ALLAN.SIMULATION
A GENERAL SOFTWARE TOOL
FOR MODEL DESCRIPTION AND SIMULATION

Alexandre JEANDEL, Fabien FAVRET, Laurence LAPENU
*GAZ DE FRANCE**

Eric LARIVIERE
*CISI INGENIERIE***

ALLAN.-SIMULATIONINEPTUNIX is a software designed at the GAZ DE FRANCE Research and Development Division and developed with the aid of CISI Ingenierie. It is a general software for the description and simulation of dynamic systems. ALLAN. Simulation is a pre- and post- processor. It is not a simulation software, and simulation is due to the choice of a solver. It is used at GAZ DE FRANCE and in other companies to describe and manage models for the NEPTUNIX 2 simulation program. It may also be used with ASTEC 4.

The intention of this paper is to introduce the reader to the central concepts and reasons behind the ALLAN project. The latter was aimed primarily at enabling engineers to work in their natural languages, i.e. differential algebraic equations and/or system drawings, thus freeing them of the concern with computer programming and equation solving and making the reuse of previous work easier.

Today, we can describe the actual implementation of the software, draw up an initial assessment of more than five years of operation and state some possibilities for new developements.

1. INTRODUCTION

This paper first introduces GAZ DE FRANCE and its needs for models and simulations. A short reminder of the uses and goals of modeling and simulating is followed by the description of the engineer approach to these studies. The constraints of the company are also discussed. The simulation needs, the model building approach and the company constraints lead us to the description of the ALLAN.Simulation software. Ten years after the first software specifications and five years after it first became operational in the company, an assessment can be made and future developements introduced.

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(*) Research and Development Division
361, avenue du Président Wilson
F-93211 LA PLAINE SAINT-DENIS CEDEX
FRANCE
(**) 3, rue Le Corbusier
Silic 232
F-94528 RUNGIS Cedex
FRANCE

2. NEEDS

2.1. STUDIES AT GAZ DE FRANCE

Gaz de France, the French public gas company, is involved in natural gas importation, transportation and distribution throughout France. To perform these tasks as well as possible, the research engineers of its Research and Developement Division work on the improvement of all the technical systems used along the gas chain : from the gas extraction and transportation, to the consumer end-uses. At Gaz de France there are many studies on, for example :

- gas liquefaction,
- gas transportation (pipe, governors, compressors, etc.),
- gas storage (underground storage, etc.),
- industrial and domestic gas uses (kilns, furnaces, gas-boilers, gas-stoves, etc.),
- thermal studies (furnaces, building performances, etc.)

One of the best ways to conduct these studies is to perform modeling and simulation of technical and dynamic systems.

2.2 THE ROLE OF DYNAMIC MODELS OF TECHNICAL SYSTEMS

We shall begin be defining what exactly is the role of modeling and simulation. Simulation serves different purposes: identification, design and analysis.

2.2.1 Identification

Practically speaking, the primary role of modeling is to explain the system being studied. In actual fact, the system to be represented is known (or thought to be known) in certain functional respects. We can generally avail of experimental readings of inputs and outputs for the systems studied. Hence, the work involved here is undoubtedly model identification (structure and/or parameters). For example, in the case of parameter identification, it may be conducted on a trial-and-error basis or by using mathematical algorithms. Identifying a system is the very core of the modeling activity.

2.2.2 Control and design

The user may wish to improve the system under study, by perfecting certain components, setting up controls or making other technical modifications in the system. In other words, the objective is to design a technical system with its controls.

In these kinds of studies, different types of models have to be build: physical ones and synthetic ones. Physical models are necessary to design the components of the systems. They can also be the starting point in elaborating the more simplified synthetic models for control synthesis purposes. Mathematical programs for linearisation and reductions may be used at this stage. The physical models are again used to validate the complete system with its controls. Simulation is used to simulate operation of the real system, because it is easier to modify a model (and so the simulator) than to modify the real system in order to perform a lot of new design part tests, and testing the validity of an new control law is safer on a simulator than on an existing process.

Designing may require the use of sophisticated mathematical algorithms in order to analyse the behaviour of the models : stability analysis, vibrating mode extraction, parameter sensitivity analysis, etc).

