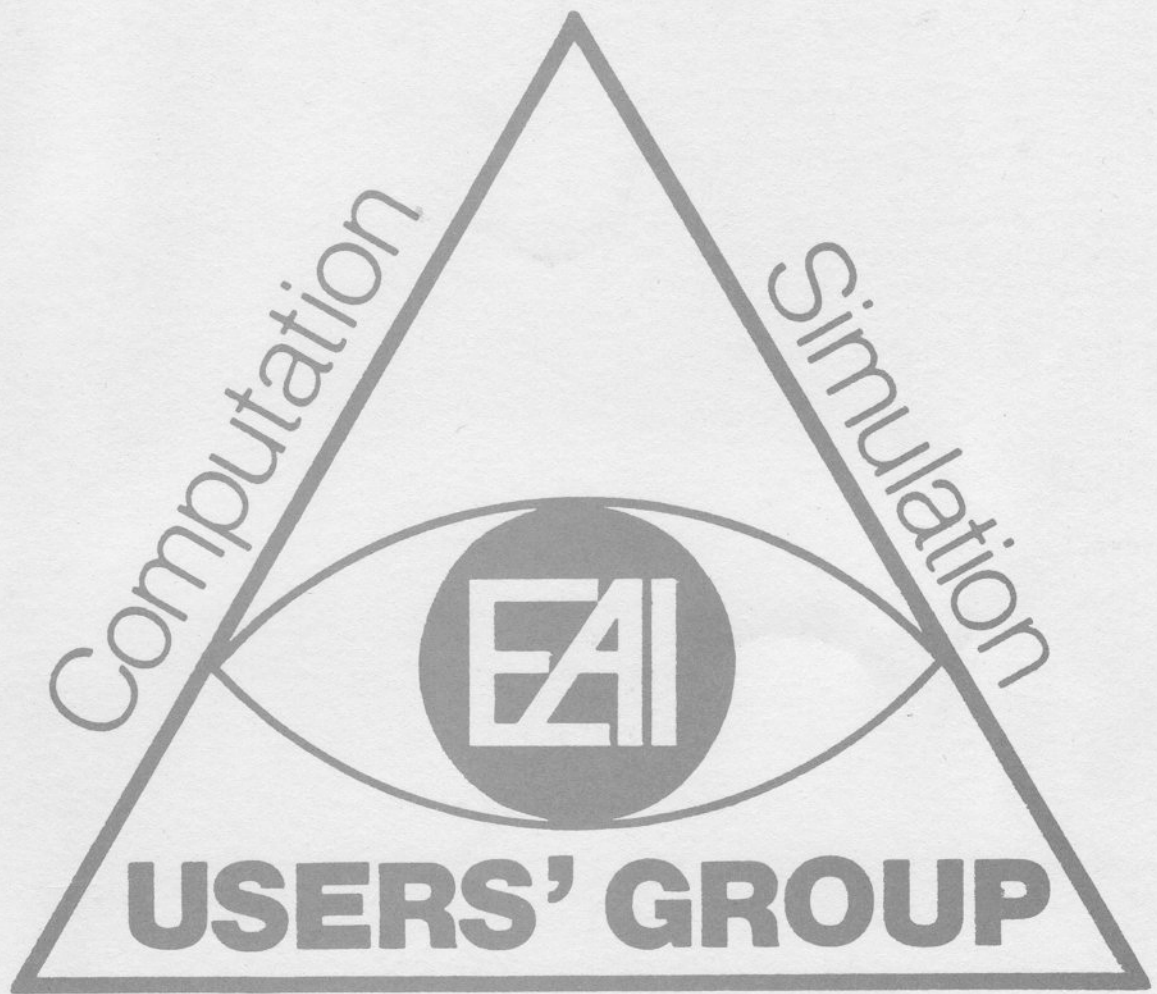


INTERNATIONAL CHAPTER



Communication

NEWSLETTER

- 14 th Edition April 1986 -

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Letter from the President

Dear User,

Here we are at the beginning of a new year planning the next meeting of the Users' Group.

The very successful meeting at Santa Margherita is described in this Newsletter and details are given of the next meeting to be held at Groningen. As the costs of this meeting will be quite reasonable we hope to have a good turnout particularly from the north and west of Europe. It is some time since we had anyone from Scandinavia at our meetings and they were very active in the early meetings.

The Users' Group started after a meeting of interested people in Holland in 1969 and we hope to have some of the original members spend some time with us at the meeting. I hope to see you there.

I cannot say often enough that your Board is anxious to hear from you about the form you feel both the meetings and the Newsletter should take. We considered issuing a questionnaire but decided to postpone it in the meantime. The new form of the flyer for announcing the next meeting was designed by Irmgard Husinsky after comments from users at the meeting at Santa Margherita. I like it and am sure you do too.

I look forward to hearing from you and, hopefully, seeing you at Groningen.

Best wishes for 1986,
Yours sincerely,

Anne I. MacKinnon
Dept. of Electronics and Electrical Engineering
University of Glasgow

President
EAI Computer Users' Group
International Chapter

Editor's Page

Dear User,

This Newsletter gives you an extensive report of the Users' Group Meeting 1985. This time user presentations covered a wide range of applications of analog and hybrid computers. EAI's presentations concentrated on applications of the new SIMSTAR Multiprocessor. I would like to say many thanks to all the authors of the presentations who provided abstracts.

Other topics of this Newsletter are news from the North American Chapter. Europe's first SIMSTAR is introduced by a few pictures. To remind you of the aims of the Users' Group the articles of our organization are published here. Although many of you may have already received the information the questions put to EAI at the 1984 meeting and the respective answers are published for the first time in this Newsletter.

I would like to draw your special attention to the invitation to the next Users' Group Meeting on page 39.

One user is looking for a special software. Maybe you can help him (page 16).

If you have any comments or suggestions concerning the activities of our Users' Group don't hesitate to contact Miss MacKinnon or me. Please note our new telephone numbers.

Sincerely Yours

Irmgard Husinsky
Hybridrechenanlage
Technische Universität Wien

Vice President, Editor of the Newsletter
EAI Computer Users' Group
International Chapter

MINUTES OF THE EAI COMPUTER USERS' GROUP MEETING

October 2-4, 1985, Genova / Santa Margherita, Italy

This report of the meeting is based on the abstracts obtained from the authors of the presentations and the editor's recordings. Due to the excellent organization of Mr. Marras, Ansaldo Componenti, this was again a very successful meeting. 27 attendees came from eight countries. A list of participants is given on page 36.

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Ansaldo Componenti, Genova Sampierdarena

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Santa Margherita Ligure

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SIMSTAR SESSION
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M. Minne, KWU Mülheim/Ruhr

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K.H. Fasol, Ruhr-Universität Bochum

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Efficient Application of the SIMSTAR Non-Homogeneous Multiprocessor
to Large-Scale Simulation Studies
P. Landauer, EAI West Long Branch

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CLOSING SESSION
Chairman: A. MacKinnon

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Delegates were welcomed by Anne MacKinnon, the President of the Users' Group, who addressed the users with the following words:

"I would like to welcome all participants to the EAI Computer Users' Group meeting at Genova, Santa Margherita.

This year our numbers are slightly smaller than last year but as one of our members said, "It is the quality that counts".

I would like to thank Ansaldo very much for arranging the meeting. I am sure we are all going to find it very worthwhile.

We have established the custom of introducing ourselves and our equipment. I think we should now do this."

After the introductions Mr. Lipari addressed the users. This was his welcome address:

"Ladies and Gentlemen:

Good afternoon to everybody.

My name is Michele Lipari, and in Ansaldo Componenti I hold the position of machining and assembly Manager of the Power Generation Division.

I am proud to welcome, on behalf of Ansaldo Componenti's top management, this group of engineers and professors who have accepted our invitation to hold their meeting in Genova. And, to this I add my own personal welcome.

My friend Dino Marras has spent a lot of time organizing and meticulously preparing the details of the next three days in order to ensure that you have a maximum of comfort. And at the closure of this meeting I am sure that we will be able to say that Dino Marras has done a really good job.

In addition, I hope that you will enjoy the natural and touristic interests offered by Liguria and Genova as well as the temperate climate found in this part of the Mediterranean.

While, for the main part, the success of this meeting will depend on the level of interest aroused by discussion of similar experiences during these three days, the meeting will be completely successful for the people from Ansaldo if we are also able to give you a better knowledge of our company.

It is with pleasure that we take this opportunity because of the high level of technical expertise and long established traditions which distinguish all divisions of this group.

To trace the origin of the Ansaldo Company one must go back to 1853 to the engineering workshop of Sampierdarena (where we are) which represented the first manufacturing centre and in which the company started its industrial activity by manufacturing the first marine boilers and the first steam locomotive, productions for which the plant very soon enjoyed a remarkable reputation.

Subsequently the manufacture of propelling machinery, both steam turbines and diesel propelling apparatus started. Three large shipyards were added to the existing engineering works for the construction of ships, both merchant and military. (It is at this point that I should like to remember the biggest one, the passenger ship named REX with its propelling machinery of 136000SHP built in 1933.)

Gradually these productions have been transferred to other companies and stationary thermo and thermoelectro power stations have taken their place.

Ansaldo is today the main Italian thermoelectro-mechanical and nuclear industry with an engineering and manufacturing capacity covering over 50% of the total national production in this sector.

Mr. Marras will now explain in detail the actual structure of the Ansaldo Group of which Ansaldo Componenti is part."

A brief Survey of Ansaldo Organization and Activities

by D. Marras, Ansaldo Componenti

ANSALDO was founded in Genova in 1853 and is today the main Italian thermoelectro-mechanical and nuclear industry with an engineering and manufacturing capacity covering over 50% of the total national production in this sector.

ANSALDO is the leader company of FINMECCANICA, the main holding company of IRI in the sector of mechanical industry. IRI is an institute of the Italian Ministry of State Participants which operates in different areas like banks (Banca Commerciale Italiana, Banco di Roma, Credito Italiano, etc.), steel (Fincantieri), shipping (Finmare), air transport (Alitalia), etc.

FINMECCANICA owns also Alfa Romeo (automotive sector), Aeritalia (aerospace sector) and Stabilimenti Meccanici VM (diesel engine sector).

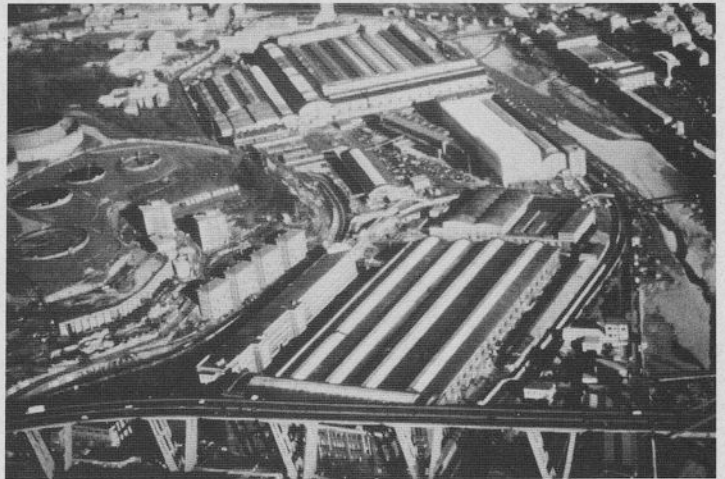
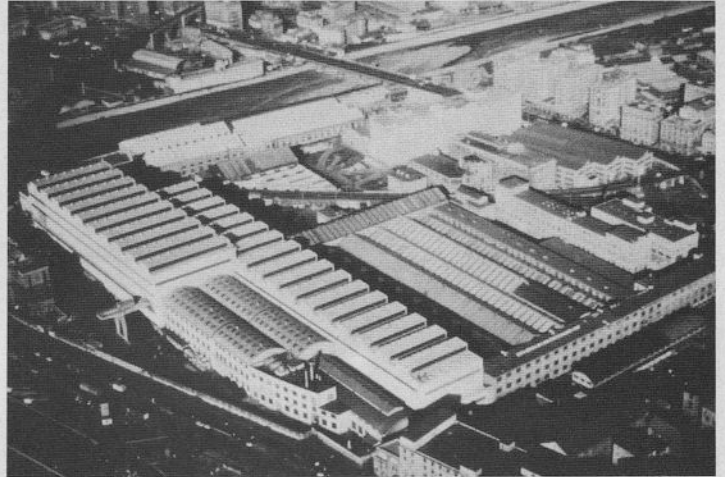
ANSALDO organization has two engineering divisions (Impianti and NIRA) and many other companies like Elettronica di Potenza, Ansaldo Transporti, Ansaldo Componenti, etc. as well as different associated companies, such as Esacontrol, Elsig, GIE, etc.

The main activities of ANSALDO in the different sectors are:

Electric transport	10%
Sundry industrial sector	20%
Energy	70%

The companies which operate in the ANSALDO energy sector are Ansaldo Impianti Division, Nira Division, Ansaldo Componenti, Cern, Aerimpianti, Sopren, Termosud.

The manufacturing activity covers the following products: components for nuclear reactors, boilers, turbines, generators for hydro-thermo, nuclear, geothermal, diesel and gas driven power plants, power transformers, nuclear reactors up to higher ratings, conventional and super conducting magnets.



Visit to the Steam Turbine Manufacturing Area and Analog Computer Facility

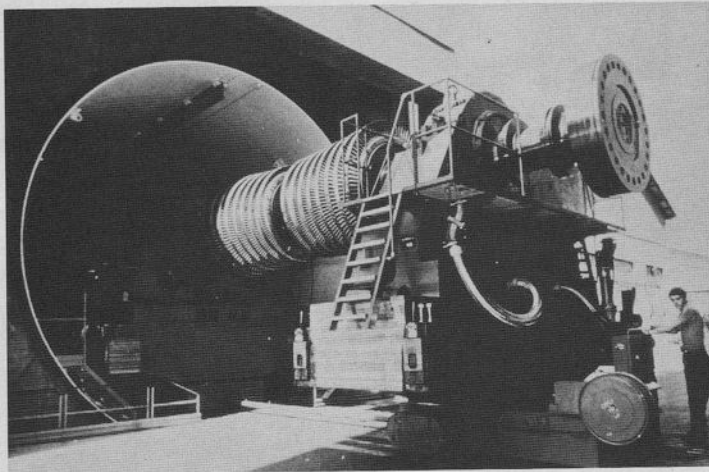
The participants of the Users' Group Meeting had the opportunity to visit the turbine manufacturing area of Ansaldo in Sampierdarena.

We first visited the balancing and overspeed test facility for steam turbine and generator rotors and the control room.

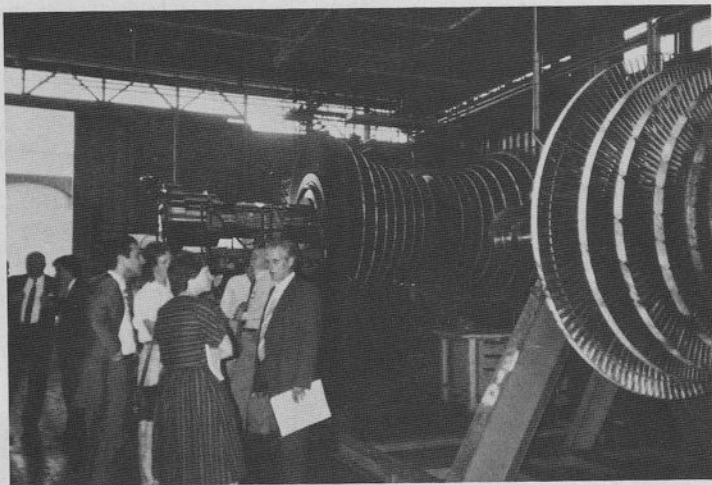
Then we went to the assembly shop where the most important components of the turbines are assembled. The workshop is equipped with benches and large cranes, operating on two levels with a lifting capacity of over 200 tons. In this shop the wheels of the LP nuclear turbines are shrunk on their shaft in vertical position in order to have a more shrinking force distribution. After assembling all rotors are balanced at the nominal speed and overspeed.

We visited also the machining shop, equipped with horizontal and vertical lathes, NC horizontal boring machines and a planner milling machine with three heads controlled along eight directions and a moving table 18 meters long.

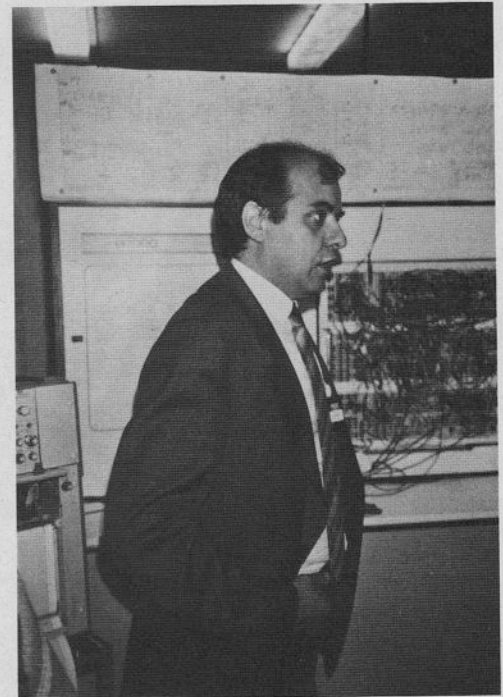
Finally we saw the simulation facilities with two EAI 2000 computers where a dynamic model of the turbines was running. The model is connected with the real electronic control system and the actuator. The control system is checked by the real-time simulation and adjusted in order to have correct behaviour. The simulation was demonstrated.



Balancing and Overspeed Test Facility



In the Assembly Shop



D. Marras

Afterwards a bus brought us to Santa Margherita Ligure, 35 km east of Genova, where the meeting would continue.

Report of EAI

by P. Landauer, EAI West Long Branch

Mr. Landauer first apologized for the fact that Mr. Wright and Mr. Mawson could not be at the meeting. They sent their regrets.

EAI covers the following areas:

- simulation computers
- service business
- contract manufacturing

To give an idea of the company organization Mr. Landauer mentioned the key people of EAI.

The present EAI products are:

- EAI 2000
- HYSHARE 2000
- SIMSTAR
- Function Generation Package

Some details about the following new products were introduced:

The SIMSTAR Standalone Computer:

- * Basic SIMSTAR System for Smaller Laboratories
- * Starter System Toward Simulation Center
- * Requires Disk/Line Printer
- * Built-in 15kHz A/D/A Data Conversion
- * Supports Full STARTRAN Programming System
- * Expandable with HOST Interface Package

Under Development: Function Generation Processor:

- * Direct Hardware Implementation of FGSYS Processing
- * Single Precision Floating Point
- * Up to 128 Functions of 1,2,3,4 Variables
- * From 256 - 1024 K Words of Function Memory
- * Shared Memory Interface to DAP in SIMSTAR
- * Approximately 8 MFLOPs Processing Speed
- * Up to two Units per Shared Memory Interface

There was a question from the users: the number of breakpoints is limited to 64.

