Travel Report from Standardization Workshop and a Congress in Sorrento, Italy, September 1979

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TRAVEL REPORT FROM A STANDARDIZATION WORKSHOP AND A CONGRESS IN SORRENTO, ITALY, SEPTEMBER 1979

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The author participated in the Sorrento Workshop for International Standardization of Simulation Languages and IMACS Congress / Simulation of Systems. This travel report tells about the activities at the workshop, about some of the papers at the congress and about the reactions on Dymola. The position paper for the workshop is included in the appendix.

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Travel Report from a Standardization Workshop and a Congress in Sorrento, Italy, September 1979

Hilding Elmqvist

INTRODUCTION

The author participated in an international workshop on standardization of simulation languages and presented a paper at the IMACS Congress in Sorrento, Italy September 1979.

The "Sorrento Workshop for International Standardization of Simulation Languages" was held on September 20-21 at St Agata about 10 km from Sorrento. It was organized by Tuncer Oren, Ottawa, Canada and Maurice Elzas, Wageningen, The Netherlands. It was sponsored by several international organizations such as IMACS and SCS. There were about 25 participants.

The IMACS Congress "Simulation of Systems" was held on September 24-28 in Sorrento.

STANDARDIZATION WORKSHOP

The first day of the workshop was used for presentation of position papers. A list of those is given below. The author's position paper is included in the appendix. There was also a two hour general discussion in the afternoon.

Richard E. Nance:
To be, or not to be - Is that the question?

Antonio P. Bongulielmi, Francois E. Cellier:
On the Usefulness of Deterministic Grammars for Simulation Languages

Hilding Elmqvist:
Some New Convenient Features of Simulation Languages

Joseph S. Gauthier:
Experiences with ACSL

Harry M. Markowitz:
Proposal for the Standardization of Status Description

Inge Troch:
Some Ideas of a "User" about Simulation Software

Giuseppe Iazeolla:
Simulation Languages and the Management of Large Modeling Projects

Peter R. Benyon:
Standardized Expression of Rate-State Relations

The discussions on the second day was organized around the following seven issues:

1. Standardization level
   - program
   - model
   - conceptual

2. Goal
   - portability
   - communication / documentation
   - error prevention
   - convenience (expressive power)
   - user friendlyness (for naive users)

3. Standardization approach
   - universal base
   - hierarchical (stratified) preserving distinction in formalisms
   - enrichable / self extandable

4. User orientation
   - different standards for different types of users
   - universal
   - expandable
   - P.O.L. (Problem Oriented Languages)
   - domain dependent (training simulators etc.)

   Strategy:
   - identify user community
   - base on experts

5. Large scale orientation
   - aggregation
   - linkage
   - modularity

6. Slicing of the pie
   - classical: continuous - discrete
   - static - dynamic
   - model description - experimentation

7. Features
   - discuss first and in detail
   - later
   - only basic ones

It was decided to continue the standardization work on the conceptual level.

An international committe was set up. Maurice Elzas was elected as chairman and Francois Cellier as secretary. The committee should seek sponsorship from international organizations like IFIP, IMACS, SCS, IAC, ISO and SGSR.

Two subcommittes were formed:

1. Describe and inventorize formalisms for hierarchical, stratisfied approaches.

   chairman: Zeigler
   cochairman: Markowitz

2. Policy and Goals. Refine, review and expand issues discussed and goals proposed.

   chairman: Troch
   cochairman: Nielsen

The committee will have a Newsletter and the subcommittes are supposed to issue a yearly progress report.

I became a member on the subcommitte on formalisms.

CONGRESS

Below follows some comments on the most interesting papers at the congress in relation to my work.

B. Ziegler presented the invited paper:

Modelling and Simulation Methodology: State of the Art and Promising Directions

The presentation by E. Toczylowski of

Large Scale Steady State Process Simulation Methods

was closely related to my work. It dealt mainly with the problem of tearing. That is a method of reducing the number of iterated variables when solving systems of nonlinear equations. He talked about static models but it is certainly interesting for dynamic models as well.

F. Cellier presented

The COSY Simulation Language

It is a combined language adapted to GASP-V.

Kettinis talked about

Combined Simulation with SIMULA 67.

His work is closely related to the program COMBINEDSIMULATION developed by Keld Helsgaun, Roskilde.

There was a special session on parallel processing. C. Brugger presented

The Third Generation Microprocessor MC68000

and H. Lienhard talked about

Simulation and Process Control with Parallel Processes as implemented in Portal - Experience and Outlook

It was a very good presentation of Portal which is a language with several nice features for parallel processes.

