATLAB-GPSS TB Homepage. http://www-at.e-technik.uni-rostock.de/MATLAB-GPSS/

S. Pawletta, W. Drewelow, Institute of Automation, University of Rostock, email: sven.pawletta@etechnik.uni-rostock.de, wolfgang.drewelow@etechnik.uni-rostock. de and T. Pawletta, Chair of Applied Computer Studies, Wismar University, email: pawel@mb.hs-wismar.de

Classes on Simulation

July 1998

9-10 **Micro Saint Course**. Worthing, UK
Contact: Rapid Data Ltd., Amelia House, Crescent Road, Worthing, West Sussex, BN11 1RL, UK, Tel: +44-1903 821266, Fax: +44-1903 820762, email: info@radata.demon.co.uk

9-10 **Creating Simulation in HLA/RTI Using DEVS Modeling**, University of Arizona
Contact: B. Zeigler, Tel: +1-520-626-4846, email: ais@ece.arizona.edu

September 1998

4 ***MATLAB - Interaktives Arbeiten***. Gümlingen, Switzerland.
Contact: Scientific Computers, Franzstr. 107-109, D-52064 Aachen, Tel.: +49-241- 47075-0, Fax: +49-241-44983, email: info@scientific.de

18 ***MATLAB Programmierung.*** *Gümlingen, Switzerland.*
Contact: Scientific Computers

21-22 ***MATLAB Kurs***. Munich, Germany.
Contact: BAUSCH-GALL GmbH, Wohlfartstr. 21b, D-80939 München, Tel: +49-89 3232625, Fax: +49-89 3231063, email: BauschGall@compuserve.com

22-23 ***Einsatz von MATLAB in der Regelungstechnik.*** *Aachen, Germany*.
Contact: Scientific Computers

25 ***MATLAB - Interaktives Arbeiten***. Gümlingen, Switzerland.
Contact: Scientific Computers

October 1998

2 **SIMULINK**. Gümlingen, Switzerland.
Contact: Scientific Computers

5-6 ***Filterenwurf mit QuickFil***. Munich, Germany.
Contact: BAUSCH-GALL GmbH

6-7 ***Einsatz von SIMULINK in der Regelungstechnik.*** *Aachen, Germany*.
Contact: Scientific Computers

9 ***MATLAB - Interaktives Arbeiten***. Gümlingen, Switzerland.
Contact: Scientific Computers

12 ***Effektive Simulation von Schaltnetzteilen***. Munich, Germany.
Contact: BAUSCH-GALL GmbH

13 ***Effektive Regelung von Schaltnetzteilen***. Munich, Germany.
Contact: BAUSCH-GALL GmbH

19-21 **Simulation mit SIMULINK**. Munich, Germany.
Contact: BAUSCH-GALL GmbH

21-23 **Micro Saint Course**. Worthing, UK
Contact: Rapid Data Ltd.

22-23 ***ACSL, ACSL/MATH, Graphic Modeller***. Munich, Germany.
Contact: BAUSCH-GALL GmbH

26-28 **CCG-Kurs.** ***Modellbildung und Simulation dynamischer Systeme*** (I. Bausch-Gall and F. Breitenecker). Oberpfaffenhofen, Germany.
Contact: Carl-Cranz-Gesellschaft e.V., Postfach 11 12, D-82230 Weßling, Fax: +49-8153 281345, email: ccg@dlr.de

November

2-3 ***MATLAB Kurs***. Munich, Germany.
Contact: BAUSCH-GALL GmbH

23 ***Effektive Simulation von Schaltnetzteilen***. Munich, Germany.
Contact: BAUSCH-GALL GmbH

24 ***Effektive Regelung von Schaltnetzteilen***. Munich, Germany.
Contact: BAUSCH-GALL GmbH

Industry News

Rapid Data has recently signed contracts to sell **DSH-Plus**, a hydraulics simulation software package, **Data Desk**, a data analysis and statistics package, and **Layout,** a package for calculations and technical report writing, which we feel fit in very nicely with our portfolio of software products.