Under Development: STARTRAN Release 1.5 (000):

- * PTRAN Language Support of:
 - SINE/COSINE Math Computing Block
 - Triple Multiplier
 - Function Generator
- * Real-time DAP Simulation Language
 - ACSL Compatible Syntax
 - Automatically Implemented Data Conversion
 - Interrupt Driven Derivative Calculations
- * Complete SIMSTAR Run-time Executive
- * Release - December 1985

SIMSTAR Status Report

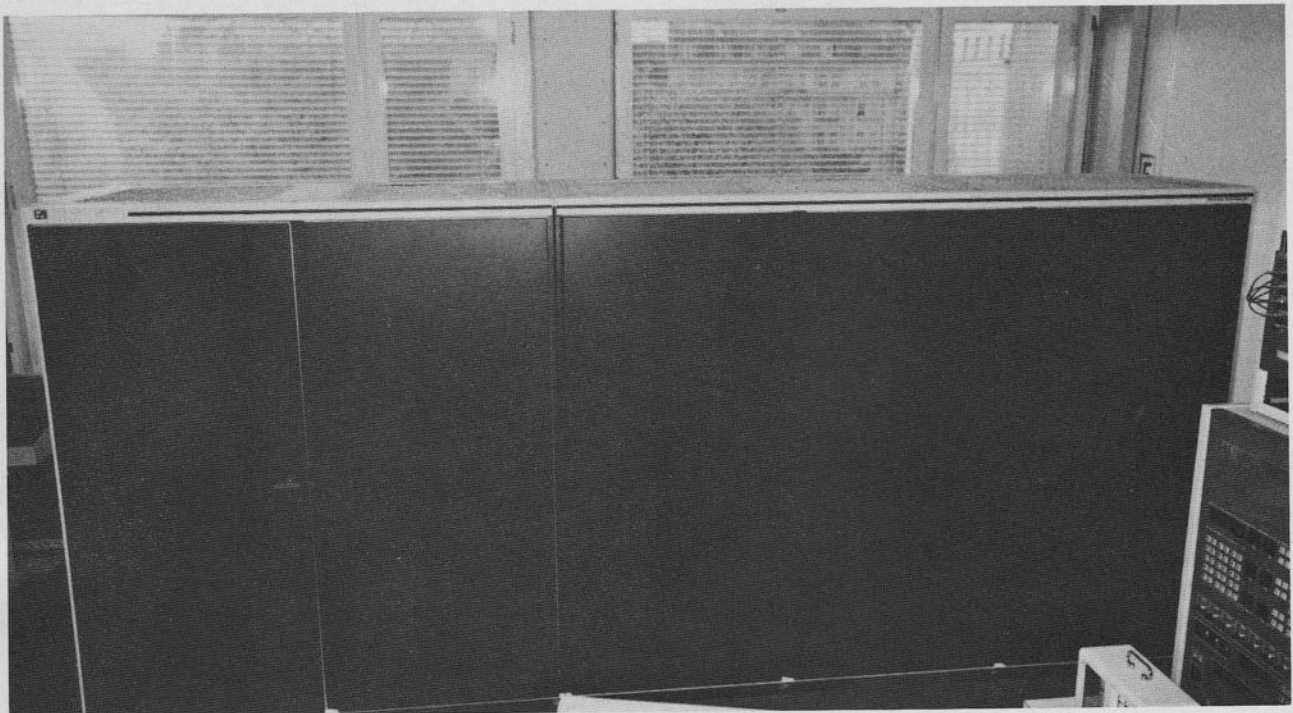
by F. Kaczala, EAI Paris

Historical Overview of the SIMSTAR program:

- 1975-1980 Presentation of an Autopatch extension possibility for the 680/681 computers
- 1981 Definition of a new simulation equipment to replace the PACER 600 and PACER 700 line of products
- 1982 DIANA marketing program presentation to major customers and at the Users' Group meetings in Europe and USA
- Jan 1983 SIMSTAR program approved by EAI board of directors
- July 1983 SIMSTAR introduction to USA market (WSCS conference Scottsdale, USA)
- Sept 1983 SIMSTAR introduction to international market (ESC conference Aachen, Germany)

SIMSTAR orders (September 1985):

order date	units	customer	application area	installed
Nov 1983	1	Westinghouse, USA	nuclear power plant controls	x
Dec 1983	1	MICOM (US Army)	missile studies	x
Feb 1984	2	MICOM (US Army)	missile studies	x
May 1984	1	TU Vienna, Austria	robotics, controls	x
Aug 1984	1	NCSC (US Navy)	torpedo studies	x
Dec 1984	1	Eastman Kodak, USA	controls of motors	x
Feb 1985	3	Martin Marietta, USA	missile studies	x
Mar 1985	2	(Name not released, USA)	-	x
May 1985	1	Nissan Aerospace, Japan	missile control studies	
Jul 1985	2	w/PAF Inst.of Technology, USA	flight system	



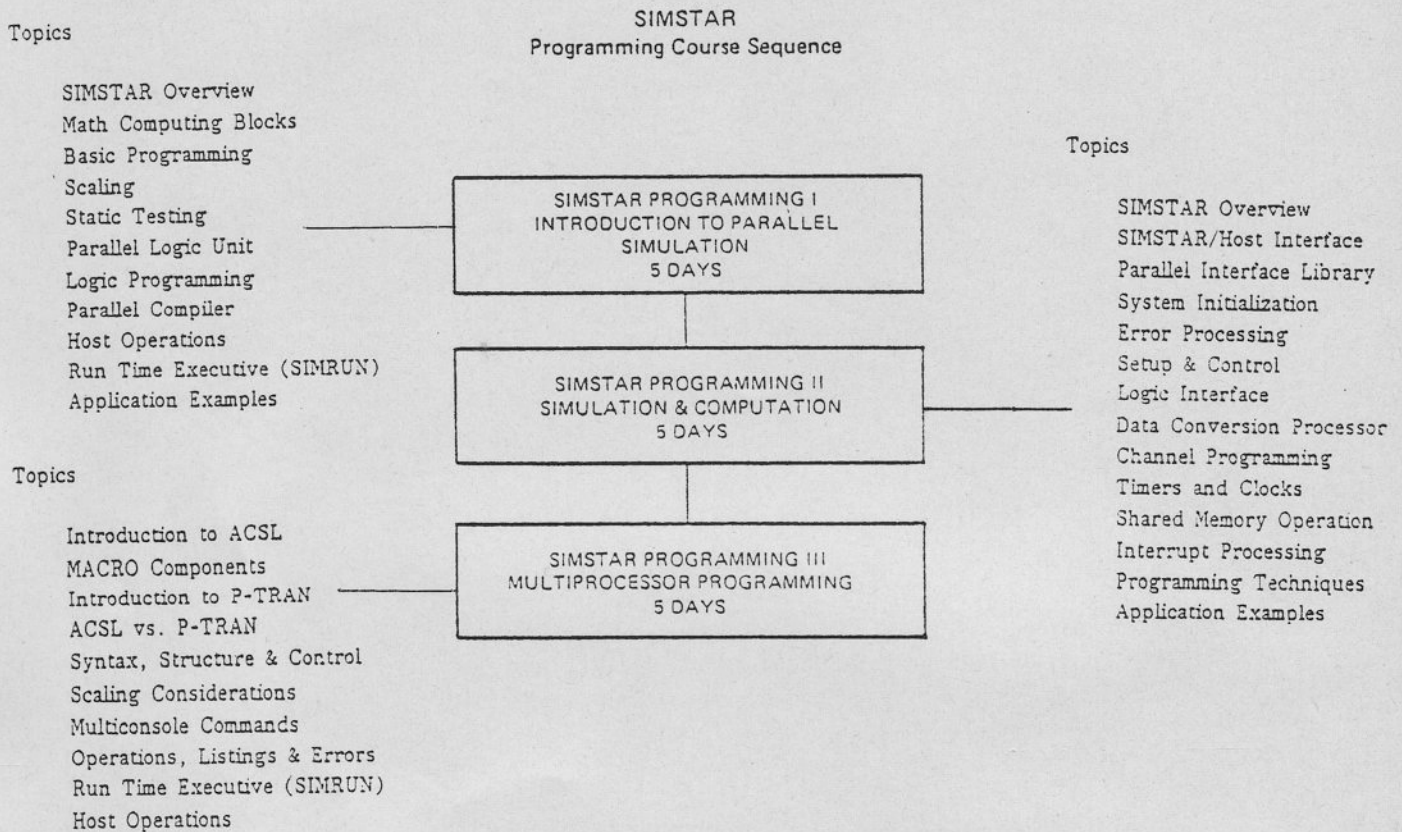
EAI SIMSTAR at TU Vienna

SIMSTAR Training and Maintenance

by F. Kaczala, EAI Paris

EAI offers the following courses for customers. The courses are held in West Long Branch, New Jersey, but can also be organized at the user's site.

A. Three weeks SIMSTAR programming course:



B. SIMSTAR rapid orientation (one week):

The course comprises five days of lectures reinforced by demonstrations.

Many of the concepts and techniques that are employed by programmers of conventional hybrid computing systems are directly transferable to SIMSTAR. For that reason, this course has been designed specifically for experienced hybrid programmers. This course, relying on the student's associative reckoning while omitting much of the theoretical basis and hands-on laboratory experimentation, provides the student with a comprehensive, albeit rapid, orientation towards programming SIMSTAR. Upon completion of this course, the student will be able to use SIMSTAR's multiprocessing capabilities to simulate continuous systems.

This course is intended for engineers and scientists who have significant experience in programming contemporary hybrid computing systems.

The topics are: SIMSTAR overview, Mathematical Computing Blocks, Parallel Logic Unit, Data Conversion Processor, Shared Memory, Parallel Compiler (SIMCOM), Parallel Translator, Parallel Interface Library, Run-Time Executive (SIMRUN).

The majority of the SIMSTAR customers want EAI to do the service of their computers. But EAI also offers a maintenance course. This is a ten weeks training sequence.

For more detailed information contact your local EAI office.

Family of Digital Arithmetic Processors in SIMSTAR

by P. Landauer, EAI West Long Branch

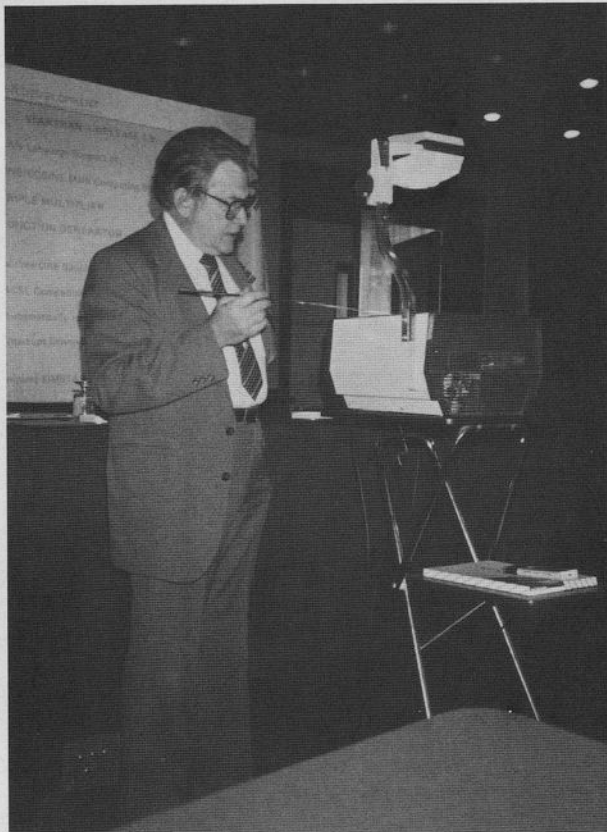
To meet the requirements of a broader range of applications, the entire family of Gould CONCEPT 32 digital processors can now be integrated into the EAI SIMSTAR multiprocessor. The original built-in Digital Arithmetic Processor (DAP) provides the most economical choice up to about 1 million operations-per-second (MOPS). The Host could be used in the solution loop but can only be supported in FORTRAN.

By choosing a 32/67 or 32/97 as the DAP, a performance up to about 4 MOPS can be completely integrated in SIMSTAR using the entire STARTRAN programming system. An IPU can be further utilized with semaphores in FORTRAN. The Host can also be added in real-time by incorporating the Gould MSX*2 shared memory. Again, this is presently supported only in FORTRAN using semaphores.

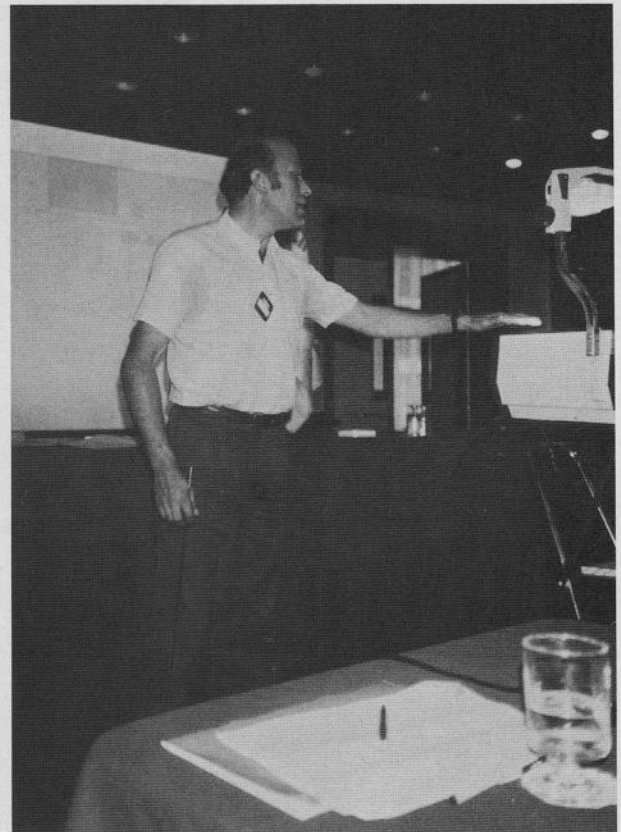
The Data Conversion Processor can communicate with up to two PSP's and all of the digital processors. The same specialized SIMSTAR interrupt processing and SIMIOCS resident multiprocessor communication system operates with the complete family of CONCEPT computers.

In most cases, the 32/67 CACHE memory operates satisfactorily in real-time. Since the 32/97 is very fast, unrepeatabe CACHE hits in an interrupt environment may require the addition of Shadow Memory for the DTRAN program.

Combined with the new floating-point Function Generation Processor (DMFG), the total digital power of SIMSTAR is increased from 1 MOPS to about 25 MOPS. This balanced digital processing opens new opportunities for effective utilization of the parallel processing power of SIMSTAR all supported in one high level programming language.



P. Landauer



D. Meerkamp

Short-form Overview about the GOULD Concept 32 Product Line

by D. Meerkamp, EAI GmbH Aachen

The following is intended to serve as a global overview about GOULD's present line of Concept 32 computers, used by EAI as DAP (Digital Arithmetic Processor) in the SIMSTAR as well as the digital part in EAI-2000 based hybrid systems. In addition the GOULD Concept 32 series can serve as Host for the EAI SIMSTAR Simulation Multiprocessor.

The CONCEPT 32 family comprises three product lines:

- CONCEPT 32/27 at the low-end
- CONCEPT 32/67 in the mid-range
- CONCEPT 32/97 at the high-end.

The performance range of the CONCEPT family extends from 0.5 MIPS of the 32/27 to more than 10 MIPS of the 32/9780 (see Fig. 1).

Of great importance is the fact that the CONCEPT 32 family provides consistent upward compatibility of the interfaces, controller, peripheral devices and software to assure the user future growth in application capacity. Hardware compatibility is obtained through the modular design of the computers. All the members have the same high-speed SelBUS which accepts the same memory modules and high-performance interfaces and controllers. They also use the same Input/Output Processor (IOP) for the medium-speed I/O subsystem (see Fig. 2).

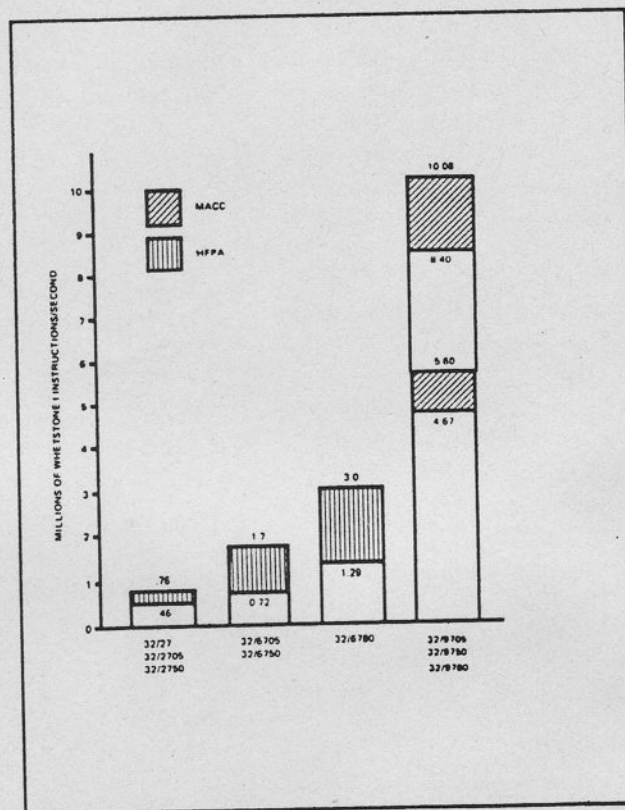


Figure 1
Relative Performance of the
CONCEPT 32 Family

The high-speed synchronous SelBUS has a transfer rate of 26.67 MB/sec. The CPU, main memory, high-performance controllers/interfaces and the IOP interface with the SelBUS. In addition to the SelBUS the CONCEPT 32 family has a second bus, the medium-speed Multipurpose Bus (MP Bus). It is generated by the IOP, a standard feature of each member. This dual-bus structure allows great flexibility in system configuration.

Software compatibility is obtained by implementing the same operating system on all the members of the CONCEPT 32 family. Two operating systems are supported: MPX-32 (used for SIMSTAR) and an authorized version of Bell Laboratories' UNIX, UTX/32. While MPX-32 is more oriented towards real-time applications, UTX/32 is a time-sharing, general purpose operating system.

Brief Outline of three CONCEPT 32 Product Lines

The CONCEPT 32/27 product line has three members:

- CONCEPT 32/27
- CONCEPT 32/2705
- CONCEPT 32/2750

These members are similar except for the packing which allows greater expansion for the 32/2705 and for the 32/2750:

- 32/27: single 15 slot processor chassis, maximum 4 MB memory
- 32/2705: 18 SelBUS slot chassis and one I/O expansion chassis with 8 MP Bus slots, maximum 8MB memory
- 32/2750: two 18 SelBUS slot chassis and one I/O expansion chassis, maximum 16 MB memory

Both the 32/2705 and the 32/2750 may be optionally expanded with a Hardware Floating Point accelerator (HFPA).

The CONCEPT 32/67 product line has three members:

- CONCEPT 32/6705
- CONCEPT 32/6750
- CONCEPT 32/6780

Again, the members differ in their expansion capability. The maximum main memory ranges from 8MB (for the 32/6705) to 16MB (for the 32/6750 and the 32/6780). The 32/6780 comes with a CPU and an Internal Processing Unit (IPU) resulting in a significant speed-up of the total system. All three members may be optionally expanded with a Hardware Floating Point Accelerator.

The CONCEPT 32/97 has three members as well:

- CONCEPT 32/9705
- CONCEPT 32/9750
- CONCEPT 32/9780

The CONCEPT 32/97 utilizes ECL-based CPUs. Important features contributing to the outstanding performance of the 32/97 members are:

- built-in Floating Point Processor
- Multiply Accelerator (MACC)
- up to 64KB of eight-way set associative cache memory per processor
- up to 256KB of shadow memory per processor
- internal processing unit (IPU).

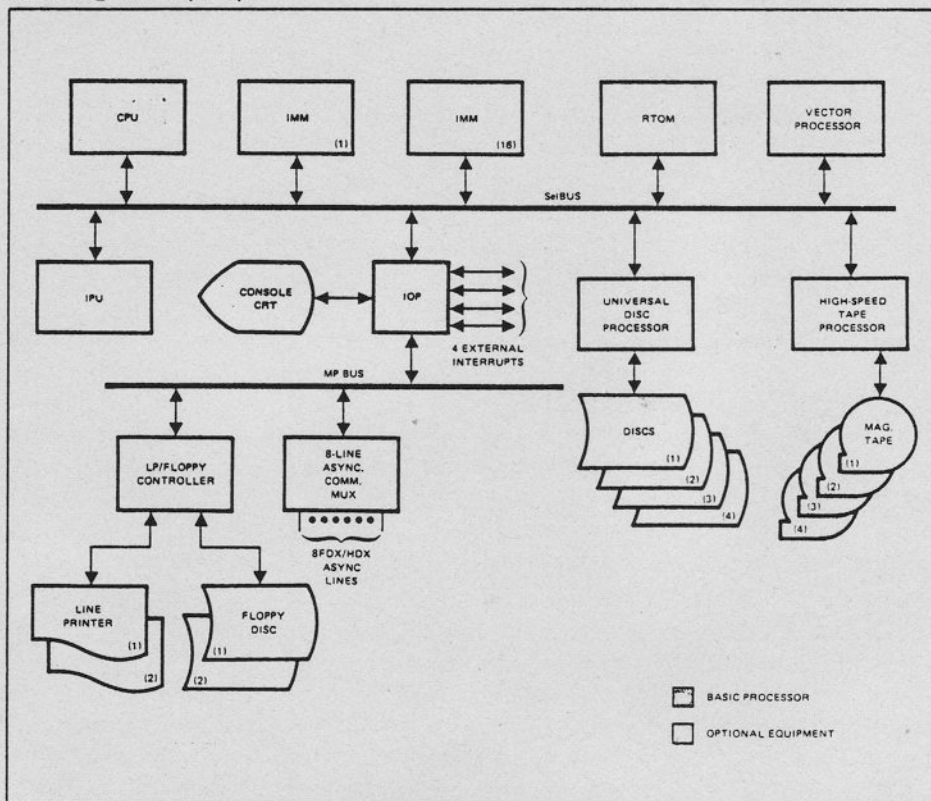


Figure 2
Gould CONCEPT 32 Family General Configuration

Experiences with SIMSTAR - First Report by W. Kleinert, Technische Universität Wien

The Hybrid Computation Centre of the Technical University of Vienna (TU) provides simulation tools to a variety of users within and outside the University. It covers not only the field of hybrid computation but also other simulation languages on different types of computers.

INSTALLATION

The autor considers the SIMSTAR a very perfect modern state-of-the-art replacement of an automatized analog computer. The order for a SIMSTAR was placed in Mai 1984. In December 1984 acceptance tests took place in West Long Branch. The system was delivered in January and March 1985. Final installation and acceptance tests were performed on March 16, 1985. The author wanted especially to mention Mark Demoresky, the EAI installation engineer, who did a particular good job on the installation.