2.2.3 Analysis

Once the simulator is created, the simulation user often carries out analyses. He extrapolates from the behavior of his system to other inputs and analyzes the results. Simulation serves as the equivalent of an experimental test bench. At this stage, it is worth stressing that it is useful to be able to put a simulator into specialized programs, for use by design offices, for example.

2.2.4 Scope of ALLAN.Simulation

Because of the variety of studies necessary to perform GAZ DE FRANCE tasks, engineers need to be able to perform all of these studies. To do so, they first need a tool including the possibility of describing and running the most general and complicated model : the physics-based models. Let us be more precise. Since the design or improvement of a system with its controls is our main goal, we stressed different aspects : "system" and "dynamic" and dropped "multi-dimension". From our point of view, multi-dimension is more useful for the spatial design of a component than for the design of the system including this particular component. Pursuing our aim, it will be desirable to allow the use of mathematical algorithms for identification, optimization, analysis and control synthesis.

2.3 THE ENGINEER APPROACH

2.3.1 Requirements analysis

The first step in any research engineer's approach is to make sure he has properly understood the question asked. As a matter of fact, he should have this concern constantly in mind. Hence, he has to reformulate the question and check it with the requesting party. He will constantly return to that departure point to check that his action is coherent.

The engineer approach to modeling/simulation
■ Requirement analysis
■ Top-down analysis (breakdown) : ♦ functional ♦ technical ♦ phenomenological
■ Choice of mathematical representation
■ Bottom-up assembly and validations
■ Responses to the requirements

2.3.2 Breakdown

His approach then consists of breaking down his system, whether it actually exists or is only imagined. Systematic top-down analysis is natural because it moves from the prehension of a complex technical system to a set of subsystems reduced to their essential behaviors. The engineer can draw on any of the various forms of division at his disposal: functional, topological, technical or phenomenological. In a design approach, the first breakdown will naturally begin with the major functions he wants his system to fulfil. Only later will he complete those functions with the appropriate technical elements. In identification or analysis, on the other hand, the breakdown to come to his mind first will be according to the technical components. This is because those are the most natural components, recognizable on a real installation and clearly identified on a technical drawing.

2.3.3 Choosing the mathematical representation

For the "hardware" (components) , as distinct from the "software" (control algorithms), he has to deal with the physical phenomena in order to complete his analysis and work out a mathematical representation. At this point, he writes the equations for each of the components in his system, after which he reverses the procedure used previously to gradually rebuild his system according to a bottom-up approach.

2.3.4 Assembly and validations

A step-by-step assembly and validations of the components and assemblies are then necessary to ensure high quality work. This is done by simulating each component and relevant assemblies leading to the complete system model. Different types of validations may be used : qualitative, numerical, analytical and experimental (Jeandel 93). Validation is based on comparison between outputs for given inputs. The engineer often has to modify the model which has to be improved during the iterative validation process. So he has to go back to one of the previous steps, modify and start the process again.

2.3.5 Responses to the requirements

Once his system is finally validated, the engineer will be able to answer the question posed. This will be the well earned reward for his toil. His study will be evaluated according to the quality and speed of the answer it provides. Subsequently, we will take account of the constraints of Company life before finally returning to our needs.

2.4 COMPANY CONSTRAINTS

What does a company really want? The best and cheapest possible answer to the question posed. Modeling is essential to systems research. The advantages of this approach are recognized. However, its drawbacks are less frequently mentioned. There are two major ones: first, it is time-consuming and, second, its result depends on the quality of the model builder's work.

2.4.1 Quality and rapidity

Company action will consistently be aimed at counteracting those drawbacks. The only way to obtain quality in work is through rigorous methods and tools, but the strict requirements these entail also slow down the process. A compromise has to be found between the two constraints, speed and quality. This appears to be a difficult task, impossible in certain cases. In fact, however, by taking not just a single study, but rather a series of studies over time, this dilemma can be solved, provided that earlier work is reused. Indeed, the broader the field of application of the tool, the more effective this solution becomes.