There was also a panel discussion.

TECNICAL COMMITTE 3 (TC3) OF IMACS

I am a member of Technical committee 3 (TC3) of IMACS (WP1 and WP2). TC3 had a meeting during the congress. The chairman of TC3 (B. Girling) and secretary (A. Bennett) then resigned. E. Crosbie was elected new chairman. TC3 had previosly 3 working parties: WP1 (simulation languages, chairman M. Elzas), WP2 (simulation compilers, chairman T. Oren) and WP3. A discussion started on weather this structure should be preserved or not. It was argued that it was not neccessary since at least WP1 and WP2 had been working in such a close contact. It was then decided to close the meeting and rejoin two days later.

At that meeting M. Elzas resigned from TC3 and also pointed out the need to have clear rules about who are allowed to vote at such meetings. There were no such rules which implied that anyone could join a meeting and vote.

F. Cellier was elected as secretary of TC3. The next meeting will take place in Interlaken, June 1980 in connection with the conference Simulation '80.

REACTIONS ON SIMNON AND DYMOLA

The author presented the model language Dymola at the Summer Computer Simulation Conference in Toronto in July 1979.

There was a very positive response to these ideas and many were interested in further information.

During the visit to Sorrento I made two presentations: once at the workshop and once at the congress. I presented a position paper, which is included in the appendix, at the workshop. It discusses the main conceptual work in Dymola and Simnon such as:

- general equations
- submodels
- connection of submodels
- submodel structure
- difference equations
- interaction

Information about Dymola in the form of the paper to SCSC in Toronto was also handed out.

There was a very positive response both formally at the sessions and informally when talking with individual participants. It seemed that concepts such as connection mechanisms, cuts and submodel structure made sense even to participants with a background in discrete simulation.

The authors paper at the congress was entitled:

Manipulation of Continuous Models Based on Equations to Assignment Statements

It deals with the application of graph theoretical methods and formula manipulation for transforming equations to assignment statements.

I was especially pleased to notice that the simulation methodologist Bernard Zeigler, Israel found the concepts so interesting in relation to his work. He said to me that he, after reading my thesis, found the concept of path and how that was used to describe submodel structure very elegant. He also commented about his need to get input of that kind for his research.

Bernard Zeigler is editor of a section of the journal Simulation called Frontiers in Simulation Methodology. He suggested that I should write an article about the concepts of Dymola to be included there.

I had several talks to Ragnar Nielsen, Los Angeles. He has recently been elected chairman of the SCS committe on simulation languages. Furthermore, he has a company called Simulation Services which provides the simulation program CSSL-IV. He is very interested in Dymola. We talked about a cooperation in which we would provide the Dymola compiler as a preprocessor to be used with CSSL-IV.

Francois Cellier, Switzerland has included some of the concepts of Dymola in his simulation language COSY. They are now writing a preprocessor to GASP-IV.

Future activities

Below follows a list of suggestions for future activities:

1. Convert the Dymola translator (written in Simula) to Pascal

2. Make the translator act as a preprocessor for different simulation languages such as SIMNON, CSSL and CSMP.

3. Write a user's manual for Dymola.

4. Write article for Simulation

5. Write paper for conference on simulation methodology in Ottawa 1981.

6. Start a master thesis project on selection of state variables for models in Dymola as indicated in my thesis.

CONCLUSIONS

It was an important visit to Italy. Since the workshop was closely related to the work I have been doing it was important to inform about that. The reactions at the congress about Dymola was very positive and I made a lot of new contacts.

Appendix: Position paper for workshop

APPENDIX

Position paper for:

Sorrento Workshop for International Standardization of Simulation Languages

Sorrento, Italy, September 1979

Some New Convenient Features of Simulation Languages

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INTRODUCTION

This paper presents some new features for simulation languages. They have been tested in two languages developed by the author: Simnon [4,5] and Dymola [1,2,3].

Simnon is a complete simulation program written in Fortran. It was developed in 1973-1974 and has been used extensively at universities and industries in Sweden. The model is described in a special model language or in Fortran. The manipulation of the model is done interactively by commands. Results are plotted on a display. The model may consist of a collection of submodels. Each submodel is either continuous time (ordinary differential equations) or discrete time (difference equations).

The Dymola language is one part of the authors Ph.D thesis [1]. It contains some new features. It is based on general equations and has concepts for submodels, connection mechanisms and submodel structure. A test compiler was developed (listed in [1]) and used when modelling some large systems [1] in order to test the convenience of Dymola. The results were encouraging.