DESCRIPTION

TU Vienna's SIMSTAR has the following specifications:

- Stand Alone System
- no DCP (- a so-called 'Poor Man's System')
- smallest DAP (32/27),
in the meantime a 160 MB Fixed Disc has been added, also an 8 Line Asynchronous Unit and 2 Lines permanently connected to the TU-Ethernet
- LCU, 0.5 MB have been added
- PSP: half size matrix with the following components:
 - 28 MINT (integrators/track stores/first order lag, var. limit)
 - 18 MULSUM (multipliers/dividers/square root with variable limit plus dual switch summers)
 - 10 MSUM (4 input summers with variable gain and limit)
 - 12 MCOMP (comparators)
 - 32 trunk inputs
 - 64 trunk outputs

Function generators are planned to be built at the University.

ACCEPTANCE TESTS

Acceptance tests were made based on EAI specifications, where as reliability measure EAI provided internal statistics on the static and dynamic accuracy of the delivered macros.

In addition special performance tests were defined by the author, guided by a 17 year experience in analog accuracy problems. In order to test the accuracy of the new analog computer the main emphasis was put on artificial problems with known mathematical results. Only one of the five test programs was a user application (highly oscillatory system). The results have been compared with results obtained from the hybrid time-sharing system MACHYS (Multi Access Hybrid System) based on the EAI PACER 600 Autopatch System.

In the presentation these performance tests have been described shortly and the results have been discussed. On the whole the SIMSTAR solution produced the results quite accurately whereas the old system showed considerable phase shift errors, overloads etc. Also satisfactory end value tests have been made with SIMRUN for different time scales.

The result of the comparison of extreme test programs showed the superior accuracy of the new system (SIMSTAR) while the MACHYS system behaves like other classical analog computers in regard to its computing accuracy. A detailed description of the performance tests is given in INTERFACE 22, Technische Universität Wien, Hybridrechenanlage, June 1985, pp 18-21.

RELIABILITY REPORT

Up to now no errors occurred at the DAP CPU, the LCU, the PLU.

The greatest problem was a disc controller failure (on the Gould part, bad soldering in SMD adapter) which caused a lot of trouble, especially in file handling.

On the PSP the SIMSTAR Automatic Test System SATS runs daily since April. One error that could not be detected by SATS was a faulty chip on a middle block card. According to these SATS diagnostic runs (static part only) the following classes of errors can be defined:

Class 1 errors: elements slightly out of specifications (Global Tolerance Factor $GTF < 1$)

- most of them vary randomly from day to day, possible reasons are:
noise on ground, high frequency noise, etc.
- few of the macros show permanent class 1 errors (are supposed to be out of specifications): 3 MINT, 1 MULSUM

Class 2 errors: elements out of specifications ($GTF \geq 1$)

- 1 MINT (since April, was successfully repaired)
- 1 MULSUM (since May 30, came still bad back from West Long Branch)

Class 3 errors: elements defective

- 1 MSUM (since April 1, was successfully repaired)
- 1 MULSUM (since May 20, was successfully repaired)
- 1 MINT (since July 8, is not yet repaired)

PROBLEMS WITH SATS

In experiences with daily runs of SATS the following problems appeared:

The dynamic part of SATS is still not available (it was scheduled for March 1985). The TIDE and integrator rate tests are not automatized and too complicated to be done preventively. For the switch matrix test a better algorithm would be necessary.

The deallocation mechanism was found to be very impractical: Most macros with class 1 errors could be used in many applications (e.g. if only the limiter networks are out of specifications). A lab manager should be able to deallocate individual components.

SOFTWARE INTEGRATION

For many years HYBSYS 5 TS is being used as simulation software system on a time-sharing base on the PACER 600 Autopatch system. This software system is highly interactive, also in the modelling process and supports extensive graphics and sophisticated experiments. Now similar facilities have to be provided for TU Vienna users on the SIMSTAR.

The software integration of SIMSTAR into the hybrid programming system at the Technical University of Vienna is now in progress. HYBSYS 6 MPX will have a new design, will be written in FORTRAN 77 and will run on the 32/27 DAP. The time schedule provides for a single user version in February 1986 and a multi user time-sharing version in September 1986.

CONCLUSIONS

In the meantime access to the old PACER 600 Autopatch based time-sharing system is still provided (also over TU-NET).

A selected group of users with applications in robotics are using SIMSTAR with EAI software.

The EAI software release D00 is impatiently waited for, where PTRAN errors should be removed and SIMRUN should have graphic capabilities.

Also a PGS version without recataloging each model change (7 to 11 minutes realtime!) is awaited.

Working Group

There was a working group on EAI 2000 systems. The answers to last year's questions (see also page 40) were discussed.

As an extension to last year's question number 1 the following question was asked: Why is the patchcord replacement limited to one dozen and not related to the purchased quantity of each customer? EAI representatives answered that there should not be a problem related to the quantity of the replaced patchcords. EAI does not know how many patchcords each customer has and is willing to make an agreement with the customer.

It was criticized that last year's question number 2 was not properly answered. The following question arose: What happens if one of the REP-OP timer values is set to zero: does it still jump for a very short time in that mode or does it not?

The president of the Users' Group is raising the matter with EAI and will report to the next meeting.

PDP 11 users were unhappy at lack of support. The president had received copies of educational notes and agreed to send copies to Mr. Schemmann and Mr. Meerkamp.



Working Group



Park Hotel Suisse, Santa Margherita

The Technical University of Graz, Austria has a hybrid computer EAI 2000/3200 (SEL 32/77) and uses RTM 7.2. EAI does not provide ECSSL software for this configuration any more. Anyone who can provide a copy of an ECSSL version for this configuration should please contact

Mr. Gerhard Walzel
Institut für Elektromagnetische Energieumwandlung
Technische Universität Graz
Kopernikusgasse 24
A - 8010 Graz, Austria

Tel.: 0316/7061 7248

SIMSTAR Nonlinear Oscillator

by P. Landauer, EAI West Long Branch

INTRODUCTION

This simple SIMSTAR example used the STARTRAN 1 software for programming and operation. The equation uses balanced positive and negative feedback to maintain a constant amplitude of oscillation. Frequencies over 5 hertz in real time or up to 2.5 KHZ at 500/1 faster than real time can be handled. The results in real time can be plotted on a strip chart recorder and the high frequencies can be displayed on a two channel oscilloscope. While the repetitive solution is displayed, the user can continue to interact through SIMRUN to investigate parametric changes.

APPLICATION

The basic nonlinear oscillator equation is

$$AX + BX^2 + \ddot{X} = 0$$

There is an initial condition on X which produces a constant asymmetric oscillation in X depending upon the value of B. This problem was first run in ACSL to determine practical ranges for the state variables and then the additional PTRAN statements were added as shown in Figure 1.

The three logic equations for LIC, LMONO, and LTERM were used to control the PSP Mode automatically for repetitive solution and display on the oscilloscope as identified in REC2. The T variable (time) feeds the Horizontal while Display Variables X and XDOT feed two of the four available channels. Channels 1 and 4 are biased to provide axes for channels 2 and 3.

The Command File was prepared in the Editor to provide simple control of the problem from SIMRUN as shown in Figure 2. A basic run is included in the PTRAN program for BETA=1, TRUN=1, A=500, and B=0.01.

Results of running the Basic Run and after the R2 conditions are established are shown in Figure 3 and 4. It can be seen that this is about 4 - 5 hertz which is actually 22 - 28 radians per second.

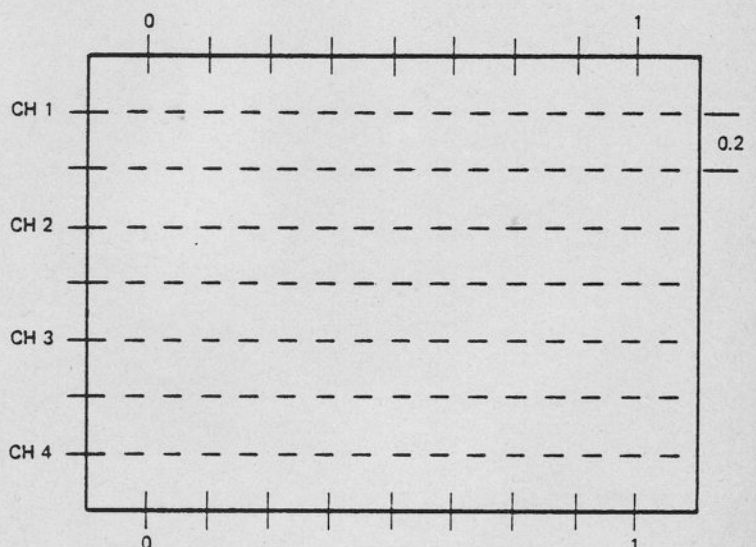
The last command procedure P speeds up the solution by 100/1, adjusts the run-time, and the scale factor for the run-time. Then, it activates the Parallel Processor (PP) mode which allows the logic circuit to control the integration. At this point, solutions containing 4 - 500 hertz frequencies are displayed with a 20 millisecond repetition period. Interactive parameter changes can then be made to study the equation.

APPENDIX

The four channel oscilloscope has been wired into SIMSTAR on Recorder 2 as follows:

- | Channel | |
|---------|--------------------------------------|
| 1 | Horizontal Input (0 - 1.0) |
| 2 | Top Channel ($\pm 0.2/\text{DIV}$) |
| 3 | Second Channel |
| 4 | Third Channel |
| 5 | Bottom Channel |

Each channel is separated by two divisions on the CRT. Note that 1.0 in the Horizontal is actually 9 volts. Also, the scaling of each channel is 1.8 volts/division. By proper specification of biasing and scaling of each channel, it should be possible to create any desired display without changing any settings on the oscilloscope. Of course, this can include crossplots in which one variable is assigned to X. There is presently no means for blanking the screen.




```

*PSP=1,0,ERR=FAT
*TITLE
  NONLINEAR OSCILLATOR
  PREPARED BY J.PAUL LANDAUER : 12 MAR 1985
*INPUT

```

PROGRAM

```

'@BETA(BETA)'
LOGICAL LIC, LMONO, LTERM, ICO
CONSTANT TO = 0, BETA = 1, TRUN = 1
CONSTANT ICO = .TRUE., ICTIM = 0.001
CONSTANT A = 500, B = 0.01
CONSTANT XO = 18, XDOT0 = 0
' @MAXVAL T = 10.0, BETA = 1, TRUN = 10 '
' @MINVAL T = 0.0, BETA = .002 '
' @MAXVAL A = 1000, B = .1 '
' @MINVAL A = 100, B = 0 '

DYNAMIC $ DERIVATIVE $ '@PARALLEL'
' TARGETTING '
' @MAXVAL X = 40, XDOT = 1000 '
' @MINVAL X = -40, XDOT = -1000 '
' @SCALE DX = 100, DXDOT = 2500, D1=1, D4=1 '
XDOT = INTEG( -A*X - B*XDOT**2, XDOT0 )
X = INTEG( XDOT, XO )
T = INTEG( 1, TO )

' MODE CYCLING '
LTERM = T.GE.TRUN
LMONO = MONO( ICTIM, LTERM )
LIC = SRFF( ICO, LTERM, .NCT.LMONO )
'@MODE IC(LIC)' $ '@MODE HD(.FALSE.)'

' DISPLAY VARIABLES '
' CHANNELS 1 AND 4 ARE AXES FOR CHAN 2 AND 3 '
D1 = -0.2
DX = X + 20
DXDOT = XDOT - 500
D4 = +0.2
' @RECORD ( REC1,////// X, XDOT ) '
' @RECORD ( REC2,////// T, D1, DX, DXDOT, D4 ) '
'@ENDPARALLEL' $ END $ END
END
*TRANSLATE

```

```

PROCED R0
S A=500, B = 0.01
S 'SF',T = 10
S TRUN = 10
S BETA = 1
END
PROCED R1
S A = 500, B = 0.01
S 'SF',T = 10
S TRUN = 10
END
PROCED R2
S A = 800, B = 0.02
END
PROCED I
SIM 'RU'
SIM 'IC'
END
PROCED H
SIM 'ST'
SIM 'HD'
END
PROCED O
SIM 'OP'
END
PROCED P
SIM 'RU'
S BETA = .01
S TRUN = 2
S 'SF',T=2
SIM 'PP'
END
SET CMD=DIS

```

Figure 1
PTRAN Source Program

Figure 2
SIMRUN Command File

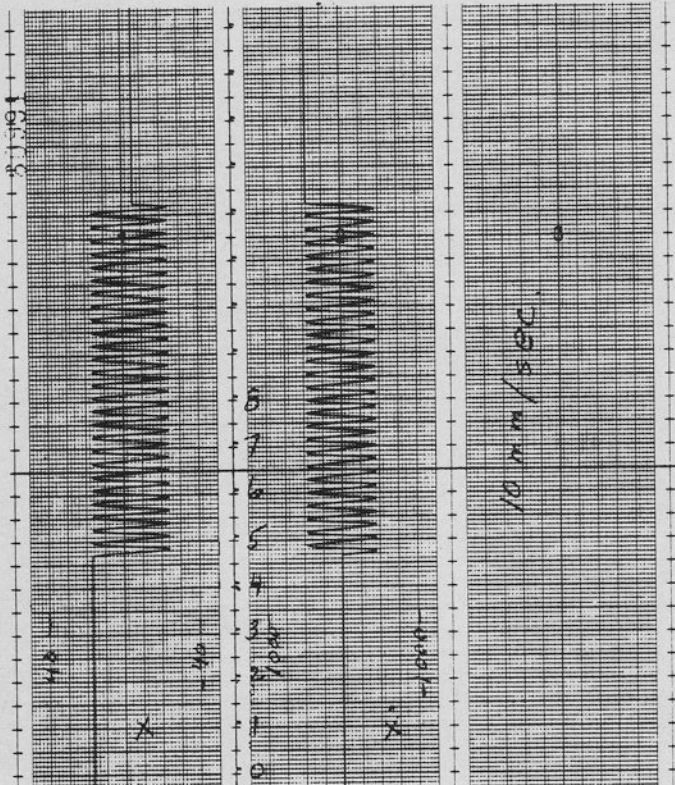


Figure 3
Basic Run

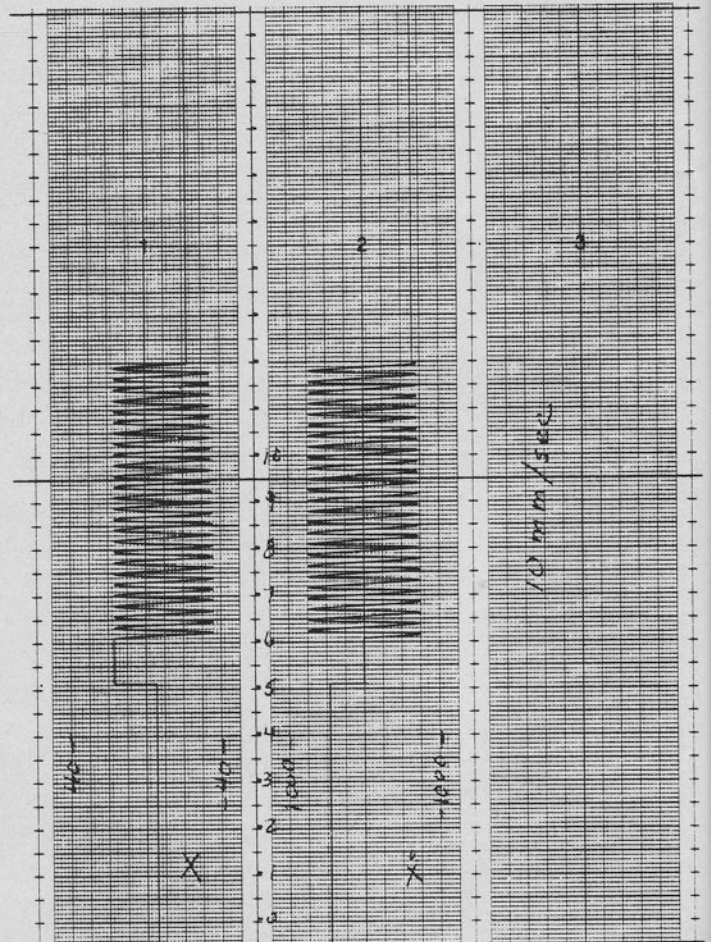
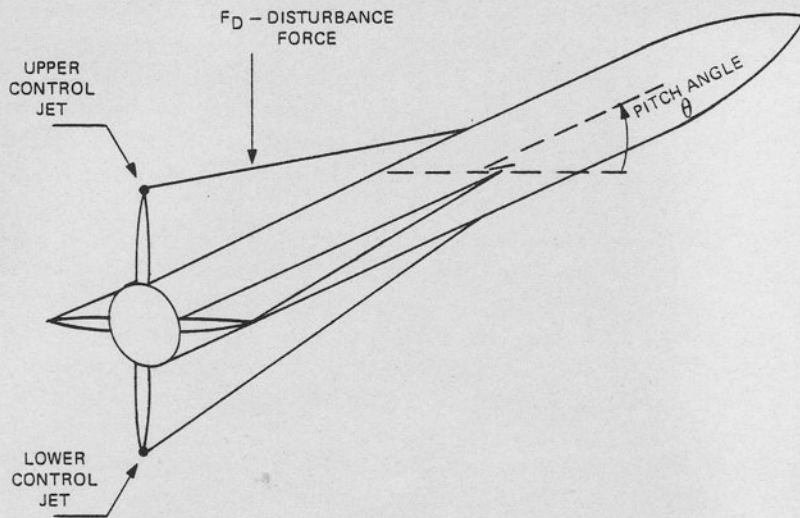


Figure 4
Run R2

SIMSTAR Simulation of a Satellite Attitude Controller

by P. Landauer, EAI West Long Branch



This simulation of a 'bang-bang' controller for the pitch attitude of a satellite launch vehicle was presented as an example of programming SIMSTAR and is typical of many applications in the aerospace industry involving the design and analysis of feedback control systems.

Using the STARTRAN Program Generation System, the macro elements of the SIMSTAR Parallel Simulation Processor can be combined easily and naturally to represent the given non-linear mathematical model. Problem parameters can be easily changed and simulation runs can be made at real-time or up to 10 times faster, with concurrent display of graphic results on a multi-channel recorder. Alternatively, simulation data can be sampled and collected during the run using the SIMSTAR Data Conversion Processor, for subsequent plotting using a graphic terminal.

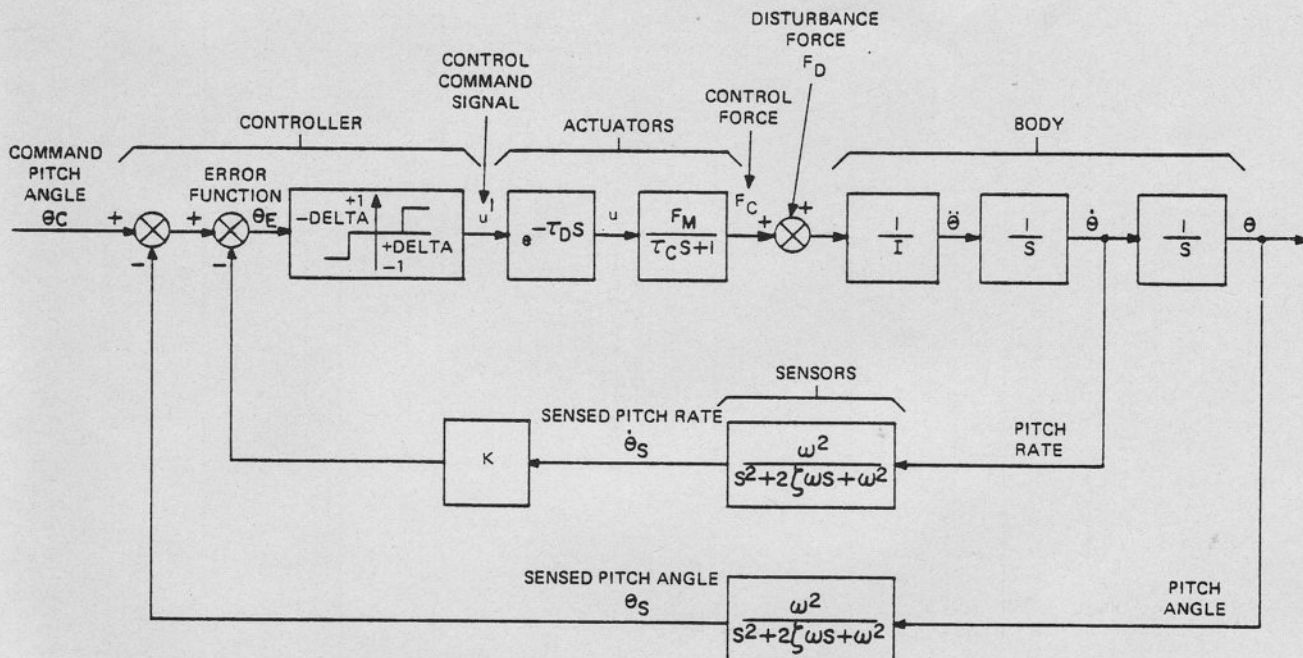


Figure 1

Figure 1 shows a block diagram of the model. With an input command pitch angle θ_C , the 'bang-bang' controller actuates firing of upper or lower control jets to achieve the commanded angle, using second order rate and position sensors. The controller model includes a trigger level or 'dead zone'. The control signal for firing the jets is delayed in time, and responds to a maximum thrust as a first order lag. A variable disturbance was also included in the model, and its effects can be observed on controller performance. Most of the model coefficients were parameterized, and can be readily changed, for controller design and evaluation.