2.4.2 Speeding up the approach

For greater rapidity in a company, efforts must be made to relieve the project manager of as much computer programming and numerical processing as possible and to get the most long-term benefit and reuse potential out of his work. Another means would be to draw on the collaboration of other partners who share the same method and tool.

2.4.3 Reusing prior or outside work

Reusing work is very demanding, because while it can speed up the study, transparency is essential. This is in fact the guarantee of quality. It effectively counteracts the problem of individualization in work. It demands a method and a tool.

2.4.4 The generality and permanency of the tool

Nevertheless, at this point, we can deduce from the constraint of reusing previous work a number of highly stringent requirements regarding the tool's specifications. Two aspects are worth stressing: the generality of the software and its permanency. Its field of application should be as broad as possible if we are to achieve the desired scale effect. Moreover, it should last long enough to justify the investment. In other words, it must be based on a representation of the most general model possible and take into account the various roles played by modeling/simulation, so as to be able to handle an ever-higher level of compatibility among the models. Finally, it has to reproduce the natural work process in the most transparent manner possible. This means that it has to memorize the engineer's initial subdivision work and provide a mathematical representation of the models which is as close as possible to the one he is accustomed to using.

2.5 THE NEED FOR A MODELER

Having dealt with the role of modeling and simulation and the very stringent company constraints, it is now possible to specify the software we want. A software in which models are already described and in which the user has only to perform the assembly of elementary components (which have been validated by specialists) would be very time efficient but would not afford a complete understanding of the system studied or easy modification of a component's behavior.

So it was decided to use (and thus to build) a general modeling tool without any previous models library, but in which it would be possible to design every kind of model to perform any kind of study. The engineer knows exactly what his own models represent. But in order to allow use of previous works, it can also be used with a model library previously created. Simulation can then be very easy. Thus identification, analysis, control and design are possible even though not included in terms of mathematical algorithms in the software.

Roles	Specifications
Analysis-study	Operating flexibility of the simulator : ♦ choice of excitations ♦ choice of initialisations ♦ choice of observations ♦ result curves ♦ calculation from results
Analysis-simulator	Portability of the simulator created
Identification	Possibility of using the simulator with mathematical algorithms.
Design and controls	Object handling of models ♦ choice of parameters Continuous-discrete coupling

3. THE MODELER

A modeler is not designed to do the engineer's work, but to help him during his work. Because of pre-existing simulation tools, we decided to use two of them to perform the simulations (NEPTUNIX and ASTEC). So, we only built the modeling software tool in which translators are available to go from its internal representation to the input language of simulator building core.

3.1 ALLAN.SIMULATION HISTORY

ALLAN.Simulation was developed in three stages. First, in 1983-86, GAZ DE FRANCE set up an experimental modeler for the ASTEC solver (Pottier 83; Chouard & al. 84). Simultaneously, another solver, NEPTUNIX (Nakhlé 91), was analyzed. After validating the concepts on this first program, the decision was made to set up a multi-solver prototype with ASTEC and NEPTUNIX (Favret 88). It was developed in collaboration with CISI Ingénierie in 1986-87 and then used internally. It served in defining the final product. From that point on, CISI Ingénierie became a partner in the venture. The final product was developed between 1987 to 1989. In early 1989, it was installed at the GAZ DE FRANCE Research Center and a few months later CISI Ingénierie began marketing it. Each year, a new release of the product takes into account observations made by the users of the software at GAZ DE FRANCE and other major companies.

3.2 MODELER SPECIFICATION

The original purposes of the ALLAN.Simulation software were to relieve the engineer of numerical analysis and programming work and to use the most natural language to perform modeling : technical diagrams and differential algebraic equations.

3.2.1 The engineer approach

Clearly, the systems approach described above has little in common with the tools conventionally used by the engineer. Traditionally, the engineer's task was essentially a confrontation with computer programming and equation solving methods. He devoted relatively little time to modeling and analysis activities and much more to computer programming and numerical tasks. Thus, the first objective was to relieve him of those tasks. As a result, the access to the program had to be made as natural as possible. This objective gave the program its name: ALLAN is short for Accès à des Logiciels en LAngages Naturels.