Equations, submodels and connection mechanisms have also been used in a program developed at University of Illinois [6].

Appendix: Position paper for workshop

EQUATIONS

The basic element of the so called equation oriented languages is in fact a restricted form of equations with only a variable as left part (assignment statements). There are several advantages by allowing models with general equations. Some of them are listed below:

- Better documentation. Since the model consists of the basic physical equations there is less need for separate documentation.

- The model becomes independent of what calculations it should be used for (simulation, static design calculations etc).

- The correctness of the model is increased. Even if the rewriting of each equation is trivial, the chance of making an error increases when there are hundreds of equations to rewrite.

- The use of equations is a basic requirement when dealing with model libraries. Which variable that should be solved from an equation might depend on the environment of the submodel.

- Small changes in a model might require major rewriting of assignment statements. This could e.g. be the case when some dynamics are neglected (some derivative is replaced by zero and the corresponding variable is considered as auxiliary).

Most integration algorithms assumes that it is possible to calculate derivatives easily. The equations have to be transformed to assignment statements in order to do that efficiently. This is, of course not always possible. However, it is possible for a large class of models. The evidence is that the modeller can do it when using languages of CSSL-type. It is possible to do the transformation automatic for many models. This transformation involves three steps:

- determine which variable to solve from each equation

- sort the equations and find systems of equations that have to be solved simultaneously

- transform each equation to an assignment statement using automatic formula manipulation

The two first steps are graph theoretical problems. These manipulations are described in [1] and [3].

Appendix: Position paper for workshop

SUBMODELS

A common principle for solving large problems is decomposition of the problem into a set of smaller subproblems which are either solved directly or further decomposed. The original problem is then solved by combining the subproblem solutions.

This principle is used when modelling large systems. The system is considered as a set of submodels. This decomposition is often inherent in physical systems. An industrial plant, for example, is in fact designed according to a decomposition principle. The language to describe the model should reflect this and encourage the use of submodels.

The languages of CSSL-type have a MACRO facility which can be used to define submodels. However, it is conceptionally more natural to have a special submodel feature instead of a general Macro concept. Furthermore, that would allow better security and error diagnostics. It also solves the problem of naming local variables in submodels. A dot-notation could be used in that case.

CONNECTION OF SUBMODELS

A model must also contain a description of how submodels interact with each other. The introduction of submodels is often done in a way that the interaction between them is rather limited. The interaction is often restricted to a set of connection mechanisms. Such connection mechanisms often correspond to some physical devices such as shafts, pipes, electrical wires etc. A model language ought to have a means of defining abstract connection mechanisms. This can be done by introducing cuts between the submodels and by declaring what variables are used to describe the interaction through each cut. Such cuts can then be used to conveniently describe the connection of submodels.

SUBMODEL STRUCTURE

There is no construct corresponding to connection mechanisms in the languages of CSSL-type. The connections are done by means of variables. Each macro has formal input and output variables. The connection of two submodels is done by having the same variables appear as actual variable in both of the corresponding macro invocations. This way of describing the connections tends to hide the structure of the model. One reason is that the details of the connection mechanisms, such as the variables involved, are considered at the same time.

The submodel structure of a model is often visualized as a block diagram consisting of boxes for the submodels and lines for the connection mechanisms. After introduction of connection mechanisms it is easy to introduce natural language elements for description of this structure. This makes the description easy to check because it does not contain so many details and it is easy to compare with a block diagram.

DIFFERENCE EQUATIONS

The subclass of combined continuous - discrete models consisting of continuous time and discrete time models (ordinary differential equations and difference equations) has become more important. The reason is that computers are often used to control e.g. industrial processes. It is then convenient to describe the process by ordinary differential equations and the control algorithms of the computer by difference equations. Discrete time models are thus natural concepts for control engineers. It might then be unnecessary complicated and error-prone to use the features of general discrete models. Furthermore, there is a nice symmetry between continuous and discrte time models. The difference is how thwe states are updated.

INTERACTION

A simulation program should be interactive to be convenient. It should be easy to change parameters of the model etc and to obtain plots of selected variables. Tables are almost always useless.

It is important to separate the model description and the manipulation of the model. The manipulation of the model is conveniently done by commands with arguments. It is useful to have a macro or procedure concept at the interaction level which allows grouping of commands for later and repeated use. Changes to the model could be done with an editor.

A general interaction module called Intrac is described in [7]. Intrac is used in Simnon.

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