Some Aspects of Interfacing a PACER 600 to other Computers

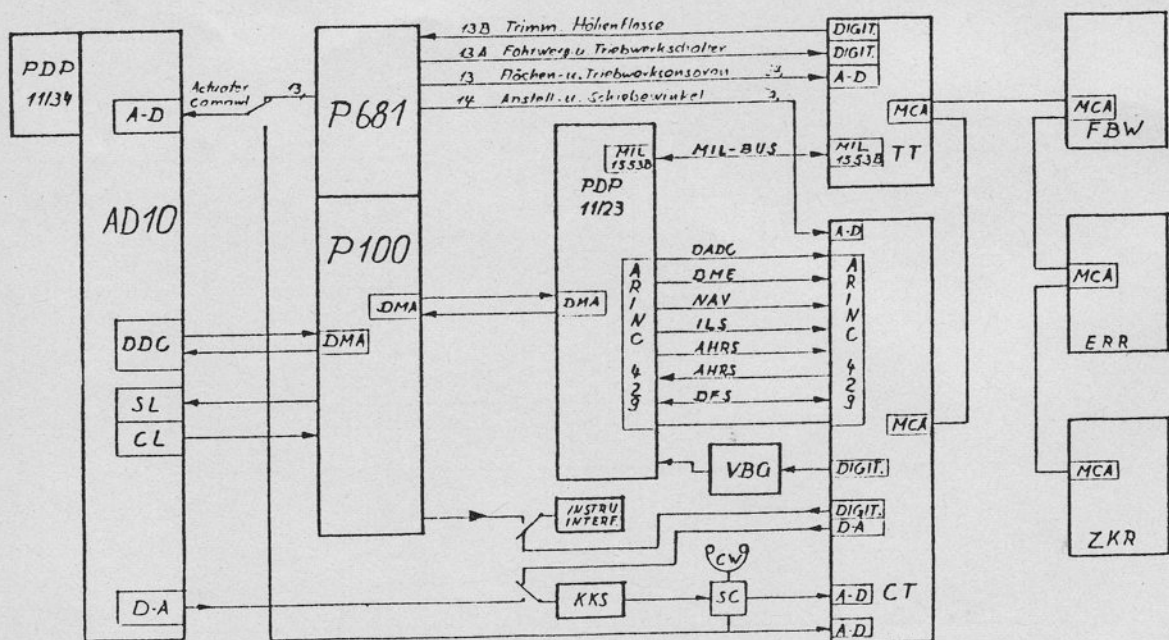
by H. Hoffmann, DFVLR Braunschweig

The project ATTAS (Advanced Technologies Testing Aircraft System) serves for in-flight simulations of other aircrafts. An accurate ground simulation of the research aircraft is absolutely necessary. The simulation of the aircraft is performed using the multiprocessor system AD10. Distribution of data is done by a PACER 600 hybrid system. The Figure shows the computer configuration for the ground simulation. A fixed time base is necessary for recording the results on magnetic tape or strip chart recorder. There are several reasons against the fact that the AD10 system as main part of the simulation takes over the generation of the time base.

1. The cycle time of the AD10 is much shorter than the cycle time of the other computers. Therefore it would be necessary to install a counter in the simulation program which generates an interrupt after each n-th step. Since the simulation is in real-time and the frequencies of the control systems are relatively high compared to the frequencies of the movements of the aircraft, the cycle time must be kept as short as possible to avoid errors in the integration caused by too large step sizes. An additional counter would increase the cycle time.
2. The cycle time of the AD10 depends on the length of the program (e.g.: 2.321 ms). To obtain a more handy time base (e.g.: 2.5 ms) pause commands would have to be inserted into the program. But this would increase the cycle time and therefore the quality of the simulation could deteriorate and all the time, at each change in the program, the number of pause commands would have to be changed too.

The fixed time base therefore is provided by the PACER 600 hybrid system. Exchange of data between two computers results mainly in a kind of handshaking. However, handshaking is not allowed in a real-time simulation, since this method implements a stand-by loop in the AD10 system and could lead to variable cycle times, i.e. the real-time condition could not be accomplished.

A specially developed interface that avoids a waiting loop in the AD10 system was described in the presentation.



Ground Computers

Realtime Control of a Servomechanism

by M. Riegel-Rauner, Universität der Bundeswehr München

ABSTRACT

"Contrary to the regulator problem the problem of returning a system to its zero state, the servo problem is the task of controlling a system so that the system output follows or tracks a desired trajectory in some optimal sense /1/." Several controllers, conventional, state and deadbeat controllers will be applied to an electrical driving motor of a tracking radar with a time constant of 5 seconds.

The time response of step and ramp input will be compared within a combined digital and analog simulation under realtime conditions.

INTRODUCTION

Concerning a tracking radar there exist two driving motors for vertical and horizontal motion. The driving motor can be modelled as an integrator /2/ with a time lag of 5 seconds for the vertical motion and of 1.5 seconds for the horizontal motion. Driving motors mostly used for positioning problems in robotics or radar technics are controlled by proportional and integral controllers or state controllers /3/. The following contribution compares proportional and integral feedback controller, feedforward controller, state controller and deadbeat controller. The simulation is separated in an analog part (motor) and a digital part (controller, feedback loop) working under realtime conditions.

PROBLEM FORMULATION

With the transfer function of the driving motor

$$F_s(s) = \frac{K}{s(1+Ts)} \quad (1)$$

we get the control loop as shown in Fig. 1. The programming symbols for the process represent the analog simulated part.

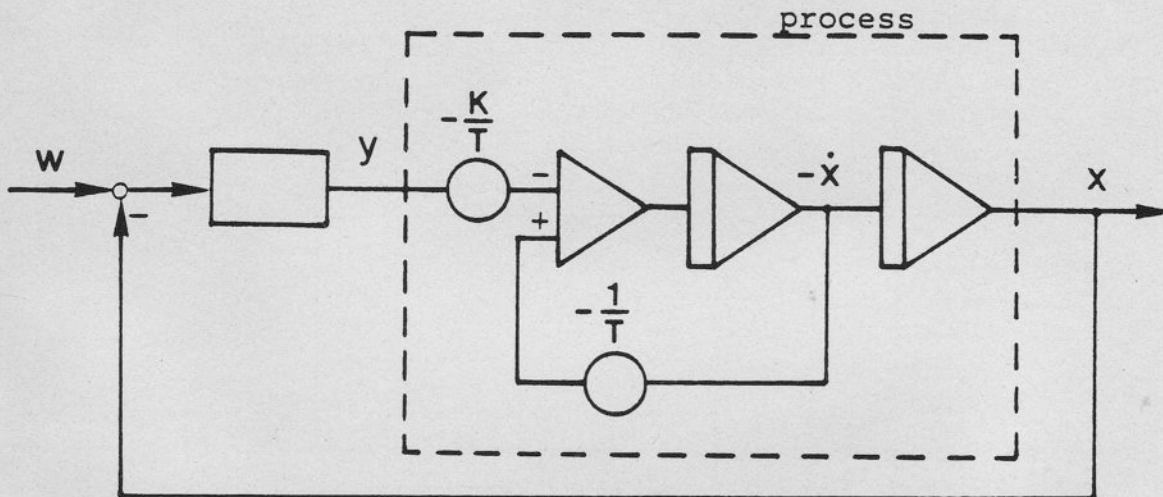


Figure 1: Control loop with analog (process) and digital separated

Time constant and proportional constant are:

$T = 5 \text{ sec}$, $K = 3.74$ (vertical motion)

with w input	x position
y controller output	\dot{x} derivation of position

CONTROL AND RESULTS

Concerning the tracking problem step, ramp and step plus ramp functions are used as input signals to the plant with the coefficient $K = 3.74$ and the time constant $T = 5$ seconds.

Starting with a proportional controller (P) the results showed that another component must be provided for exact ramp tracking. Therefore a proportional plus integral (PI) and a feedforward controller were implemented. The settling time of the step response of these three controllers was between 60 and 100 seconds and not acceptable for a military radar.

With a PI/P-cascade, a state controller and a deadbeat controller settling times within 2 and 5 seconds were reached for step response (Fig. 2). Whereas controller outputs of the proportional controllers were extremely low, the total range of controller output ($\cong |1|$) for cascade, state and deadbeat controller was used (Fig. 3). The sampling time for this realtime simulation was set to 1 second.

The state controller, see Fig. 4, where output and derivation of the process output are fed back, needs the derivation of the input signal added to the weighted input itself. The proportional/integral component is necessary to reduce an eventually occurring output error to zero. The control parameters are chosen after a parameter variation and are constant for all input signals.

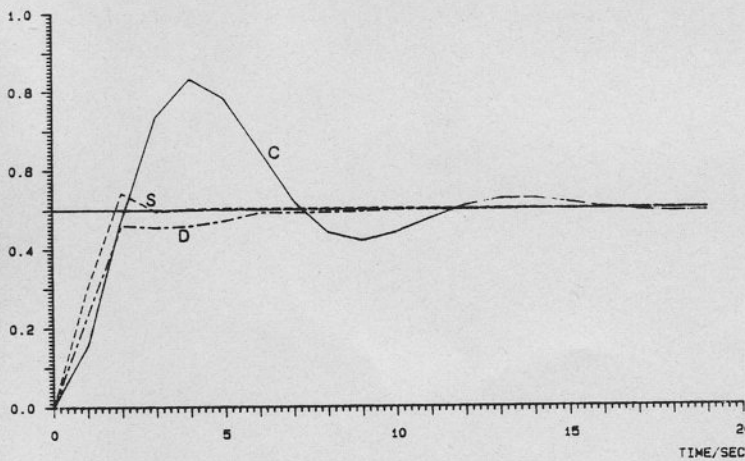


Figure 2
Step response of the circuit with a cascade (C), state (S) and deadbeat (D) controller; sampling time of 1 second, realtime simulation

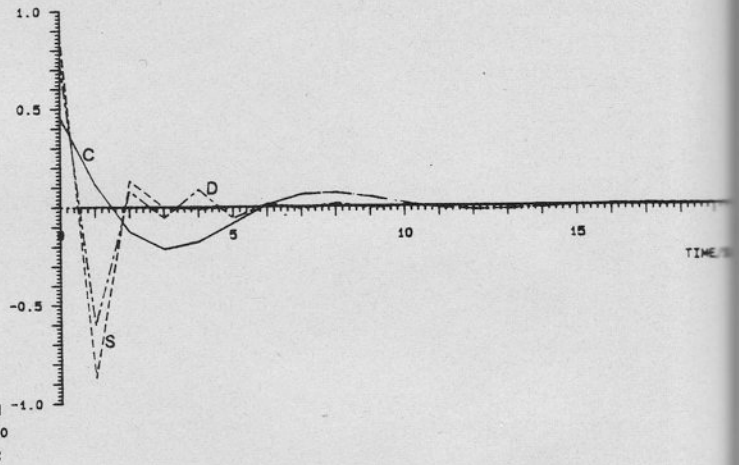


Figure 3
Controller output of step response related to Fig. 2

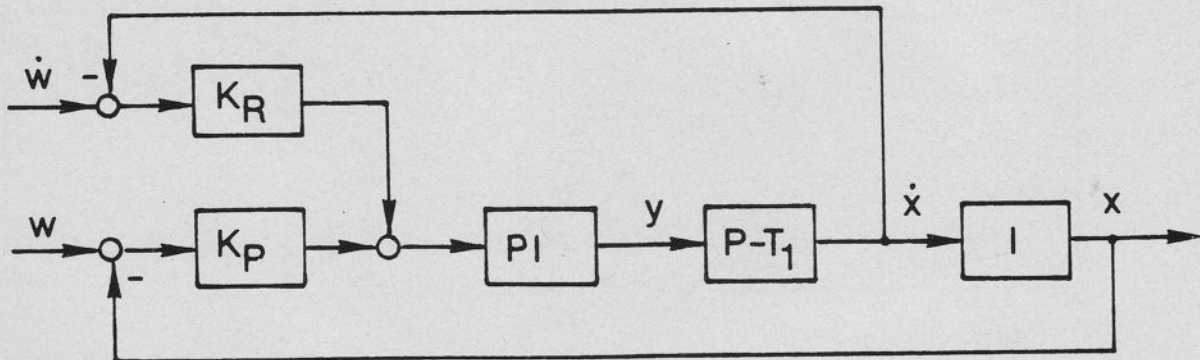


Figure 4: Block diagram of the system with state controller

For the application of a deadbeat controller one needs the state variable difference equation of the process

$$\underline{x}_{k+1} = \underline{\Phi}(T) \underline{x}_k + \underline{h}(T)u_k, \quad \underline{\Phi}(T) \text{ Transition matrix}$$

The controller output u_0 and u_1

$$\begin{Bmatrix} u_0 \\ u_1 \end{Bmatrix} = \underline{M}^{-1}(T) [\underline{x}_n - \underline{\Phi}(nT) \underline{x}_0], \quad \underline{M}(T) = [\underline{\Phi} \quad \underline{h}, \quad \underline{h}]$$

of a second order ($n=2$) process will be calculated every second time period, so that the controller output is alternating u_0 and u_1 each time period. Therefore a discrete time of 1 second for example results in a 2 seconds time base for the deadbeat controller. This means that the deadbeat controller works with the information one step delayed.

A tracking radar has to perform two different tasks. If a target has been detected the radar has to lock on the target starting from a waiting position and then follow the moving target. These requirements shall be simulated by an input signal composed of a step and a ramp. Fig. 5 shows the results of a simulation by using a cascade (C), state (S) and deadbeat (D) controller.

The system performs best with the state controller, it needs only 3 seconds to reach the input signal. The cascade controller causes very slow reaction and exact tracking on and after 13 seconds, whereas the system output with deadbeat controller has a settling time of 9 seconds.

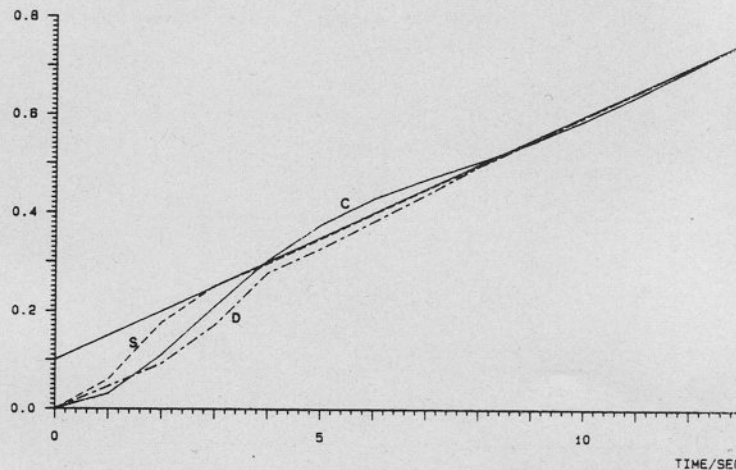


Figure 5: Response of the system to a step/ramp input with cascade (C), state (S) and deadbeat (D) controllers

CONCLUSION

With respect to the results discussed before, the tracking radar problem to lock on and track a moving target can be solved with controller concepts, which do not afford large calculations.

In this simulation with step, ramp and step/ramp inputs all controllers are set with the same parameters. The time constant of the system is 5 seconds, which means a slow process behaviour. It was demonstrated that the input signal can be tracked on and after 3 seconds exactly, whereby the controller output was within the signal range ± 10 Volts forced by the analog computer. The simulation was done under realtime conditions to show the possibilities for further implementation in a real process control.

REFERENCES

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- /2/ Pfaff, G., Meier, Ch.: Regelung elektrischer Antriebe, Bd. II, Reihe Methoden der Regelungstechnik, R. Oldenburg Verlag, München-Wien (1982)
- /3/ Bültges, H.: Zum Einsatz von Kaskaden- und Zustandsregelungen für einen servovalvengesteuerten hydraulischen Linearantrieb, Automatisierungstechnik at-33 (1985) pp.247-252

Dynamic Simulation Facilities at Gasunie Research

by J.E.J. Hermans, N.V. Nederlandse Gasunie

The company N.V. Nederlandse Gasunie buys, transports, and sells natural gas. It has about 1800 employees and the annual turnover is approximately US \$ $8 \cdot 10^9$.

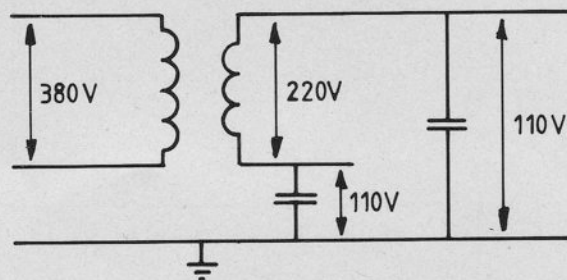
The tools for dynamic process simulation are a hybrid computer and Tutsim for an Apple II and for the PDP 11/34. Tutsim is a simple, easy to handle, block-oriented computer simulation program. The hybrid computer consists of a PDP 11/34 (operating system RSX11M V. 3.2) and an EAI 2000. In addition to 56 DCAs and 8 Pots the analog computer contains 46 analog computation amplifier trays and several digital trays. Moreover, a serial and a parallel interface between the analog and digital computer is available.

The expertise is distributed over a number of 5 employees within a specialist group which is part of the Services department at the laboratory of Gasunie Research. At this moment there is a vacancy for a senior control engineer.

Hardware Problems

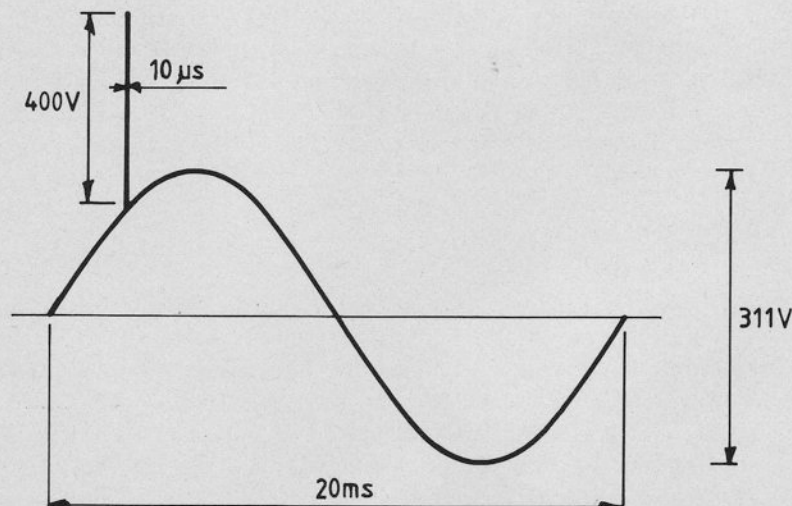
1. For two months no hybrid computation has been possible! The Macs terminal showed continuously: 'Serial port not on-line'. In spite of good service of DEC as well as EAI the inavailability lasted from 16-11-1984 until 16-01-1985. It appeared that there were two errors in our hybrid facility:

- a. The power supply of the hybrid computer, which was delivered by GTI, produced a floating voltage and the computer showed a capacitive behaviour.



Connecting one of the secondary wires with ground solved this problem.

- b. A life wire which damaged insulation in the EAI 2000 intermittently touched a grounded fan-grid. Because of the floating voltage supply no fuse was blown. The Dranetz power supply observator could not detect the voltage peaks because the rise time was too short.



The PDP however reacted on these peaks. DEC used over 100 man-hours and 11 boards; beside this a spare PDP was installed.

2. One of the simulations had to be finished before January 1st, 1985, so the operational hybrid model was translated into Tutsim on the Apple. Each Tutsim run took about 8 hours. It appeared that the Apple II (about 5 years old) has been worn out. It was almost impossible to use the accelerator board; board contacts also needed cleaning about once a week.

Planning Simulation Facilities

1. Trying to find out the demand for simulations in the future and to promote it:

December 1984: Mr. Willemse and Mr. Hermans held an introductory presentation on dynamic system simulation.

January 1985: Mr. Jungbauer (EAI Aachen) joined Mr. Ilic (EAI West Long Branch) who held a more in depth presentation on this subject at Gasunie.

Since then the simulation demand has slightly increased but is more steady now; some people are starting to simulate by themselves.

2. Simulation tools available:

a. now: hybrid: PDP 11/34 - EAI 2000
Tutsim: for Apple and PDP 11/34

- b. near future (1/2 year):

- i. Gasunie has rented an IBM AT with coprocessor and ACSL as well as Tutsim for one month, starting October 7th. If the above set is functioning properly, Gasunie will purchase it and thereby replaces the Apple-Tutsim combination.

- ii. Extension of the EAI 2000 by either 4 function generators or 1 multiplier/summer tray and 2 integrator/summer trays.

- c. far future (1 year):

- i. FORTRAN version of Tutsim (institute license) for HP PCs.

- ii. ACSL on two more IBM ATs and on a mainframe if Gasunie still likes to work with it.

- iii. Mr. Hermans' personal wish: replacement of the hybrid computer by a SIMSTAR because if it is once installed several people can start using it because of the quality and the comfort; right now Gasunie has to do too many simulations in a very short time.