DSH-Plus is a user-friendly graphics-based simulation program especially designed for the simulation of complex hydraulic components and systems. With DSH-Plus , the user intending to design or to optimise a hydraulic system is given quick, easy and reliable information about the behaviour of the hydraulic system from the very first moment the design process commences. Thus, the process of designing or revising hydraulic systems becomes simpler, quicker and more efficient in terms of time and money.

Data Desk is an interactive tool designed to help the user understand the data better. The program is based on the philosophy of Exploratory Data Analysis, emphasising visual, interactive tools for finding patterns, trends, subgroups and outliers. No other application offers as powerful a set of tightly linked interactive tools. Plots or tables can be modified by simply picking up a variable with the mouse and dragging it into the table. The table updates instantly. To change a variable in a plot, drag a new variable onto an axis.

Layout uses the concepts of Spreadsheet and DeskTop publishing and combines them into a powerful tool for creating dynamic reports. It introduces a DeskTop Publishing (DTP) view to the spreadsheet environment. The spreadsheet view provides conventional spread-

sheet functionality where formulae are typed into a spreadsheet toolbar and the result is displayed in a spreadsheet cell. The DTP view uses the same spreadsheet toolbar and formulae syntax to create equation objects, which display the formulae in maths textbook format together with the result. Text, graphics and charts can be added and positioned on the page.

Please contact for further information: Rapid Data Limited, Amelia House, Crescent Road, Worthing, West Sussex BN11 1RL, Tel: +44 1903 821 266, Fax: +441903 820 762, email: info@radata.demon.co.uk, WWW: http://radata.demon.co.uk

Fortran 90

With the full adoption of Fortran 90 as both the ANSI and ISO standard, Fortran has emerged as the only computer language to receive approval from both of these respected organizations. As a result, the entire computing industry has given its full support behind the language.

Fortran 90 offers language features that make coding and time management of application development more efficient. Features such as array intrinsics, array syntax and optional arguments, just to name a few, provide a streamlined approach to programming. An additional benefit of the Fortran 90 language standard is that users can continue programming with FORTRAN 77. Because FORTRAN 77 is a subset of Fortran 90, users do not have to discard their large investment in FORTRAN 77 applications.

Visual Numerics has created the IMSL Fortran 90 MP Library not only to take advantage of the efficient features of Fortran 90 but also to provide a syntax that leads to a more natural, algebraic approach to application development.

Contact: Visual Numerics Ltd., Centennial Court, Easthampstead Road, Bracknell, RG12 1YQ, UK, Tel.; +44-1344-458700, Fax: +44-1344-458748, nigel.brown@vniuk.co.ak, www.vni.com

Savastano Award

Prof. Savastano was the first EUROSIM president. He died suddenly in February 1990. After his death the EUROSIM Board decided to install the Savastano Award, to be granted every three years. The Award was selected by people from ISCS and the winning paper has been announced during the congress dinner at EUROSIM'98 in Helsinki. The winners are:
Vanco B. Litovski, Tihomir Ilic and Zeljko Mrcarica
University of Nis, Yugoslavia.

40th Year Anniversary and Recognition Celebration for Dr. Granino A. Korn

Dr. Korn started as Director of the Computer Engineering Research Laboratory in 1957. During his tenure in the Electrical and Computer Engineering (ECE) department, he had an illustrious career that impacted on computer technology and students. He retired as Professor Emeritus in ECE in 1983.

The celebration held on March 26 & 27, 1998 in Tucson, Arizona was in recognition for the many contributions that Dr. Korn made to industry, The University of Arizona, and his students. Friends, colleagues and former students of Dr. Korn have been invited. A Web page has been prepared, where contributions could be entered into the Commemorative Guest Book. Activities for participating guests included a social dinner, a recognition seminar and local Tucson activities. The seminar featured historical overviews and talks by former students of Dr. Korn.