A finer analysis of the approach to studying systems showed that the natural languages were the technical diagrams and equation and that putting the "box and links" diagrams into hierarchical order reproduced the analytical work accomplished. To be of assistance to the engineer in his design research, the equations must be able to handle both continuity and discontinuity.

3.2.2 Re-use

The reusability of models results from a balance between readability, modularity, coherency and the generality of the models.

In practice, the reusability of the models proves to be the single most important factor in speeding up a study, but it is also the most restrictive factor in describing the models. The assumption that a model can be run under another simulating system implies the highest possible level of description. Only pure physics is capable of ensuring us future coherency. But it is sometimes difficult to formulate a representation with all the desired properties. Offsetting this difficulty requires a major methodological effort. For several years now, GAZ DE FRANCE has been promoting the PROFORMA form as a model documentation resource (Dubois 89; Jeandel & al. 91). This library may be considered today as an integral part of a more general methodological approach.

For large-scale systems (several dozen models), we should point out that reusability conflicts with the combined use of different levels of equational representations. How can we be sure that a block-diagram type model (oriented equations, mono-variable oriented bounds) will not conflict with another model of the same type via a dozen non-oriented models? By analyzing the system and by orienting the intermediate elements. In other words, we have brought all the models down to the least productive and least usable level. This is a rule.

The reusability of outside models is also difficult, for similar reasons. Technically speaking, a FORTRAN model can easily be incorporated in an assembly of ALLAN models. It is more difficult to ensure its coherency with the rest of the assembly. Yet this is not the most restrictive factor on the reuse of outside models. Almost none of the existing models were designed to be incorporated in a model library, but rather for performing a very specific computation in a very specific case.

3.2.3 The special role of Physics

The use of ordinary differential algebraic equations and assembly of technical components apparently ensures proper readability of the work performed. A breakdown into technical or phenomenological components makes it possible to manage models of the reusable type. The equations used in those components must describe their behavioral laws without conditioning how they will be used, which can only be determined by implicit formulation. Physics then comes into play to ensure inter model coherency, as its role is precisely that of tending toward the universal. Hence, the host structure must tend to reflect the above constraint by directly integrating the physical laws of conservation. The choice of the types of intensive and extensive variables and automatic generation of balances stems from this consideration, as does the use of multivariable bounds.

3.2.4. Open-endedness

The concern with reusing outside work further requires that the tool offer a complete, communicable representation of the objects and relations it handles. This is what we refer to as a hub language. As we can clearly see, it should not be restricted to handling the formulation of continuous equations, but must also handle discontinuity, breakdown and hierarchical ordering of models. The model-builder's analysis is just as important as the equations he establishes. In addition, such a hub gives anyone wanting to enhance his work with this tool the opportunity to do so.

At present, ALLAN.Simulation is only open textually to the recovery of models generated by other software. Three levels of description are then possible: multi-solvers, for ASTEC or for NEPTUNIX. In actuality, users rely on NEPTUNIX alone, because this solver meets their needs. This means that the translator to ASTEC is less complete than the one to NEPTUNIX, leaving us with several languages for textual description.

The ALLAN.Simulation software internal representation might be translatable into various forms for computation by other software. For example, an ALLAN.Simulation textual representation might be as general as possible, to be translatable into input form used in control command software, symbolic manipulation software, etc.

ALLAN.Simulation/NEPTUNIX
Model textual description ♦ differential algebraic equations ♦ fine handling of discontinuities ♦ automata ♦ FORTRAN
Model graphical description ♦ box and links ♦ multi-variables ports ♦ automatic conservation laws ♦ model instanciation ♦ model libraries management
Going through the model description ♦ model tree ♦ bottom-up description ♦ top-down description
Ease of operation ♦ free choice of initialisations ♦ free choice of observations ♦ reading of input data ♦ result curves ♦ calculation from results ♦ generation of independent simulators

3.2.5 Permanency

The permanency of the tool involves a number of aspects, which of course include the quality and maintenance of the program, but also its ability to maintain a mode of approach and modeling representation which is constant over time, regardless of the solver used. The tool's ability to serve several solvers ensures the permanency of the modeler. This applies to the number of users of the program as well.