As an example the simulation of a compressor station near Arnhem was shown. The problem was that with the installed two-stage controller it was impossible to operate three centrifugal compressors in parallel. According to the hybrid simulation a three-stage controller would be the cheapest solution. This controller is being installed now and it will be used this winter.

Experience with an EAI 2000/Apple Link
by A. MacKinnon, University of Glasgow

Because of delays over the past year, the author changed the title of the presentation to "NON-experience with the EAI 2000/Apple Link". Delays were caused by long delivery of the software, manuals which were difficult to understand, lack of experience on the part of the EAI representative in the U.K., and building alterations.

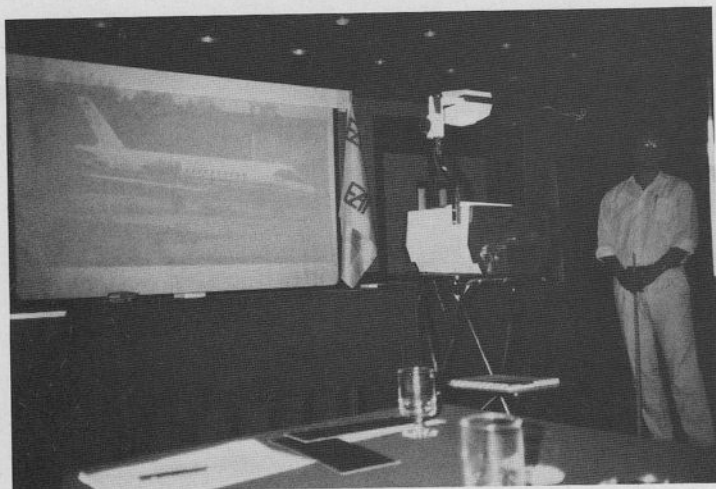
The main conclusions reached were that long-term planning was essential and that hybrid software for the Apple was very expensive.



A. MacKinnon



M. Riegel-Rauner



P. Saager

Analog Simulation brings Quick Solutions of Control Problems

by M. Minne, KWU Mülheim/Ruhr

SIMULATION WITHIN THE KWU TURBINE MANUFACTURING FACILITY

- Development of turbine components (hydr. actuators, valves, blades, ...)
- Development of turbine control loops (speed, load, pressure, ...)
- Turbine-grid coupling problems (load oscillations)
- Improvement of the dynamic of control loops on site
- Direct digital control problems

EQUIPMENT

PACER 100, Interface 690, Analog Consoles 680, 580, PDP 11/23+ with A/D

TASK: MULTIPLE CONTROLLING OF TWO PROCESS-STEAM-TURBINES

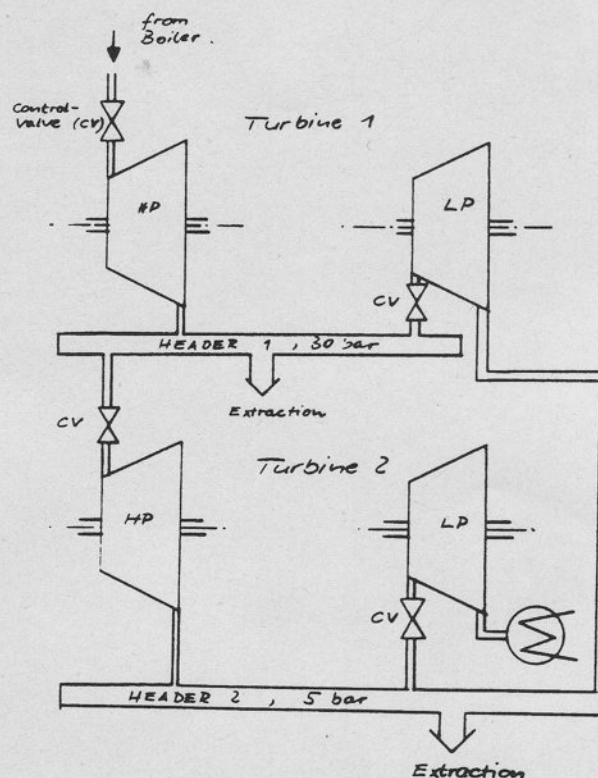


Figure 1: Two Turbine Process

FEATURES

- Coupling the control loops through steam header pipes, i.e. every control quantity depends on the other.
- Separate speed control loop with associated hydraulic actuated control valves for every turbine.
- Separate pressure control loops manipulating the above mentioned valves for every turbine resp. header.

POINTS OF INVESTIGATIONS

- Structural stability of the multiple coupled control loop.
- Necessity of a special controller resp. network to provide decoupling.
- Parameter sensitivity of the system.
- Controller-structure and optimized parameters.

DEVELOPING THE MODEL

Linearization of all equations referring to the stationary operating point. Selection of an adequate algorithm for the controller (see Fig. 2).

EXPERIMENTS WITH THE MODEL

Varying the controller parameters. Varying the turbine parameters and the order of the frequency response function.

THEORETICAL INVESTIGATIONS

Development of the frequency domain equation for every control quantity to receive analytical terms for the coupling of the control loops. Dependency of the coupling influence of one control loop to another by terms of the difference of the high and low pressure turbine (HP resp. LP) transfer function.

FURTHER EXPERIMENTS

Variation of the high and low pressure turbine transfer function according to thermodynamics.

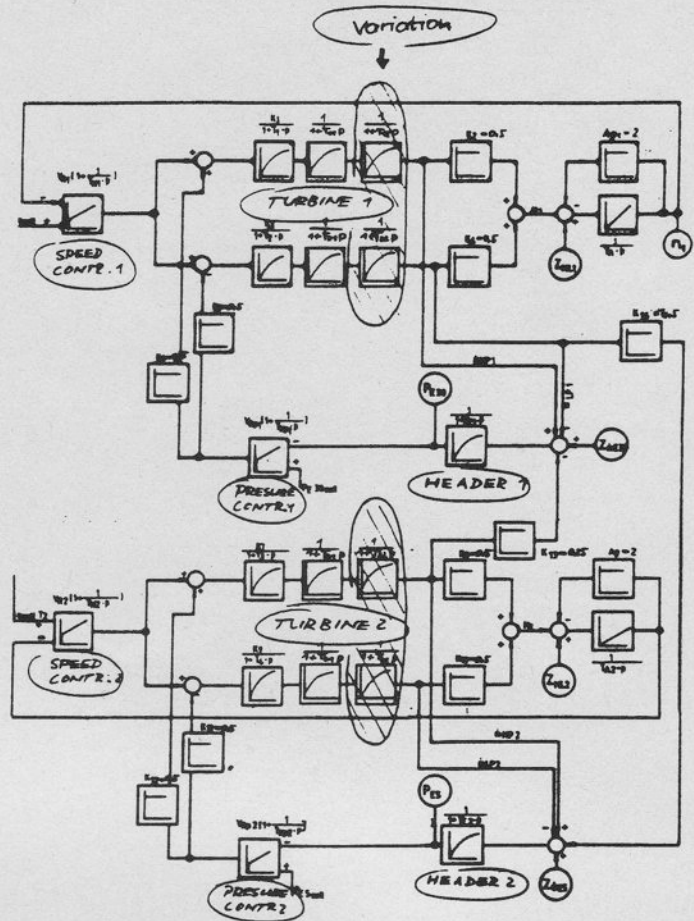


Figure 2

Figure 3

Turbine 1 with 50% difference of the time constants of HP resp. LP
Turbine 2 with HP resp. LP identical time constants

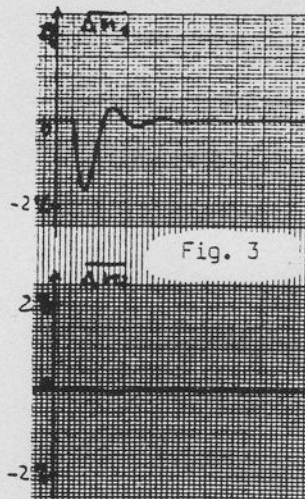


Fig. 3

Figure 4

Turbine 1 as above
Turbine 2 with 50% difference of the time constants of HP resp. LP

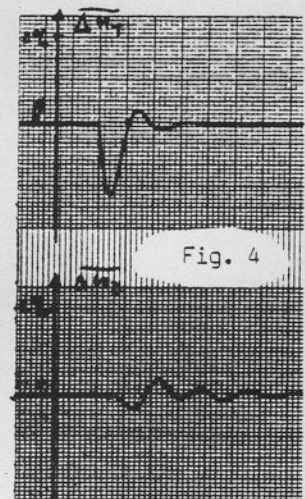


Fig. 4

$\overline{\Delta M}^1, \overline{\Delta M}^2$:= Speed turbine 1 resp. turbine 2

Disturbance : mech. torque of turbine

CONCLUSIONS

- Structural stability of the coupled speed and pressure control loops
- Amount of coupling depends on the difference of the HP resp. LP turbine behaviour
- As a first approach every loop can be handled as independent from the others
- No special decoupling network necessary.

Special Problems with the Simulation of the DFVLR Research Aircraft VFW 614 (ATTAS)
 by P. Saager, DFVLR Braunschweig

This presentation contained a short description of the research aircraft ATTAS (Advanced Technologies Testing Aircraft System) of DFVLR Braunschweig, especially of the equipment of the aircraft (e.g. Direct Lift Control (DLC) Flaps, Noseboom, On-Board Computers (MIL-Spe)) and pointed out the object of the application by the Institute for Flight Mechanics (In-Flight Simulation).

Within the scope of the project ATTAS an extensive and extremely accurate real-time simulation of the research aircraft is necessary (e.g. for development of software for the board computers). At the moment the following program packages are integrated into the simulation:

- flight mechanics, aerodynamics, control systems, atmosphere,
- engines, navigation, instrument control, equilibrium calculations

The simulation of the control systems turned out to be extremely difficult (e.g. elevator control system, see Figure 1), because of the complexity of the model which consists of EHS (Electro Hydraulic Actuator), booster, and rudder (elevator). There it had to be considered that the EHS are limited in pressure: The forces that effect the surfaces are partly fed back to the EHS and thereby determine the pressure in the EHS. If the forces cause a maximum pressure the output is limited by the EHS whereupon the surfaces cannot be controlled any further. Thus it is achieved that maximum given forces on all the control systems cannot be exceeded.

Finally a system of order 6 has been implemented which could be validated by comparison with a simulation running on the large computer not real-time. Similar systems have been implemented for all control systems.

Figure 2 shows a small part of the results of a validation documented by means of the EAI 681 and an 8 channel recorder. Here a jump signal was chosen as input to three of six DLC control systems. A few variables for flight mechanics and the positions of the individual DLC flaps have been recorded. Thereby the different deflection of the flaps is to be noted which is caused by different aerial forces which effect the flaps.

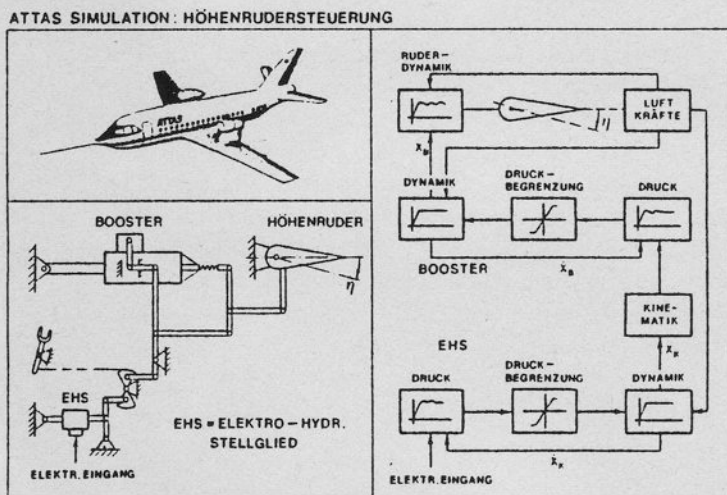


Figure 1

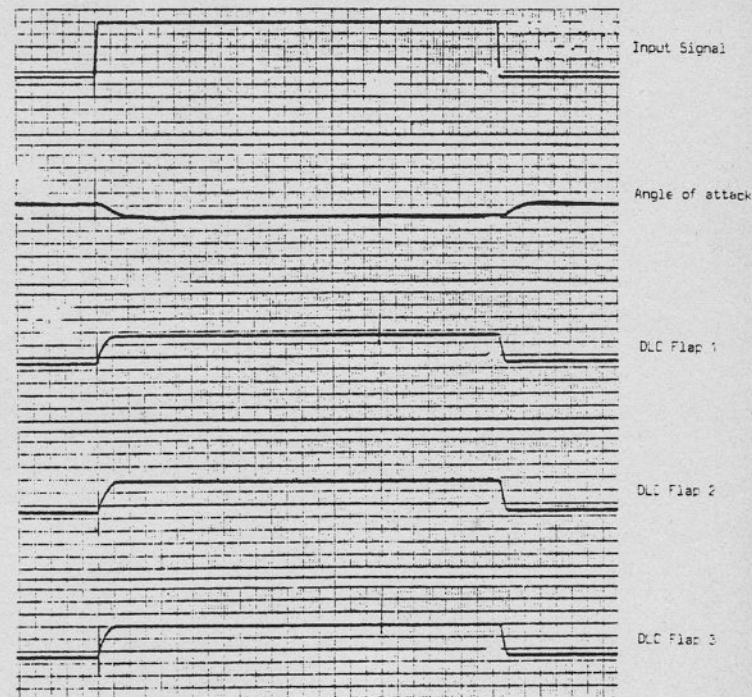


Figure 2

To conclude the presentation the artificial feel simulation was pointed out which is also part of the real-time simulation and gives the pilots in the fixed-base cockpit the realistic sensation of the appearing control column forces.

Modelling and Simulation of a Controlled Motor-Vehicle Drive*)

by K.H. Fasol, Ruhr-Universität Bochum

The Institute for Gear Techniques of the Ruhr-Universität has recently developed a new concept and has already built a prototype of a highly effective transmission gear for motor cars (Fig.1).

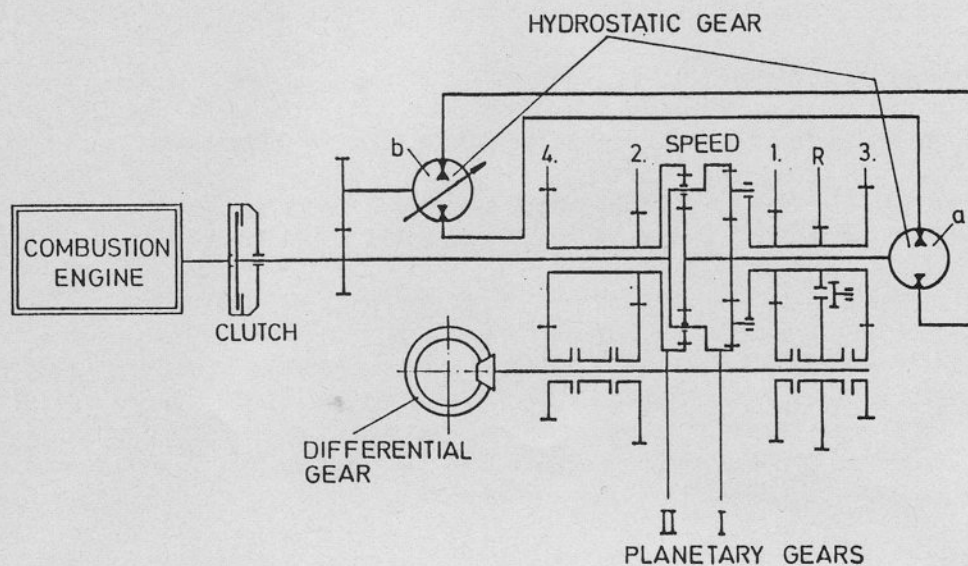


Figure 1: Gear-unit

The essential figure of this drive is a power-split transmission consisting of both mechanical planetary gears and a continuously variable hydrostatic gear. Thus, a very high efficiency* of the gear was obtained. As part of a jointly executed project, members of the author's Institute have carried out model building and simulation studies with the goal to design a microcomputer-based control system to obtain optimal performance of the car. By continuous regulation of both the gear ratio and the engine throttle valve, depending on required power, the engine can operate, with little deviation, along the characteristic of minimum fuel consumption.

For both digital and analog simulation, in the first stage, most exact mathematical models for the mechanical part as well as for the hydraulic part of the gear unit were developed by means of theoretical system analysis. In the oral presentation of the contribution some examples for modelling of subsystems were given. These elementary subsystems of which the gear is composed are e.g. shafts, couplings, torsional masses, cog-wheel transmission, planetary gears, the specific components of the hydraulic gear, etc.. Simulation models of the combustion engine and of the vehicle behaviour were taken from literature. By means of theoretical considerations supported by both digital and analog simulation, finally, a reduced model was received that was still reliable enough. Figure 2 gives an impression of the complete detailed model of the gear (before model reduction). Each symbolic block represents an elementary subsystem.

*) This presentation is based on a paper by R. Dreiholz and R. Vonnoe: "Simulation and Control of a Continuously Variable Transmission in a Motor Vehicle", presented at the ISATA Conference, Graz, Austria, September 1985. The subject research project is supported by the DFG (Deutsche Forschungsgemeinschaft).

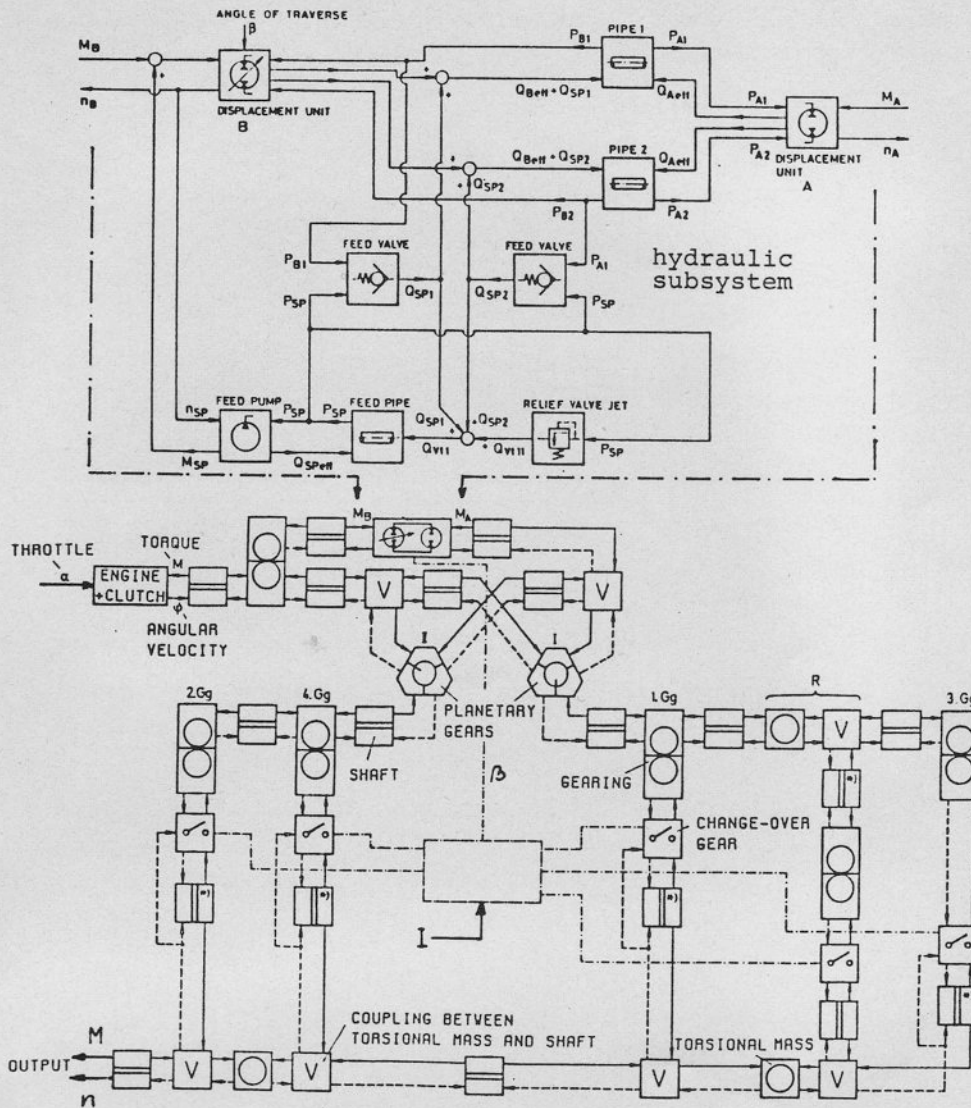


Figure 2: Block diagram of the detailed gear simulation model

Figure 3 shows the complete control system. Optimal control means, in this case, that the engine, at any steady state as well as at transients, operates with minimum fuel consumption and that the power output follows the setpoint given by the driver as fast as possible. Contrary to conventional cars the driver does not actuate the throttle valve directly but he acts on the power setpoint.