The editors of "Simulation News Europe" could not take part in the celebration, but submitted the following contribution to the Guest Book:

We don't know exactly, when we first heard of Granino Korn and when met him the first time. When we made our first steps in the simulation business (in the end of the seventies) in analog computation we learned about Granino Korn, about the alternative digital simulation, and about Korn's early (digital) desire with EARLY DESIRE. Needless to say that also for us "Digital Continuous-System Simulation" by Korn/Wait was one of our bibles.

A direct contact evolved when we dealt more with digital simulation, in teaching and research (at the Department for Simulation Techniques at the Technical University of Vienna) as well as in the services and support area (at the Hybrid Simulation Center of the Technical University of Vienna). Granino Korn held lectures at our early Conferences on Simulation (in English as well as in German), and we tested DESIRE with desire.

The contact became closer when we started our simulation activities and our journal "Simulation News Europe" under the umbrella of ARGESIM. Granino Korn gave lectures at a seminar on „Modeling and Simulation", and he is one of our most-active authors in "Simulation News Europe".

Granino Korn has the attitude of a prophet and a pioneer. Really surprising, he seems to recognize future trends earlier than other simulationists:

- *He dealt with digital simulation at an early stage.*
- *He very early dealt with neural nets. We gratefully remember Korn's contribution to our seminar on "Neural Nets in Simulation" where he was the first to present features for neural nets in a simulator.*
- *He believed from the very beginning in the "direct executing"-implementation of simulators, as best compromise between fast execution of simulation models and fast change of models. We meet this approach in nowadays graphical modeling systems as features like "accelerator", "fast execution" etc.*
- *He early believed in PCs, in PCs as powerful simulation machines, indeed earlier than others even thought about that. It has become quite a reality now.*
- *And he believes in our journal "Simulation News Europe". He sent us very interesting contributions from the beginning, which helped us when starting the journal, and up to now he enriches the journal with comparisons, notes on software developments, essays, etc. We are proud to say that "Simulation News Europe" has become an established journal, and we gratefully thank Granino Korn for his support.*

What do we wish him ?

- *A splendid eve of his social and scientific life.*
- *A lot of new ideas for stimulating the simulation community.*
- *Time for writing further essays, contributions, comparisons for "Simulation News Europe".*

What can we present him on the occasion of this anniversary ?

- *Our grateful thanks for his ideas and support.*
- *A hardcover volume of all issues of "Simulation News Europe" which appeared up to now (mailed separately).*

As we cannot be present at the celebration, we today marked a bottle of Austrian wine which we will open for a toast to Granino Korn when we next meet him.

Felix Breitenecker
Irmgard Husinsky
Editors "Simulation News Europe"

Calendar of Events

July 1998

19-24 **MASCOTS'98.** Int. Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems. Montreal, Cananda
Contact: Azzedine Boukerche, McGill University, School of Computer Science, Montreal, H3A-2A7, Canada, email: azedine@cs.mcgill.ca, WWW: http://www.cs.mcgill.ca/~azedine

August 1998

12-14 **IASTED International Conference on Applied Modelling and Simulation**. Honolulu, USA
Contact: IASTED Secretariat, 1811 West Katella Avenue, Suite 101, USA-Anaheim, CA 92804, Tel.: +1-714-778-3230, Fax: +1-714 778 5463, email: iasted@iasted.com, WWW: http://www.iasted.com/

23-25 **Intl. Workshop on "Advanced Simulation and AI"**. Bucharest, Romania
Contact: Philippe Geril, SCS European Simulation Office, University of Ghent, Coupure Links 653, B-9000 Ghent, Tel.: +32-9 233 77 90, Fax: +32-9 223 49 41, email: philippe.geril@rug.ac.be, WWW: http://hobbes.rug.ac.be/~scs/

September 1998

6-8 **Intl. workshop on "Modelling and Simulation within a Maritime Environment"**. Riga, Latvia
Contact: Philippe Geril, SCS European Simulation Office, University of Ghent, Coupure Links 653, B-9000 Ghent, Tel.: +32-9 233 77 90, Fax: +32-9 223 49 41, email: philippe.geril@rug.ac.be, WWW: http://hobbes.rug.ac.be/~scs/

6-13 **European Summer School on Reliability and Safety of Human-Machine Systems**. Crete, Greece
Contact: Virginia Bocci, Multimedia Lab, University of Siena, Via del Giglio 14,

8-11 **ASRTP'98.** Process Control and Simulation. Kosice, Slovak Republic
Contact: Prof. Dr. D. Malindzak, Technical University of Kosice, dept. of Management and Control Engineering, SK-042 00 Kosice, email: asrtp98@ccsun.tuke.sk

15-17 **ASIS.** Advanced Simulation of Systems. Krnov, Czech republic
Contact: J. Stefan, VSB - TU Ostrava, tr. 17 listopadu 15, CZ-70833 Ostrava, email: jan.stefan@vsb.cz

15-18 **ASIM'98.** *12. Symposium Simulationstechnik*. Zürich
Contact: Ilona Deutsch, Institut für Werkzeugmaschinen und Fertigung, ETH Zürich, ASIM'98 Tagungssekretariat, Tannenstrasse 3, CH-8092 Zürich, Tel.: +41-1-632-2421, Fax: +41-1-632-1125, email: asim98@iwf.bepr.ethz.ch, WWW: http://www.iwf.bepr.ethz.ch/asim98/

24-26 **ERK'98.** 7th Electrotechnical and Computer Conference. Portoroz, Slovenia
Contact: Baldomir Zajc, Faculty of Electrical Engineering, Trzaska 25, SLO-1000 Ljubljana, Slovenia, email: baldomir.zajc@fe.uni-lj.si, WWW: http://www.ieee.si/erk98/

30-October 2
24th Conference of the Association of **SIMULA Users**. Salzau, Schleswig Hostein, Germany
Contact: Broder Breckling, Ecology Center, University of Kiel, Schauenburger Str. 112, D-24118 Kiel, Tel.: 49 431 880 4029, Fax: 49 431 880 4083, email: broder@pz-oekosys.uni-kiel.de

DBSS Symposium **Visulaisation**. Delft, The Netherlands
Contact: Mrs. Marja Dekker-Genemans, email: dekker@cp.tn.tudelft.nl

October 1998

7-9 **5th PSCS Workshop on Simulation in Research and Development**. Jelenia Gora
Contact: Prof. Tylikowski, email: ptsk98@simpr.pw.edu.pl

8-9 **Electronic Computers and Informatics**. Herlany, Slovak Republic
Contact: Jan Baca, email: bacj@tuke.sk

14 DBSS Symposium **Neural Networks in Water Management.** Rotterdam, The Netherlands
Contact: TechnoTrans b.v., Tel.: +31-10 2341082 , Fax: +31-10 2341172, email: technotrans@per.nl

22-24 **DAAAM Symposium: Intelligent Manufacturing, Automation & Networking**. Cluj-Napoca, Romania
Contact: Prof. Branco Katalinic, TU Wien, Karlsplatz 13, A-1040 Wien, Tel.: +43-1-58801-3124, Fax: +43-1-5041497, email: katalinic@mail.ift.tuwien.ac.at, WWW: http://wwwift.tuwien.ac.at/~www311a/daaam.html

26-28 **ESS '98.** 10th European Simulation Symposium. Nottingham, UK
Contact: Philippe Geril, SCS European Simulation Office, University of Ghent, Coupure Links 653, B-9000 Ghent, Tel.: +32-9 233 77 90, Fax: +32-9 223 49 41, email: philippe.geril@rug.ac.be, WWW: http://hobbes.rug.ac.be/~scs/conf/ess98/index.html