*) controlled system: engine, gear, vehicle

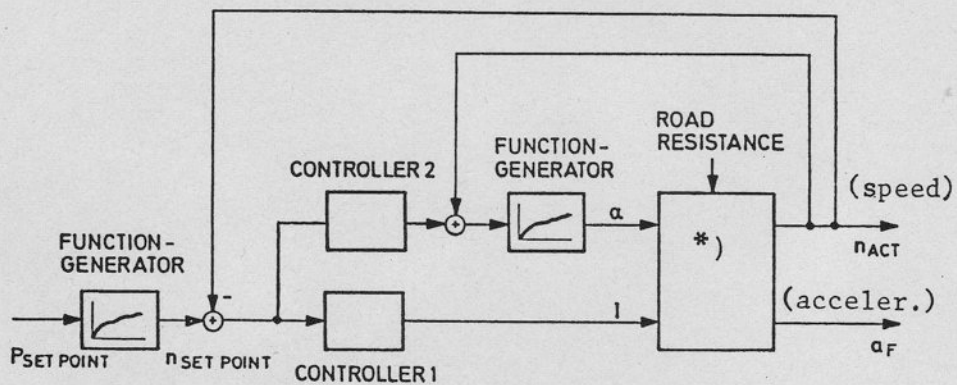


Figure 3: Speed control system with optimal throttle adjustment

A function generator then determines the optimal speed setpoint. The throttle valve is set by a second function generator appropriate to the actual engine speed.

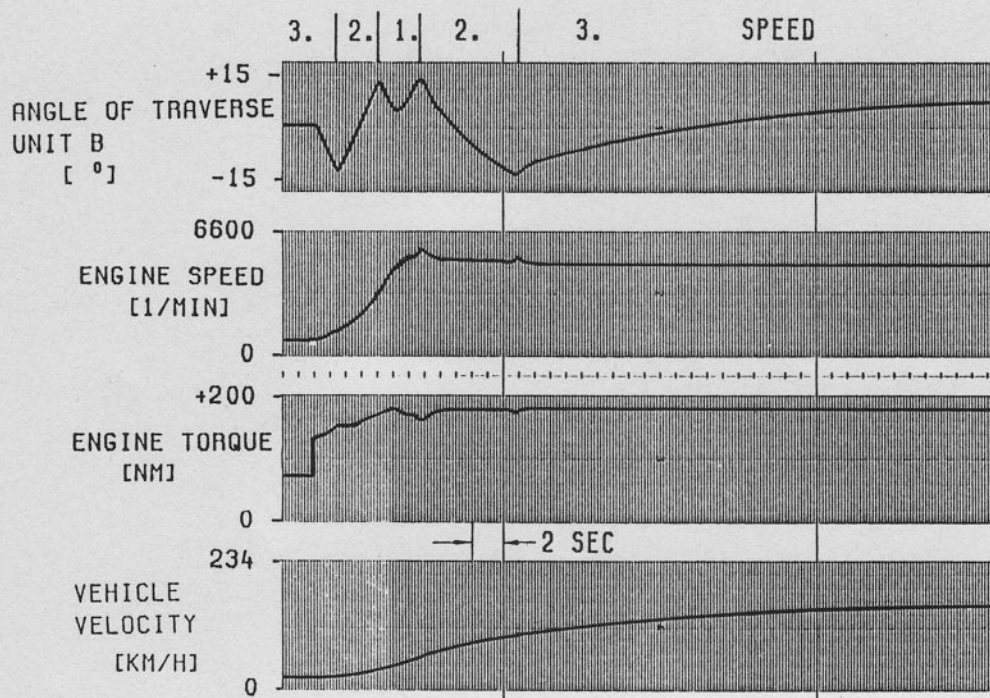


Figure 4: Example for simulation results:
stepchange of throttle-valve

Figure 4 is an example for simulation results. The simulation was performed on EAI 2000 computers connected to a DEC LSI 11/23. In simulation, not only all kinds of system responses at various operating conditions but also the influence of various parameters such as road condition were investigated. It should be mentioned that, not only as a gag but also as a good help, in the final stage, the power setpoint was received from a real pedal operated by foot and the engine speed signal acted on a sound generator thus imitating the noise of the car.

The prototype of the gear unit is on the test stand in the moment. The final goal of the study will be to carry out experiments with a real car.

Closing Session

The president expressed many thanks to Dino Marras for the excellent organization of this meeting. Dino Marras then thanked the participants for coming to Santa Margherita.

There was a general discussion about user meetings, meeting frequency and user attendance. It was considered to send out a user questionnaire. Users suggested to keep the invitation more formal.

Gasunie is willing to host next year's meeting. Mr. Hermans will be the organizer. Details are given on page 39.



Closing Session

The following pictures document some of the social events.

On the second evening some of us went by car to Camogli, a wonderful old fisher town on the sea and took a walk through town and the harbour.

The last evening brought the traditional farewell party. This time it was very special. On an extraordinary mild October evening we made a boat trip from Santa Margherita to San Fruttuoso with a stop in world famous Portofino.

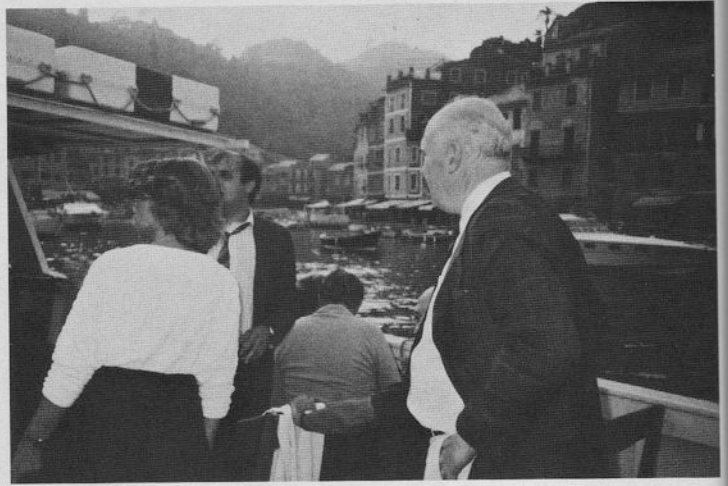
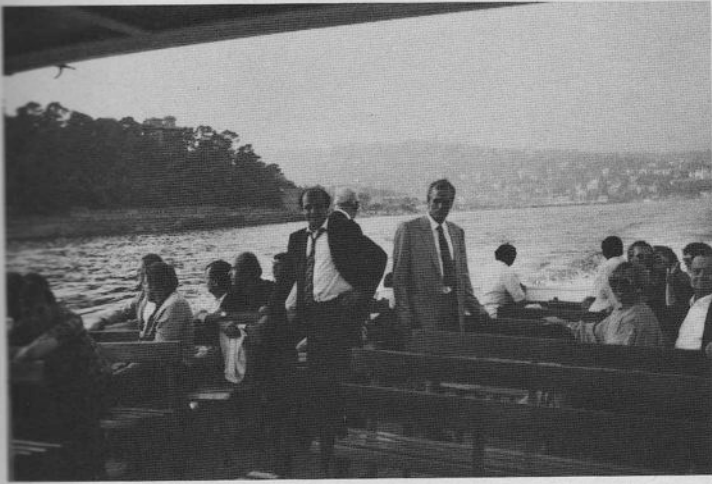
In San Fruttuoso we first visited the abbey with its old cloister and Doria's graves. At the farewell dinner we had delicious sea food.



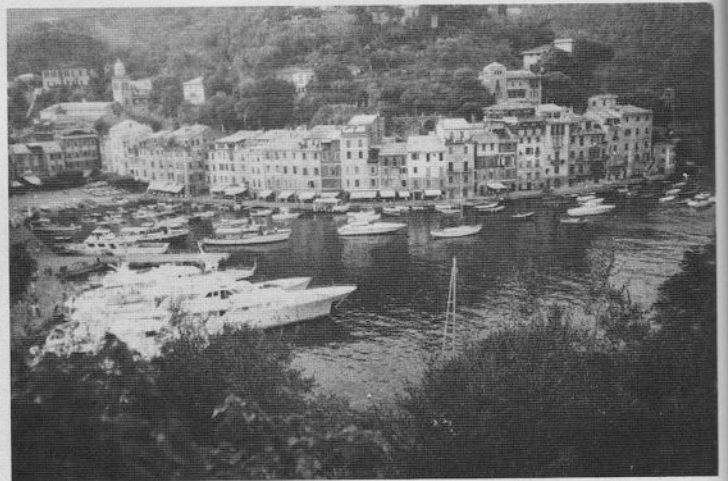
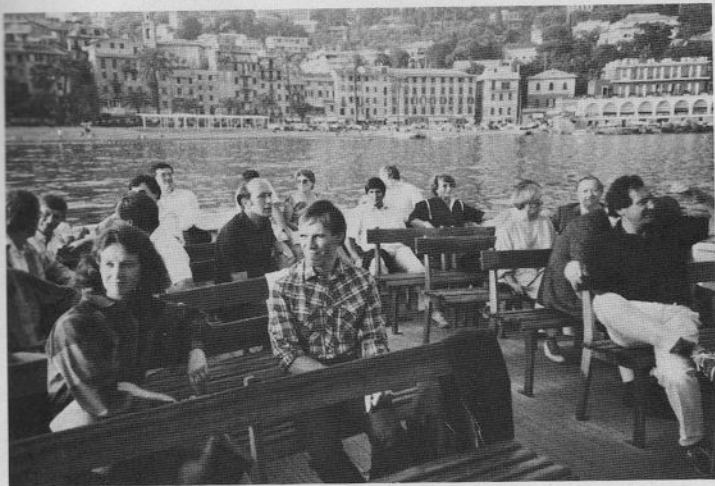
Camogli



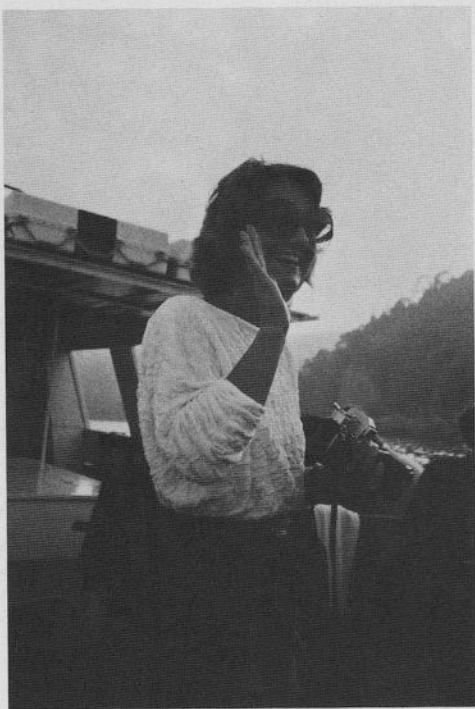
Group Picture



On the Boat



Portofino



I. Husinsky



H.W.A. Jungbauer



Farewell Party



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Application Fields: Radar tracking, mil. system simulation, automatic control

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Ing. Jan E.J. Hermans

Dear EAI Computer User,

This year the annual EAI-CUG meeting will be held from October 8 till 11, 1986 and N.V. Nederlandse Gasunie will be pleased to receive you at their head office in Groningen on October 8.

The meeting starts on Wednesday. In the morning there will be a guided visit to the permanent exhibition "Gaspoort" for early arrivers. After registration and lunch the meeting will be opened officially. A visit will be payed to the CCR (Central Control Room) from where the entire Gasunie gas transmission system is permanently controlled.

Early in the afternoon a bus will take us to the compressor station at Spijk and to Lauwersoog, from where we will go by ferry to one of the Frisian Islands: Schiermonnikoog.

Schiermonnikoog is a beautiful island with dunes, beaches and a forest; it has a characteristic village, also called Schiermonnikoog, and an area of outstanding natural beauty. We will stay at "Hotel van der Werff", which has an original interior and a period tap-room. Although not being a luxury hotel, it is comfortable and has atmosphere, with good conference facilities.

Thursday and Friday we will stay in this hotel for presentations, working groups and discussions. It is our pleasure to invite you to contribute to the meeting; a registration form with several questions e.g. to your area of interest and a call for papers will be sent to you later on.

If we finish the meeting in time, there will be a farewell party on Friday evening!

Saturday morning we leave after breakfast by ferry and bus transfer will be provided to Groningen.

I trust the meeting will be as successful as the previous ones. Looking forward to meeting you in Groningen,

Yours sincerely,

Jan Hermans

EAI's answers to the questions of the EAI 2000 working group
held at the EAI Computer Users' Group Meeting 1984

Question 1: The patchcord problem.

If the pin of a patchcord is not completely straight, there is a big chance that it will cause a short-circuit when it is used in a patching.

As describing this problem is very difficult, we gave Mr. B. Mawson (EAI, West Long Branch) detailed information and a possible solution.

Answer: We believe we understand the patchcord complication which is stated. Reasonably careful handling/usage of patch cords is required. At this stage in the 2000 product's life cycle, the suggested solution is not economically viable. However, to minimize the inconvenience, EAI is willing to accept a free of charge trade-in of up to one dozen patch cords of any type.

Question 2: Accuracy of the IC-OP-HD times.

Are the IC-OP-HD times (RT0, RT1 and RT2) exact, especially for very small values of RT0, RT1 and RT2 (e.g. RT values from 0 to 10)?

Answer: The rep op timer is composed of 15 bit digital timers (counters) which are each accurate to one part in a million (meaning it can count one microsecond intervals of the one megahertz clock frequency).

Question 3: Setting of a DSFG.

If there is a DSFG value that should be bigger than +1.0000 (or smaller than -1.0000) there is an error message, which is correct. But no setting at all of the DSFG is done, also not when the value is within the tolerance.

Sometimes DSFG values are calculated as a function of terminal input on the digital computer and then it may occur that one or more values are outside the area of +1.0000 and -1.0000.

Answer: When a digital is used to calculate DSFG values (using hybrid library routines), it may occur that one or more values are outside the area of +1.0000 and -1.0000. Here error checking (check of error flag, IERR) is the responsibility of the user. Note in the subsequent description of the routine QWDSFR (taken from manual) the out-of-range error is listed. (For your information, when the MACS terminal is employed for DSFG set up, out-of-range error checking occurs automatically, because it is built into the firmware.)

Question 4: PSSR nr. SEL091 of Erlangen University is not correctly answered.

- 13.04.1982: first time PSSR SEL091 has been sent to EAI.
- 24.08.1982: answer: EAI WLB could not reproduce error and included an example program
- 2.09.1983: example program with the produced wrong results sent to EAI-WLB
- 1.11.1983: answer: error not reproduced on EAI-WLB equipment, probably malfunctioning of Erlangen's HSFP, EAI hands problem over to Gould SEL.
- 4.01.1984: answer: problem caused by Hyshare module IOCS, the included patches to solve the problem are for MPX2.1A, as MPX1.4 is installed in Erlangen the patches don't fit.
- 31.08.1984: Erlangen replaces MPX1.4 by MPX2.1, but still the provided patches don't fit.
- 14.09.1984: Erlangen phones EAI Aachen to ask for corrections in the patches.
- 28.09.1984: EAI Aachen sends corrections by telex, but after the corrected patches have been installed the operating system gets into an infinite loop.

Answer: Separate discussions have occurred directly with Erlangen University personnel to address specific concerns. In general, the mentioned PSSR and many other are being corrected in the MPX2.2 version of the hybrid library. It is scheduled to be available in the third quarter of 1985.

Attachment to Answer 3

Routine: QWDSFR

Function: Loads the specified DSFG with a user defined function containing from 2 to 41 X,F(X) pairs.

Calling Sequence:

CALL QWDSFR (IADR, XARY, YARY, NPTS, IB)

Arguments: IADR is the integer DSFG address in the range of 0 through 17

XARY is the real array containing from 2 to 41 X breakpoint values to be loaded into the specified DSFG. They need not be in ascending order.

YARY is the real array containing from 2 to 41 Y values (F(X)) representing the desired function value at each of the breakpoints in XARY. The valid range is $-1.0002 < YARY < 1.0002$.

NPTS is the integer number of elements defined in XARY and YARY. Valid range is 2, NPTS, 41.

IB is the integer number of hardware breakpoints to be used (must be 21 or 41).

Error Conditions:

IERR

- 96 Component Missing: The DSFG specified in IADR is within the range of 0-17; however, it is not physically present in the system.
- 102 Illegal Argument: One of the following argument errors has been detected:
- IADR is not in the range of 0-17
 - One of the XARY elements is not on an X breakpoint value $\pm .0002$.
 - One of the YARY elements is outside the range $-1.0002 < YARY(i) < +1.0002$
 - More than one f(Y) has been specified for a given breakpoint
 - NPTS is not in the range 2-41

ARTICLES OF THE ORGANIZATION OF THE
EAI COMPUTER USERS' GROUP
International Chapter

ARTICLE I - NAME OF THE ORGANIZATION

1. The name of this organization shall be EAI Computer Users' Group, an organization of users of computational systems manufactured by Electronic Associates, Inc.
2. The group shall be organized into International and North American chapter, the organization of the first group being set forth below and henceforth referenced to as the Users' Group.
The elected officers and the Executive Secretary of each chapter set forth under Article VI shall constitute an International Coordinating Board for the common affairs and influences of both the International and North American chapters.

ARTICLE II - PURPOSE OF THE ORGANIZATION

The purpose of this organization is to:

1. Provide a means to exchange programs and other information pertaining to the use of computational systems;
2. Advance the art of digital, analog and hybrid computation through mutual education and exchange of ideas;
3. Specify standards for all communications made through the established channels of the organization;
4. Provide a means for users to present suggestions and improvements to EAI;
5. Provide a means for EAI to maintain an awareness of user activities and to recognize and respond to user needs at the individual level;
6. Maintain a data bank of computational applications;
7. Administer Users' Group meetings.

ARTICLE III - GROUP MEMBERSHIP

Qualifications

Each computational facility engaged in the use of EAI products shall be entitled to membership in the Users' Group after application to and approval by the Executive Board of such group. Membership shall entitle each facility to vote on each item of business brought before such group. Each member facility may be represented at all meetings by several delegates.

ARTICLE IV - DUES, EXPENSES AND FEES

This organization is to be a non-profit organization having no legal standing. No membership fee, general assessments or dues shall be required of any member. Each member shall be responsible for the travel and communication expenses of its respective delegates.

ARTICLE V - GROUP OFFICERS

SECTION A - TITLES

The Users' Group shall have officers, as follows:

1. The President, elected by the General Meeting;
2. The Vice-President Europe, elected by the European members of the Users' Group at the General Meeting. The Vice-President Europe also functions as editor of the Newsletter;
3. The Vice-President outside Europe, elected by the non-European members of the Users' Group at the meeting outside Europe or by a written election;
4. The Chairman of the next General Meeting or the next Regional Meeting;
5. Chairmen of standing committees, appointed by the President;
6. An Executive Secretary, to be appointed by EAI.

SECTION B - TERMS OF OFFICES

1. The President and Vice-President offices are elected for a term of two years;
2. All offices by presidential appointment should be confirmed by the new-elected president, this for continuity reasons, unless this office is declared vacant (see Article VI Section B).

SECTION C - ELIGIBILITY FOR ELECTIVE OFFICES

1. Only delegates in good standing are eligible for election to an elective office. No Person shall be nominated for Office unless he has given prior assurance to those making the nomination that, if elected, he will diligently carry out the duties of that office.
2. Any candidate may withdraw his name from nomination by sending such a request in writing to the Executive Secretary prior the close of the election.

ARTICLE VI - GROUP NOMINATIONS, ELECTIONS AND VACATED OFFICES

SECTION A - NOMINATION AND ELECTIONS

1. At the General Meeting of each even-numbered calendar year, the Executive Board (see Article VIII) shall present at the beginning of the first day a slate of candidates nominated for elective offices.
2. Additional nominations may be made from the floor by delegates, subject to the following restrictions:
 - a) Nominations from the floor must be submitted in a manner specified by the Executive Board;
 - b) Each delegate can nominate only one candidate for each elective office;
 - c) Nominations shall be closed at the end of the first day of this General Meeting.
3. Elections shall take place at the end of the second day by secret ballot. Each member facility, in the sense of Art. III, will be entitled one vote.

Those facilities not present at the meeting could vote by power of attorney.

4. A plurality of half plus one of the valid votes shall be required to elect. If none of the candidates obtains this plurality, a second vote is needed, where the candidate with the majority of the valid votes is elected. If this second vote does not result in an election there will be a draw between the candidates that ended together with the most valid votes.
5. Results of the election shall be announced to all present members during last day of the meeting.
6. All elected officers shall take office at the final business meeting of the meeting.
7. Written elections shall be organized by the Executive Secretary, according to rules approved by the Regional Meeting.

SECTION B - VACATED OFFICES

1. Any office may become vacant in any of the following ways:
 - a) Death;
 - b) Resignation: A letter of resignation must be sent to the Executive Secretary;
 - c) Ineligibility: When the officer can not longer carry out the duties of his office, he immediately ceases to be an officer and shall notify the Executive Secretary;
 - d) Re-Appointment: Executive Board appointment to another office;
 - e) Removal: An officer may be removed from office by the Executive Board for just cause before his term of office has expired.
2. If any office other than President or Executive Secretary becomes vacant before the normal expiration of its term, the President shall appoint a successor who shall immediately assume the duties of that office upon approval of the Executive Board.

SECTION C - VOTING ELIGIBILITY

Each organization must be registered with the Executive Secretary.