December 1998

13-16 **WSC'98.** Winter Simulation Conference. Washington, D.C.
Contact: WWW: http://www.wintersim.org/

15 **1998 Annual Conference of ISCS**. Naples
Contact: ISCS, Univ. di Roma Tor Vergata, Via di Tor Vergata, I-00133 Roma, Tel.: +39-6-7259-7380, Fax: +39-6-7259-7460, WWW: http://remlab.dis.unina.it/iscs/iscs_hp.htm

January 1999

17-20 **1999 International Conference on Web-Based Modeling and Simulation**. San Francisco, USA
Contact: Agostino Bruzzone, DIP, Univ. of Genova, Via C. Colombo 6813, I-17019 Varazze, Tel.: +39-19 97 398, Fax: +39-19 97600, email: agostino@itim.unige.it, WWW: http://cpsi4.dibe.unige.it/~websim/webconf.html

February 1999

16-18 **ACPC99.** 4th International Conference of the ACPC. Salzburg, Austria
Contact: Dr. Andreas Uhl, University of Salzburg, RIST ++, Hellbrunnerstr. 34, A-5020 Salzburg, email: uhl@cosy.sgb.ac.at, WWW: http://www.coma.sbg.ac.at/acpc99/home.html

March 1999

1-2 **Meeting of ASIM FG5 "*Simulation Technischer Systeme*" and FG2 "*Simulationssoftware und -hardware*"**. Aachen, Germany
Contact: Dipl.Ing. Ewald Hessel, Hella KG Hueck&Co, Abt. EE-87, Werk II, Beckumer Straße, D-59552 Lippstadt, Tel.: +49-2941-388572, Fax: +49-2941-388427, email: hessel@hella.de

8-10 **7th Symposium "Simulation for managerial decision support"**. Braunlage, Germany
Contact: Prof.W. Hummeltenberg, Univ. Hamburg, Institut für Wirtschaftsinformatik, Max-Brauer-Allee 60, D-22765 Hamburg, Tel.: +49-40-4123 4023

April 1999

7-9 **UK Sim 99.** Fourth United Kingdom Simulation Society Conference. Cambridge, U.K.
Contact: Prof. Russell Cheng, Canterbury Business School, The University, GB-Canterbury, Kent CT2 7PE, Tel.: +44-1227-823665, Fax: +44-1227-761187, email: R.C.H.cheng@ukc.ac.uk

20-22 **BioMedSim'99.** 1st Conference on Modelling and Simulation in Biology, Medicine and Biomedical Engineering.
ModSim'99. Workshop on Modelling and Simulation Methods. ESIEE Noisy-le-Grand
Contact: Prof. Dr. Yskandar Hamam, Groupe ESIEE, 2 Bld Blaise Pascal, F-93162 Noisy le Grand, Tel.: +33-1 45926611, Fax: +33-1 45926699, email: hamam@esiee.fr, WWW: http://www.esiee.fr/~hamamy/bioconf.html and http://www.esiee.fr/~hamamy/confmodsim.html

June 1999

1-4 **ESM'99** European Simulation Multiconference. Warsaw
Contact: Philippe Geril, SCS European Simulation Office, University of Ghent, Coupure Links 653, B-9000 Ghent, Tel.: +32-9 233 77 90, Fax: +32-9 223 49 41, email: philippe.geril@rug.ac.be, http://hobbes.rug.ac.be/~scs/

August 1999

31-September 3
ECC 99. European Control Conference. Karlsruhe, Germany
Contact: Conf. Sec., VDI/VDE Ges. Meß- und Automatisierungstechnik, POB 101139, D-4002 Düsseldorf, Tel.: +49 211 6214 224, Fax: +49 211 6214 161, email: gma@vdi.de, WWW: http://ecc99.uni-duisburg.de/

September 1999

21-24 **ASIM'99.** *13. Symposium Simulationstechnik*. Weimar
Contact: Dipl.-Lehrerin Chr. Rieger, Bauhaus-Universität Weimar, Coudraystraße 13, D-99421 Weimar, Tel.: +49-3643-584251, Fax: +49-3643-584216, email: rieger@dracula.informatik.uni-weimar.de

February 2000

2-4 **3rd MATHMOD.** International Symposium on Mathematical Modelling. Vienna, Austria
Contact: Prof.Dr. Inge Troch, TU Wien, Wiedner Hauptstrasse 8-10, A-1040 Wien, Tel.: +43-1-58801-5367, Fax: +43-1-586 29 59, email: inge.troch@tuwien.ac.at, WWW: http://simtech.tuwien.ac.at/3rdMATHMOD/

September 2000

ASIM'2000, ESS'2000. *14. Symposium Simulationstechnik* together with European Simulation Symposium. Hamburg, Germany.
Contact: Prof.Dr. Dietmar P.F. Möller, TU Clausthal, Inst. f. Informatik, Erzstraße 1, D-38678 Clausthal-Zellerfeld, Tel.: +49-5323-72 2402, Fax: +49-5323-72 3572, email: moeller@informatik.tu-clausthal.de

June 2001

26-30 **EUROSIM'2001.** European Simulation Congress. Delft
Contact: M. Dekker-Genemans, Noordeinseweg 61, 2651 LE Berkel en Rodenrijs, The Netherlands, Tel: +31-10 51 12714, Fax: +31-10 51 13883, email: dekker@cp.tn.tudelft.nl

ARGESIM

ARGE Simulation News (ARGESIM), located at TU Vienna, is a non-profit working group disseminating information on simulation, organising activities in the area of modelling and simulation, publishing journals and books, and providing support for EUROSIM and ASIM administration.

One of ARGESIM's activities is the organization of seminars on Modelling and Simulation at TU Vienna. Mr. Manfred Schandl from the Computing Services of TU Vienna helped through many years in the organization – from buffet support to PC networking. Manfred retired in June 1998 and in a small ceremony in a pub in Vienna he was honored, becoming the first honorary member of ARGESIM. The photo, taken at the ceremony, shows Mrs. Husinsky, Mr. Breitenecker, Mr. Schandl (with plaque) and Mrs. Troch.

ARGESIM maintains WWW servers for EUROSIM, ARGESIM and ASIM:

`http://www.argesim.org/`

Individual subscriptions to SNE may be ordered via WWW at

`http://www.argesim.org/sne/subscribe.html`

EUROSIM - Simulation News Europe

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

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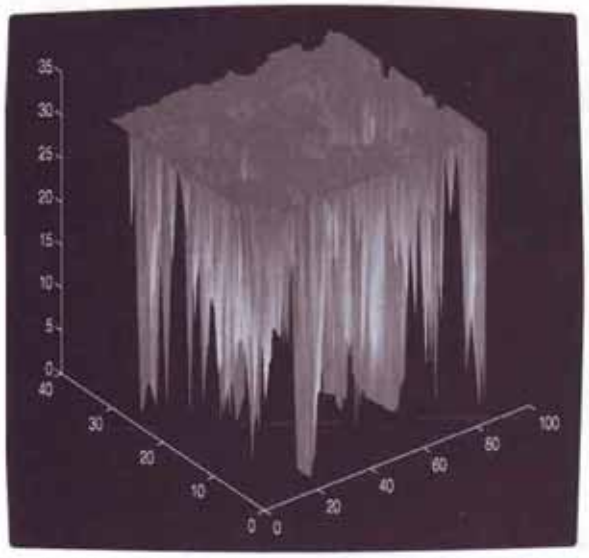

Dieser Oberflächenplot zeigt Stoßbeschädigungen einer Hubschrauber-Verbundwerkstoffstruktur. Zur Automatisierung zerstörungsfreien Prüfens klassifizierte die MATLAB Neural Net Toolbox Echos von Ultraschallsignalen. Die Daten wurden freundlicherweise von McDonnel Douglas unter einem AATD contract zur Verfügung gestellt.