ARTICLE VII - DUTIES OF GROUP OFFICERS

1. The President shall:
 - a) Appoint all committees not otherwise provided for and be ex-officio member of all committees;
 - b) Make provision for the discharge, pro tempore, of the necessary duties of the elected or appointed officers;
 - c) Ensure that the By-Laws of the Organization are observed;
 - d) Appoint Chairmen to serve on the standing committees. Each Chairman shall be responsible for appointing his own committee members;
 - e) Be a member of the International Coordinating Board.

2. The Vice-President shall:

- a) Be an aid to the President;
- b) Be a member of the International Coordinating Board;
- c) In the absence of the President, perform, pro tempore, the duties of the President;
- d) In the event the office of the President becomes vacant, become President;

3. The Executive Secretary shall:

- a) Be responsible for the correspondence of the Organization;
- b) Maintain a current mailing list of the delegates;
- c) Be a member of the International Coordinating Board.

4. Chairman of the Annual Meeting:

- a) Establish the mechanic of the annual meeting (including dates, location agenda, etc.) subject to approval of the President;
- b) Ensure the minimum required facilities for the meeting (at least meeting room, blackboard, projection apparatus). All other facilities are facultative and left over to the local possibilities of the receiving organization;
- c) Organize the technical program of the meeting in collaboration with the President;
- d) Arrange to have the technical program of the meeting distributed to the membership in advance of this meeting;
- e) Record the proceeding of the meeting and be responsible for the distribution of these proceedings.

ARTICLE VIII - EXECUTIVE BOARD

- 1. The Executive Board shall assume the responsibility delegated to it by the President and shall consist of the President, Vice-President, Executive Secretary and the Chairmen of the group's standing committees.
- 2. The President shall be ex-officio Chairman of the Executive Board.
- 3. The Vice-President shall be ex-officio Vice-Chairman of the Executive Board.
- 4. The Executive Secretary shall be ex-officio Executive Secretary of the Executive Board.

ARTICLE IX - MEETINGS

- 1. At the least one General Meeting shall be held during a calendar year.
- 2. Each General Meeting shall be organized by the Meeting Chairman appointed by the President amongst the delegates of the inviting organization.
- 3. Each Presentator of a technical paper at a General Meeting shall provide a

full-print of his paper which shall be distributed to all delegates registered at the meeting.

4. Minutes of the General Meeting shall be published in the Newsletter.
5. Regional Meeting may be organized outside Europe. To organize the meeting the Vice-President outside Europe shall appoint a Chairman. The Chairman sends the minutes of the meeting to the editor for publication in the Newsletter.

ARTICLE X - COMMITTEES

SECTION A - STANDING COMMITTEES

The standing committees of this organization are:

1. Software Library Committee
2. Application Library Committee
3. Maintenance Software Committee
4. Hardware Committee.

SECTION B - COMMITTEE MEMBERS

1. Chairmen for the above committees shall be
 - a) Appointed by the President and
 - b) Serve on the Executive Committee as a member thereof.
2. Members of the Standing Committees shall be selected by the Chairman and appointed by the President.

ARTICLE XI - PROCEDURE

Except as otherwise provided for by these Articles, all matters of business shall be conducted by the general body of delegates in accordance with accepted rules of parliamentary procedure.

ARTICLE XII - AMENDMENTS

These Articles, with the exception of I, II, III and IV may be amended at any General Meeting of the delegates by a two-thirds majority of the valid votes, provided that written notice of the proposed amendments have been given at least four (4) weeks in advance. To initiate an amendment, a delegate must submit a draft of the proposed amendment, along with the reason therefore, to the President, at least eight (8) weeks before the General Meeting. Each member facility has one vote; voting is possible, for those not present at the meeting, by power of attorney, or by writing, the vote being sent to the President.

Articles I, II, III and IV may be amended only by the unanimous approval of the International Coordinating Board.

ENCOURAGEMENT AND ASSISTANCE BY EAI

The role of the Electronic Associates, Inc. in this organization is one of encouragement and assistance. EAI supports the group in its efforts and shall give material assistance in typing, duplicating and distribution of whatever material is reasonably to sustain this organization.

News from the North American Chapter

At the beginning of May 1985 the North American Users' Group Meeting was held at EAI's West Long Branch, New Jersey facilities. The major topics were SIMSTAR and EAI market research group discussions. Here is a look at the programme:

Wednesday, May 1, 1985

- Registration, Welcome by CUG president Dick Israel, Announcements
- SIMSTAR - Present/Future (B. Mawson)
- SIMSTAR
 - Introduction (B. Kaplan)
 - Installed Units Report (B. Kaplan)
 - Status (B. Kaplan)
 - MICOM Simulation (K.L. Hall)
 - Concept (P. Landauer)
 - Programming (L. Michaels)
 - Training Courses (A. Markman)
 - Service/Maintenance (D. Drummond)
 - Applications (L. Michaels)
 - Remote Demo (L. Michaels)

Thursday, May 2, 1985 at the EAI plant

- SIMSTAR
 - Manufacturing Tour (R. Embley)
 - Packaging (S. Buckley)
 - Lab Demo (L. Michaels)
 - Lab Hands-on (L. Michaels)
 - In-Depth Technical Forum (Embley, Giddens, Buckley)
- Market Research Discussion Groups
 - SIMSTAR with VAX Host (L. Michaels)
 - Digital Multivariate Function Generator (G. Hannauer, J. Shotliff)
 - All-Digital Simulation System (G. Hannauer, J. Shotliff)
 - Simulation Work Station (J. Shotliff)
 - Electronic Trunking System (P. Landauer, G. Sichel)
 - Parallel Logic Processor (G. Hannauer)
 - Engineering Work Bench (B. Mawson)

Friday, May 3, 1985

- Roundtable Discussion
 - Panel (O. Wright, B. Mawson, J. Mericle, N. Lemonde)
 - General and SIMSTAR
 - Complaints, Problems, Suggestions
- Software (D. Stokes)
- Applications (L. Michaels)
- CUG Business Meeting (D. Israel)

The next EAI Computer Users' Group Meeting, U.S. Chapter, will be held in Orlando, Florida, February 5, 6, 7, 1986.

The meeting will feature SIMSTAR and other EAI computer applications, status reports, and a tour of the Martin Marietta Orlando Aerospace Technical Computation Center (Hybrid Lab). US SIMSTAR users will report on their experiences with SIMSTAR. For more information please contact your local EAI office.

Efficient Application of the SIMSTAR Non-Homogeneous Multiprocessor
to Large-Scale Simulation Studies *)

P. Landauer, EAI West Long Branch

ABSTRACT

In contrast to the relatively structured programming methods for single stream Von Neumann computers, the programming of multiprocessor systems has been rather an art. Real-time operational requirements further intensify the complexity of the task so that few high-level programming environments address the problem. SIMSTAR, which is the latest Simulation product from Electronic Associates, is a multiprocessor designed from a hardware and software point-of-view to overcome these problems and to provide high-level programming for real-time multiprocessor solution to simulation problems.

This paper describes a variety of methods for targeting computational tasks to appropriate processors in SIMSTAR. Considerations for both real-time with hardware-in-the-loop and faster than real-time are discussed. Effective use of the autonomous Data Conversion Processor is explained which overcome simple communication bottlenecks. Shared memory throughout SIMSTAR eliminates I/O overhead for inter-processor communication.

The use of the STARTRAN/ACSL programming system is described as an aid in targeting subsystem models by deriving the Eigenvalues at some solution point. STARTRAN features for convenient retargeting are also described to show how an implementation can be conveniently optimized.

Finally, an example SIMSTAR application is presented which was previously run at slow speed on a digital processor. The SIMSTAR program arrangement is presented and the resulting performance is discussed. This program shows the use of some of the specific techniques briefly described earlier in the paper.

INTRODUCTION

The design of modern large-scale, high performance systems demands the best that is available in both engineering talent and computer technology. Successful implementation and support of such complex systems requires a structured approach to specification, modeling, and analysis. While smaller systems in the 1960's could be designed on a single analog or digital computer, large high performance systems could only be modeled by hybrid computers or a multiplicity of digital computers. In an attempt to overcome this requirement, minicomputers have been upgraded to the speed of supercomputers of twenty years ago. However, the requirements have grown at an even faster rate and we still see a need for multiple processors on the same application.

In the past, users have reverted to manual analog, array processor, and FORTRAN programming to implement efficient large-scale programs. All of the commonly available simulation languages are designed for operation on a single processor. For a software system to efficiently program more than one processor for parallel operation, the user must provide information on the natural parallelism in the system. This specification of physical system structure also defines information flow which can be used to minimize interprocessor communication.

*) This paper has been presented at the 11th IMACS World Congress, August 5-9, 1985, Oslo, Norway

STARTRAN, which is being developed by EAI, is designed to provide a natural, structured means for the user to describe a large-scale dynamic system. In turn, the various system elements can be targeted to the set of non-homogeneous processors in SIMSTAR. This leads to processor independent programming with only incremental information required for a given implementation. The basic statements of STARTRAN used to program the mathematical model are CSSL compatible as implemented in ACSL /1/.

The example application presented at the end of this paper is programmed for the planned STARTRAN preprocessor but has not yet been completely implemented automatically on SIMSTAR.

DEFINITION OF NON-HOMOGENEOUS MULTIPROCESSOR

A Non-homogeneous Multiprocessor (NHM) is a computer system consisting of a number of strongly cooperating specialized processors. The design of individual processors is usually tailored to some class of computational tasks such as vector processing, function generation, graphic processing, or solution of differential equations.

In the past, systems utilizing non-homogeneous computers included VAX/AP120B for signal processing, EAI HYSHARE hybrid computers and VAX/AD-10 digital computers for simulation. Of course, the earlier hybrid computers all fit into this class. While only rather dedicated analysts have been successful in using these systems, it seems that in the future it will be necessary for the average user to be able to efficiently apply NHM systems. Of course, many of the concepts for NHM systems are also applicable to homogeneous MIMD processor systems.

Except for a few specialized applications such as seismic data analysis, real-time high performance system simulation, and computer generated imagery, the computer field has been dominated by Von Neumann type uniprocessors (CPU's) which have simply become faster to meet the increasing computational demands.

Although application processing has remained primarily in a single CPU, the peripheral I/O tasks have been increasingly off-loaded to much smaller, specialized processors (SP's). The Operating System, which usually resides in the CPU, handles the complex procedure of allocating tasks to the SP's. Some of these tasks include:

- Disk Input/Output
- Terminal Polling/Concentration
- Direct Memory Channel Programming
- Graphic Processors

Each of these SP's is pre-programmed and data driven to perform a specific task as a result of a user program request through the Operating System.

When the remaining application code saturates a CPU, there have been three choices commonly available:

- Addition of a Second CPU
- Addition of a Specialized Digital Processor
- Addition of Analog Computer/Interface

In systems like the GOULD 32/97, the second processor may be an Internal Processing Unit (IPU) which is homogeneous with the CPU except for the Operating System functions. That is, an application must be partitioned into two coprocessor tasks which communicate through a GLOBAL COMMON. No high level programming language is provided to define or control the coprocessing tasks.

Specialized digital processors include primarily array processors such as the Numerics 432 and Simulation Computers such as the AD-10. In either of these cases, the user must partition the application and code for the specialized processors.

Addition of an analog computer and interface simplified the partitioning task since the two processors were radically different and the CPU could handle all communication. Of course, the user had to prepare separate programs for the analog and digital processors.

OVERVIEW OF SIMSTAR

SIMSTAR /2/ is the latest simulation computer product from Electronic Associates, Inc. designed to satisfy the most demanding engineering computational needs. While utilizing the proven methods of the earlier hybrid computers, SIMSTAR provides convenience of programming and operation found only with digital computer systems.

The architecture of a single SIMSTAR multiprocessor is shown in Fig. 1. This shows the flow of various data types between the five processors and to/from external equipment. The highest bandwidth is provided by the analog and binary Parallel Signal Lines. Data rates over 200,000 words per second can be maintained on the Memory Link lines. The Data Bus is used for single word or bit communication under program control. Finally, Logic Control lines are used to automatically initiate computations or conversions from timer or logic programs. The parallel processor is the main workhorse in SIMSTAR providing an equivalent capability up to 100 million operations per second (MOPS). High accuracy computing is handled by the digital processor for about 1 MOPS capability but, in conjunction with the Host, can be extended to nearly 10 MOPS. Although the conversion processor performs no mathematical functions, its powerful automatic analog/digital communication capabilities significantly off-loads the digital processor.

For many simulation applications, arbitrary function generation from tables of data is essential. The function processor provides an additional 8-15 MOPS to off-load the digital processor requirement. Intimate shared memory communication with the digital processor and the conversion processor allows the function generation to be distributed easily to the complete model.

Communication to external equipment can include a multiplicity of analog and binary logic lines from each parallel processor. In addition, an expandable set of 16 bit bi-directional buses can be added to operate external digital equipment such as guidance and control computers. The conversion processor provides the timing and data transfer to/from the digital processor.

If capability beyond the basic SIMSTAR is required, additional units can be interfaced in the analog, logic, and digital processor domains depending upon the closeness of coupling required. An expanded SIMSTAR system can include up to three multiprocessors for a total of six parallel processors with a potential of over 500 MOPS total performance.

STRUCTURED LARGE-SCALE SYSTEM DESCRIPTION

Digital computer programming started at the binary level and analog computer programming started with amplifiers, resistors, capacitors, and diodes in the late 1940's and early 1950's. Since then, everyone has followed a bottom-up methodology enhancement through assembly language to FORTRAN and through analog computing devices to HYTRAN. However, none of these were end use oriented.

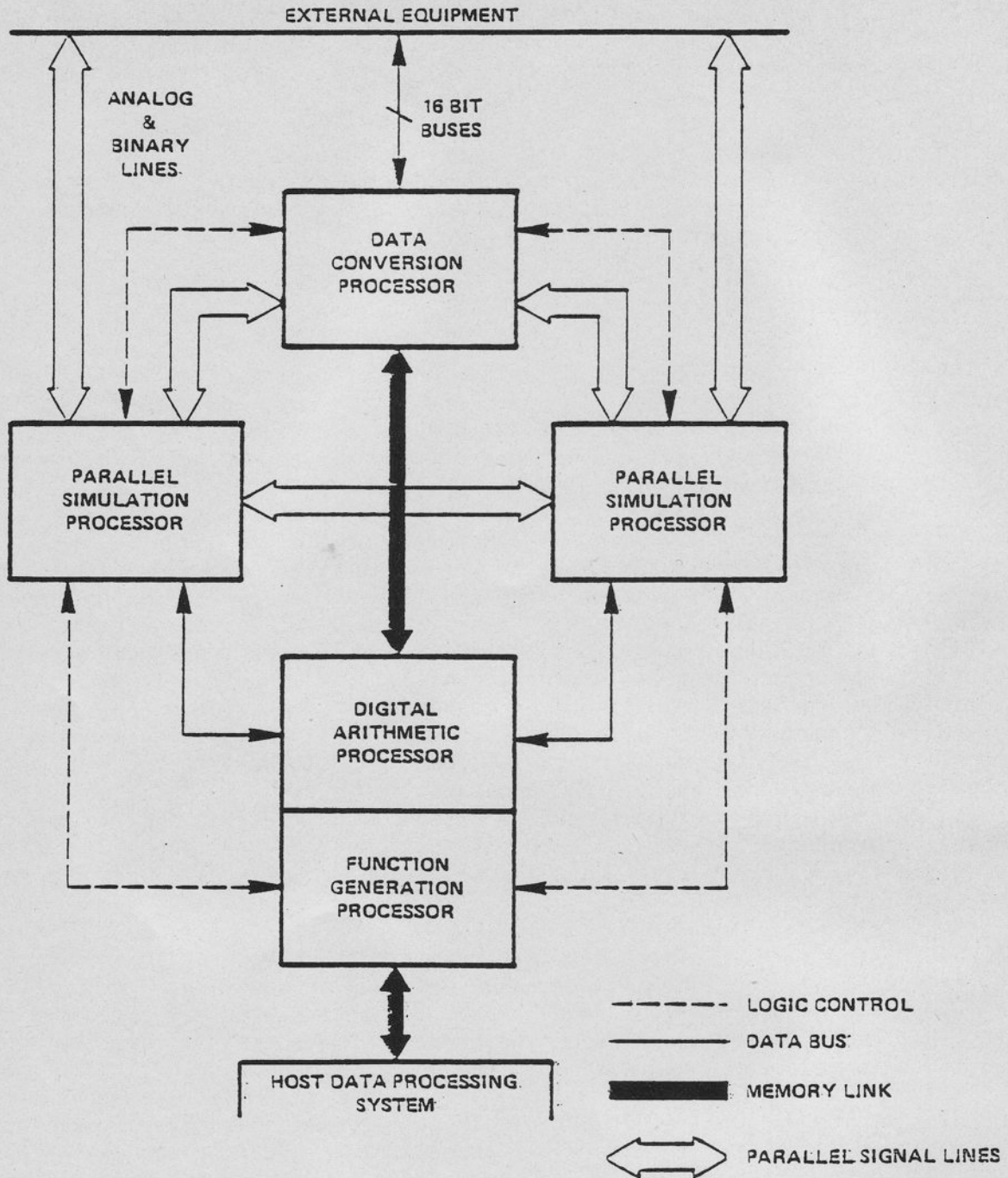


Figure 1 - SIMSTAR Multiprocessor Architecture

In 1967, the first attempt to make another step up on the back of FORTRAN was the development of a framework for Simulation Languages resulting in CSSL which evolved to CSMP, ACSL, and CSSL IV. The computing devices and the applications often outstrip the capability of these languages whereupon users fall back to FORTRAN. ECSSL, which used the ACSL language, was developed by EAI to support analog computers but did not adequately cover the multiprocessor case. A simulation language is still computer technology oriented and only marginally addresses the large-scale application requirement. In fact, many applications of CSSL processors use more FORTRAN than simulation language statements.

For SIMSTAR, Electronic Associates has taken a fresh, top-down look at the programming requirement. The most common base for any system analysis is a high-level block diagram showing the flow of primary variables between major subsystems as shown generically in Fig. 2. The names shown are simply representative of variables. For real-time applications, there is an external disturbance as input and certain variables drive the external environment. Another dimension not usually shown on the block diagram is the experimental environment which may need run-time access to many system variables. This diagram of a parallel system structure is analogous to a high-level flow diagram for a sequential algorithmic procedure. Tools like PASCAL and ADA have evolved to naturally program sequential flow diagrams including management of large sets of non-homogeneous data. However, no such programming system has evolved for parallel system representation for engineering design independent of the target computer(s).

Another important dimension to the total design problem is the ability of the user to efficiently monitor and interact with the simulated system operation. Again, the structured approach is most efficient since the user can interactively partition the system into only those subsystems of interest at any time. This also helps to ensure that parameters are not inadvertently changed.

STARTRAN /3/, which is the highest level programming environment planned for SIMSTAR, is designed to provide a convenient means for the user to describe the system structure and data. The structure statements and a brief description of the content of each region is shown in Fig. 3. A global SYSTEM region is provided to initialize any global aspects of the model including specification of data and SYSTEM dynamics if any. Program initialization, run-time control and terminal processing are reserved for the RUNTIME and TERMINAL regions after the model descriptions.

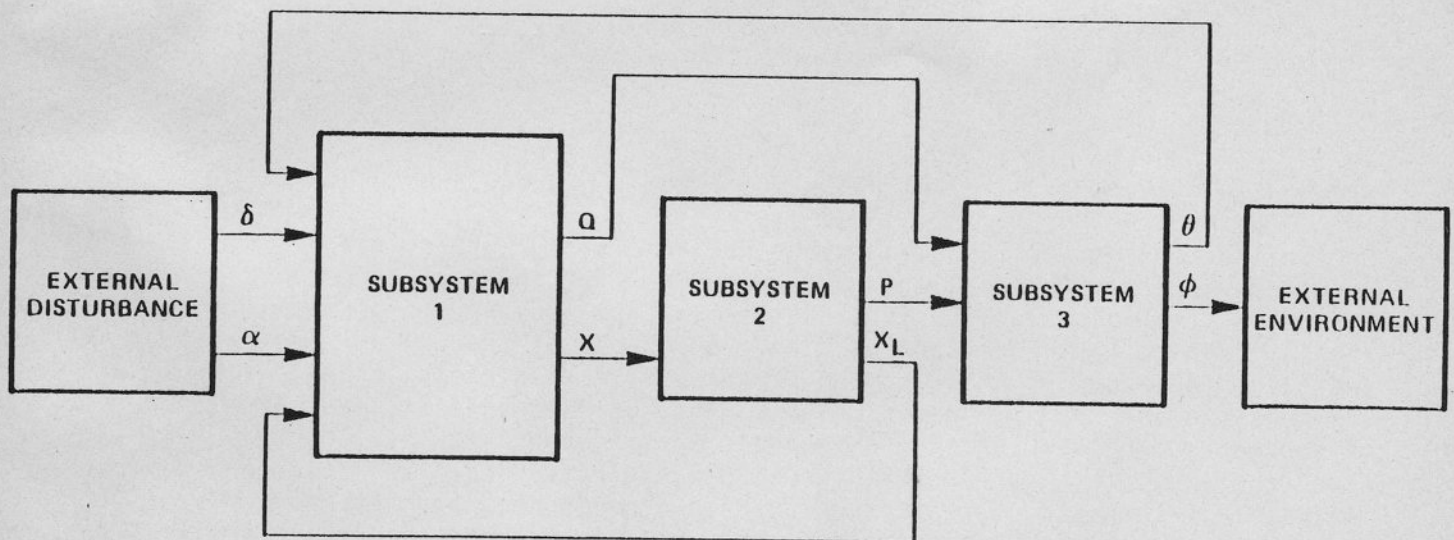


Figure 2 - Generic System Block Diagram


```

SYSTEM name (outvars = invars)
  (Global declarations and assignments)
  INITIAL
    (System startup procedure)
  DYNAMIC
    DERIVATIVE
      (System dynamic model)
    DISCRETE
      (Timed algorithmic process)

SUBSYS nam 1 (outvars = invars)
  (Local declarations)
  INITIAL
    (Subsystem startup)
  DYNAMIC
    DERIVATIVE
      (Subsystem model statements)
    DISCRETE
      (Timed algorithmic process)
  TARGET
    (Assign variables to integration procedure)
    (Assign variables to parallel processor)
    (Specify range of variables)
END

(Additional SUBSYS's)

RUNTIME
  (Program startup code)
  INITIAL
    (Specify recording and setup run)
  DYNAMIC
    (Program control, display, and termination)
  TERMINAL
    (Post run analysis, recording, and termination)
  TARGET
    (Global integration procedure)
    (Assign subsystems to processors)
    (Specify range of SYSTEM variables)
END.

```

Figure 3 - STARTRAN Preprocessor Language Structure

One or more subsystems (SUBSYS) may be declared along with a list of output and input variables. Declarations are provided for the data types local to that subsystem. Initial values of local parameters are assigned before INITIAL. The INITIAL region is executed at the beginning of each run and will set coefficients in any of the targeted processors. A simulation language model of the subsystem is provided under DYNAMIC. This permits establishment of a library of subsystem models which can be included in different studies. There is further consideration of MODULE's within SUBSYS but are not yet planned to be implemented. This structured system description approach permits many different types of analysis, allows the translator software to more completely verify the program completeness and provides more meaningful documentation. Also, the opportunity exists to use interactive graphics effectively for program development, parameter change, and visualization.

After the SYSTEM and SUBSYS model description, special regions are provided to handle the experiment. This includes RUNTIME which is the process begun when the cataloged task executes. Between RUNTIME and INITIAL, the statements are executed only once to establish initial system constants or logic conditions. Also, an interactive REINIT command will re-establish these conditions.

The RUNTIME INITIAL region executes before each run along with the INITIAL regions of the SYSTEM and all SUBSYS's. Any experiment control statements which run in parallel such as TERMT, processor rescaling, alarm testing, etc. are placed in the RUNTIME DYNAMIC region. These statements execute only at Communication Intervals which may be selected to be any multiple of the integration step which is equal to the frame time for real-time solution.

When TERMT becomes true, the DYNAMIC routine stops and the TERMINAL sequential code is executed which can analyze and document results. Also, this code may loop to RUNTIME - INITIAL for the next run. If the user program does not loop, the program will return to the Run-time Executive where the user has control.

ALGORITHMS FOR TARGETING

Given this structured system description including problem data and initialization procedure, translation into a simulation language structure and to FORTRAN is relatively straightforward for a non-real-time uniprocessor using a single variable step integration algorithm. However, if real time is required, the user must target all or parts of the system to be solved by appropriate real-time integration algorithms using fixed frame times. In this case, the STARTRAN program will usually have specified SYSTEM Input/Output Variables which require A/D/A conversion, at some interval.

For large-scale system simulations, a single processor is often inadequate. For a non-homogeneous multiprocessor, the simulation model must be allocated to processors according to unique mathematical requirements and/or solution frequencies. If an Eigenvalue analysis is run on the entire system model solved on a single digital computer for a few critical regions in the time solution, the resulting frequency distributions can provide essential information on range of time constants. Subsystems with the fastest time-constants can be targeted for parallel processors while low frequency subsystems remain on the digital processor.

By proper specification of subsystem inputs and outputs, the interface between time constants varying by more than 10/1 can be handled by periodically updated coefficients to ensure high-frequency stability. If subsystems have only state variable input/output, the entire subsystem calculation can proceed in parallel with other calculations.

In addition to targeting complete subsystems, individual variables can be targeted to other processors which implies that the entire statement defining the variable will go to that processor. If variables from other processors are required, the appropriate interface operations are automatically created.

For statistical analysis or solution of partial differential equations, it is often necessary to run much faster than real time and up to the full performance of the available parallel processor. Here, one will first target the entire dynamic mode for the parallel processor. If it does not fit, certain calculations such as algebraic equations may be redefined as functions to use the function generation processor. Only a minimum portion of the high speed problem can be targeted for the digital processor.

STARTRAN - THE SIMSTAR PROGRAMMING SYSTEM

STARTRAN is the term coined by Electronic Associates to describe the programming system developed for the SIMSTAR multiprocessor. A flow chart of this complete system design from source input to multiprocessor execution is shown in Fig. 4. The highest level language preprocessor will accept the structured system description, sort out and tag statements and identifiers, and generate one or more simulation language programs according to targeting statements. For many

applications, the user will enter function data directly into the source program. However, in some applications, very large sets of function data are required which are best handled by reference in the source language while the actual data is resident in a file. This may then be passed through to be used as a data base for other software processors and finally by the hardware. The digital simulation language program may contain multiple DERIVATIVE sections for equations with similar time constants. For subsystems or variables targeted to the parallel processor, appropriate A/D and D/A conversions are automatically programmed to occur at the corresponding digital frame time. Any variables declared as SYSTEM Input/Output are assigned for A/D and D/A conversion at the Communication Interval.

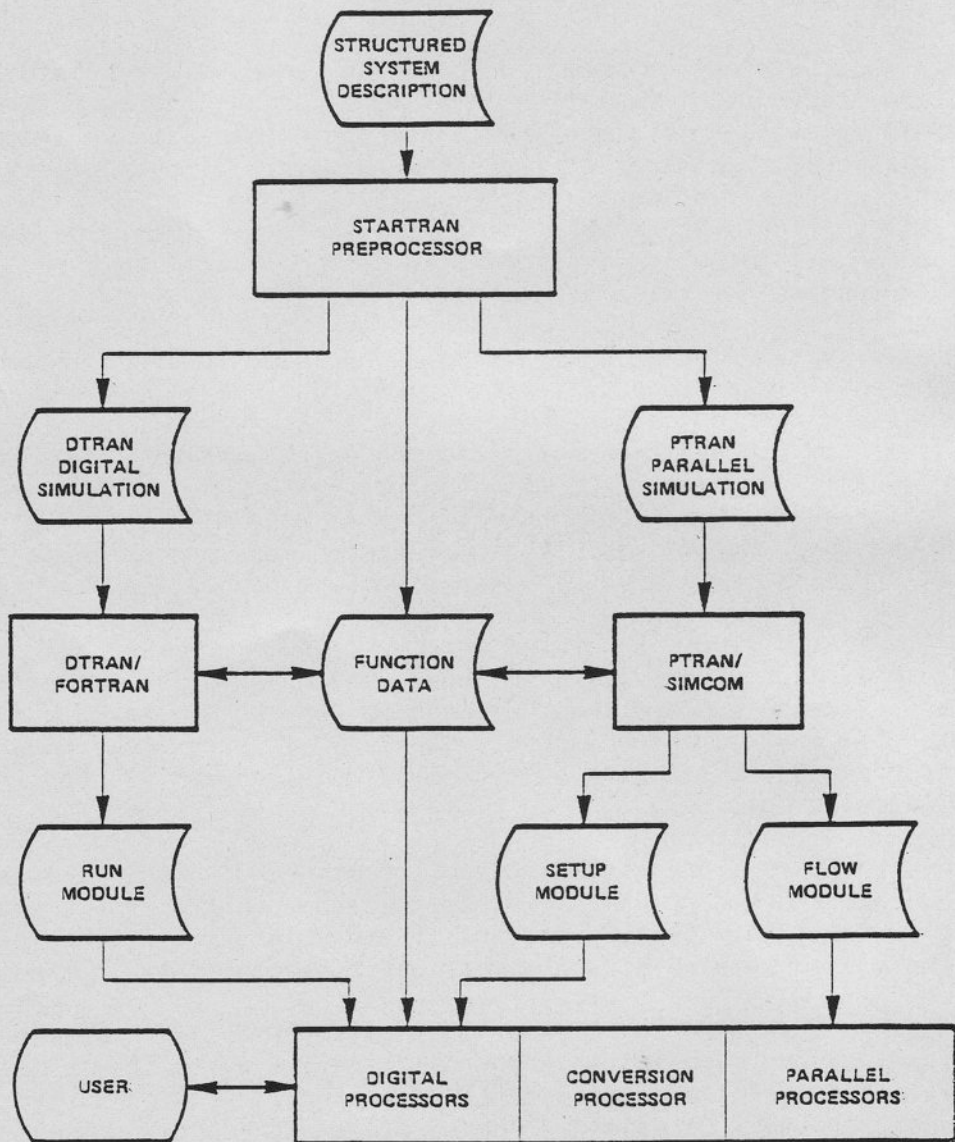


Figure 4 - STARTRAN Program Generation

After the preprocessor has re-arranged the program for simulation processing, the various sequential and parallel compiling processors may proceed to create the various load modules for program FLOW, SETUP, and RUN. The user interacts through the digital processor in SIMSTAR to load and operate the complete program in the structured form originally presented to the STARTRAN system. Variables and parameters are accessed in any of the processors using only the original source name. Values are automatically read from parallel processor components and unscaled before display. The user can enter new parameters or range values and all parallel processing math blocks are automatically set.

EXAMPLE SIMULATION STUDY

This simple real-time simulation has most of the attributes of a large-scale study. A block diagram of the vehicle system including a driver is shown in Fig. 5. The vehicle is composed of the three primary subsystems: Body, Tires, and Engine. Only acceleration in a straight line is represented. The driver can control the throttle position (THRC) and the clutch to start the vehicle motion. His only feedback is the engine speed as it might drive a Tachometer.

Since the details of the simple mathematical model are not germane to the system description concepts, the STARTRAN source program shown in Fig's 6a-c will suffice. In 6a, the system-wide variables such as engine 1 or 2 selection SELE1, clutch logic, displacement X , and TIME are declared. In the SYSTEM INITIAL region, global constants are established which will not be accessible at run-time.

The output=input variables for the BODY are shown just as on the block diagram. Values for BODY parameters are assigned next. These statements are placed in a special REINIT routine which is executed once at the beginning of the program and again only if REINIT command is entered.

The DYNAMIC statement is optional and is not in these subsystem descriptions. The mathematical model is a straightforward set of ACSL statements. Since the outputs of the BODY are all state variables, this subsystem can be sorted to be the last processed.

The TIRES subsystem is very similar and would be sorted for solution just before the BODY. Finally, the TIRES needs the MOMENT from the ENGINE subsystem so the ENGINE would be sorted to be the first part of the derivative calculation. The ENGINE model allows the driver to set the initial engine speed before the clutch is engaged.

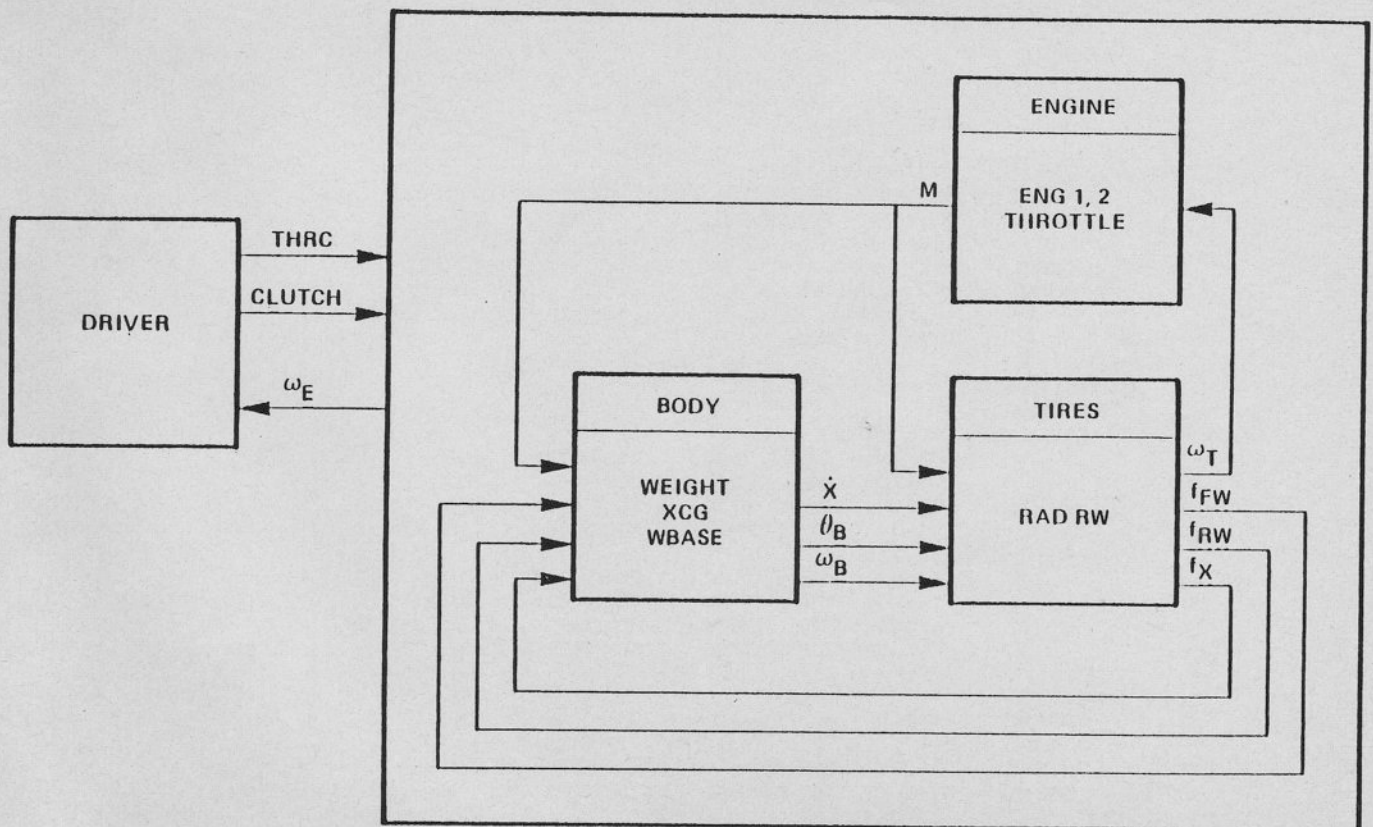


Figure 5 - Block Diagram of Vehicle System

STARTRAN SYSTEM DESCRIPTION

SYSTEM DRAGSTER(OMEGAE = THRC, CLUTCH)

LOGICAL SELE1, CLUTCH
 REAL X
 VARIABLE TIME = 0

INITIAL

G = 32.2; RHO = 0.081; XTERM = 1320

SUBSYS BODY(XDT, THETAB, OMEGAB = ...
 FTIRE, MOMENT, FORFW, FORRW)
 WGTB = 1500; WBASE = 18; RCG = 4
 PHI = 10(DEG); CDRAG = 0.1

DERIVATIVE

TRANSLATION

MASB = WGTB/G
 FDRAG = 0.5 * RHO * CDRAG * XDT * ABS(XDT)
 XDDT = (FTIRE - FDRAG) / MASB
 XDT = INTEG(XDDT, 0)
 X = INTEG(XDT, 0)

ROTATION

OMEGAB = INTEG((MOMENT + WBASE*FORFW + MASB*RCG*XDDT* ...
 SIN(PHI + THETAB) - WGTB*RCG*COS(PHI + THETAB)) / ...
 INERTB, 0)
 THETAB = INTEG(OMEGAB, 0)

END

Figure 6a - STRATRAN Structured Program for Vehicle Design

SUBSYS TIRES(FTIRE, FORFW, FORRW, OMEGAT = ...
 MOMENT, OMEGAB, THETAB, XDT)
 KFT = 2400; DFT = 100; WGTB = 200
 XD TM = 500; RADT = 1.8

DERIVATIVE

VERTICAL TIRE FORCES

INERT = 0.5*WGTB*RADT**2/G
 FORFW = BOUND(0.0, 5000.0, - (KFT * WBASE * THETAB + ...
 DFT * WBASE * OMEGAB))
 FORRW = WGTB - FORFW

REAR TIRE ROTATION

OMEGAT = MODINT((MOMENT - FTIRE*RADT) / INERT, 0, ...
 CLUTCH, .FALSE.)
 SLIP = (OMEGAT*RADT - XDT) / XD TM
 FTIRE = (WGTB + FORRW) * FRCOEF
 FRCOEF = RSW((SLIP .LT. 0.2), ...
 BOUND(0.0, 1.4, 1.4*SLIP/0.15), 0.65)

END

SUBSYS ENGINE(MOMENT = OMEGAT)

OMEGEO = 100

TABLE ENGIN1, 1, 13 ...

/	0,	60,	120,	180,	240,	300,	360,	...
	420,	480,	540,	600,	660,	720,	...	
	2000,	3050,	3700,	4150,	4300,	4200,	3900,	...
	3600,	3100,	2500,	1750,	900,	100	/	

TABLE ENGIN2, 1, 13 ...

/	0,	60,	120,	180,	240,	300,	360,	...
	420,	480,	540,	600,	660,	720,	...	
	1000,	1970,	2820,	3480,	3930,	4130,	4220,	...
	4250,	4130,	3750,	3030,	1910,	430	/	

DERIVATIVE

ENGINE ROTATION

OMEGAD = RSW(CLUTCH, 720*THRC, 3*OMEGAT)
 OMEGAE = INTEG((OMEGAD - OMEGAE) / 0.1, OMEGEO)
 MOMENT = THRC * RSW(SELE1, ENGIN1(OMEGAE), ENGIN2(OMEGAE))

END

Figure 6b - Vehicle Tires and Engine

```

RUNTIME
  INIT SYSTEM PARAMETERS
    SELE1 = .TRUE.
  COMMUNICATION/INTEGRATION
    CINT = 0.05, NSTP = 5

  INITIAL
10..  CONTINUE
     CALL INTACT

  DYNAMIC
     TERMT( X.GT.XTERM .OR. THETAB.GT.1 )

  TERMINAL
    IF (THETAB.GT.1) GOTO 100
    XDTMPH = 3600 * XDT / 5280
    WRITE( 2,3000) TIME, XDTMPH
    GO TO 10
100..WRITE( 2,2000 )
    GO TO 10
2000..FORMAT( 1H0, ' ** CAR FLIPPED ** ' )
3000..FORMAT(1H0, 'ELAPSED TIME = ',F7.3,' SECONDS ',/, ' ...
      ' TOP END SPEED = ',F8.2 , ' MPH',/ )
END.

```

Figure 6c - STATRAN Execution Control

If this system were implemented on SIMSTAR, the TIRES and ENGINE would be targeted for the parallel processor. All of the output variables to the BODY would go to D/A converters and the input variables would come from A/D converters. Note that the high gain tire loop is closed continuously on the parallel processor and only the lower frequency resulting tire force FTIRE is passed to the numerical body calculations.

The RUNTIME region selects Engine 1 at program startup and the numerical solution communication interval of 0.05 seconds. A problem time step of 0.01 seconds is specified by 5 integration steps per communication interval. The INITIAL section provides for program run control and a convenient paged means for interactive parameter changing in the subroutine INTACT. The TERMT statement in the DYNAMIC section will stop the run when X is equal to XTERM or if the vehicle pitches to one radian. Then the TERMINAL region analyzes/presents the results and loops back to statement 10 to setup the next design run.

CONCLUSION

Efficient application of the SIMSTAR non-homogeneous multiprocessor (NHM) has been discussed in terms of a system description language approach. It seems there will be an increasing need for NHM systems since the economical uniprocessor speed barrier seems to have been met and the application requirements are still growing rapidly. Users will not tolerate having to custom tailor models for NHM implementation. The system description approach provides the user a natural medium to specify his dynamic system. SIMSTAR system requirements of partitioning and sorting model for multiprocessor implementation is relatively transparent to the user.

Although some of the high level elements of the STARTRAN program generation system are still under development, the parallel simulation language compiler and the ACSL digital simulation compiler have proven the feasibility.

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2. Landauer, J.P.: SIMSTAR - An Attached Multiprocessor for Dynamic System Engineering. 1983 SCSC Proceedings, pp. 166-175
3. STARTRAN 1 Program Generation System. Electronic Associates, Inc., PIB-15, December 1984.

SIMSTAR at the Technical University of Vienna



In December 1985 a two-day informative meeting for people interested in the SIMSTAR Multiprocessor took place at the Hybrid Computation Centre of the Technical University of Vienna. 15 attendees from German speaking areas in Europe (from universities and industry) were joined by EAI representatives. The programme featured reports from the Technical University about the technology, the operation, and applications of the new SIMSTAR system in Vienna, and many interesting discussions.

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