Mit den MATLAB-Toolboxen, die von anerkannten Fachleuten entwickelt werden, können erprobte, dem neuesten Wissensstand entsprechende mathematische Vorgehensweisen erlernt und auf eigene Aufgabenstellungen angewandt werden.

Visualisierung kombiniert mit mächtigen Analysefunktionen

Leistungsfähige objektorientierte Grafik erlaubt interaktive Analyse und dynamische Modellbildung. Die umfangreichen Visualisierungsfunktionen umfassen 2-D, 3-D und 4-D Darstellung sowie Beleuchten von Oberflächen und Schattieren.

MATLAB
für ingenieurtechnische Aufgaben

MATLAB
MATLAB Compiler
MATLAB C Math Library
MATLAB C++ Math Library
Anwendungs-Toolboxen für:
Signalverarbeitung
Reglerentwurf
Financial Engineering
Bildverarbeitung
Datenanalyse & Modellbildung

Entwicklung von MATLAB-Programmen und standalone-Anwendungen

Umfangreiche GUI-Entwicklungswerkzeuge erlauben das individuelle Gestalten interaktiver MATLAB-Anwendungen.

Man kann MATLAB mit C und FORTRAN Programmen linken, Toolboxen einbeziehen, Daten mit anderer Software austauschen und MATLAB als ein Analyse- und Visualisierungs-Werkzeug einbauen.

Mit dem neuen MATLAB Compiler und der C Math Library lassen sich automatisch MATLAB-Algorithmen in standalone Programme umwandeln.

MATLAB 5 IST DA!

Weitere Informationen...

Nehmen Sie mit uns Kontakt auf, und fragen Sie nach kostenlosen, technischen Unterlagen zur MATLAB-Produktfamilie:

Tel.: 089/995 901 0
Fax: 089/995 901 11
http://www.scientific.de

Die Sprache der Ingenieure

MATLAB—eine leistungsfähige, schnelle, interaktive Software—

ist das beste Bindeglied zwischen Forschung und technischer Ausführung.

MATLAB ist eine Programmierumgebung für die Entwicklung von Algorithmen, Simulation und Analyse mit Visualisierung, numerischen Berechnungen und einer technischen Sprache.

Mächtig für Untersuchungen und Prototyping

In MATLAB werden Aufgabenstellungen und Lösungen so formuliert, wie es in der Mathematik üblich ist—ohne eine Zeile C oder FORTRAN Code zu schreiben.

Hunderte mächtiger Funktionen, die auf Effizienz und Zuverlässigkeit optimiert sind, sind mit einer leistungsfähigen und intuitiven Programmiersprache gekoppelt.

Fachwissen in MATLAB verfügbar

Toolboxen bieten eine große Auswahl an optimierten Funktionen für Datenreduktion, Analyse, Modellierung und Systementwurf.

Hinter vielen technologisch fortschrittlichen Entwicklungen steht die Sprache der Ingenieure und Wissenschaftler:

MATLAB

McDonnell Douglas verwendet MATLAB zur Entwicklung von automatischen zerstörungsfreien Prüfprozessen für Hubschrauber, wie z.B. den Longbow Apache

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• Geschäftsstelle München: Münchner Str. 24, 85774 Unterföhring, Tel.: 089/9959010, Fax: 089/99590111, E-mail: matlab.info@scientific.de
• Schweiz: Scientific Computers SC AG, Liebewiistr. 35, CH-3174 Thörishaus, Tel.: 031/8820288, Fax: 031/8820270, E-mail: info@scientific.ch

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