3.3 ALLAN.SIMULATION

All these previous specifications describe the ALLAN.Simulation software. The main interest lies in learning how those objectives were reached and especially the lessons to be drawn from this. The objectives were indeed reached but, as usual, the details are more telling.

3.3.1. Data acquisition scenario

The software has four main menus : model description, simulator generation, simulator operation and results analysis.

During model description, it is possible to perform the breakdown (top-down approach), to model the atomic parts (textual representation) and, after that to verify (automatic checks) the assembly of sub-models (bottom-up approach). Textual description is very close to mathematical description, and allows on-line documentation to assure a maximum re-usability of models. Graphical description is very natural and can be done upward or downward. When a model or a model assembly is described, it becomes possible in the second menu to translate the internal representation of the model with limit conditions into solver syntax, and to generate the simulator. The operation of the simulator in the next menu is then easy : free choices of initialisations, observations or input files. A large number of runs may be performed to verify the model. Visualisation, printing, drawings or calculus on output data can be done with the last menu.

The engineer's approach was considerably curtailed. First, he no longer has to be concerned with the computer programming of his models. Nor does he have to choose the numerical algorithms to be used. He does, however, have to know the related constraints: problems of initialization, nature of the discontinuities, algebraic loops, etc.

3.3.2 Model libraries

Because of the high-level description and the considerable documentation allowed using ALLAN.Simulation, it became possible, during specific studies, to build specific model libraries which then may be re-used in further studies. These model libraries are open ones that can be modified for specific studies : changing the level of representation, modifying the assumptions, take account of other physical phenomena, etc.

3.3.3 Complementary tools

In 1992, to continue the project and try to be as open ended as possible, some other demonstration or prototype tools were designed. For example :

- a prototype translator tool between ALLAN.Simulation and MAPLE™ for symbolic manipulation (formal reduction, changing representation from equation to transfer formulas, etc.),
- a prototype translator tool between MAPLE and BASILE© for control, identification, numerical reduction and signal processing purposes,
- a prototype integrator tool between NEPTUNIX generated simulators and BASILE.

Previous work lead us to investigate the relations between different levels of model representations, the building of a demonstration tool using bondgraph modeling and ALLAN breakdown techniques : "SCRIBT" (Bushing & al. 92).

In 1993, a prototype translator to DASSL is in project for feasibility purposes.

3.3.4 Software permanency

The permanency of the tool is determined by the quality of the program development. The quality of the computing product, and particularly its modularity and maintainability, received special attention. The ALLAN.Simulation software consists of several modules developed in FORTRAN 77. The graphics module utilises the GKS level 2B primitives.

Because of the modularity of the software structure, it can be linked with another solver. Specifically, a translator handles translation of the ALLAN.Simulation representation into the language of the target solver. The modules dependent on the solver are clearly identified.

4. FIVE-YEAR ASSESSMENT

ALLAN.Simulation became operational as a tool five years ago. Since then, it has been used in a large number of studies at the GAZ DE FRANCE Research Center.

There, ALLAN.Simulation has freed the engineer of numerical and computer programming chores. Our hope was to see its use spread throughout the Research Center and have it become a tool accessible to all. It is clear to us today that this tool requires know-how which is not easily acquired. "Modeling" is not a skill that can be improvised. We therefore took two kinds of remedial action. First, we devoted substantial methodological work to making it even faster to obtain results. Second, a team specialized in modeling under ALLAN was formed to assist engineers using ALLAN at the Research Center.

4.1.STUDIES RESULTS

The appended list of studies demonstrates the general character of the tool. Yet it only reflects work with ALLAN.Simulation/NEPTUNIX at GAZ

Studies conducted at GDF with ALLAN.Simulation
Control strategy for a commercial heating circuit
Development of a gas governor simulator
Intermittent ceramic firing kiln
Comparison of controls in the controlled-environment test chamber
Modeling of a 2-room flat in the experimental building (Boulkroune 93)
Gas pipelines
Compressor station
Simplified natural gas transmission system
Withdrawal and retrieval from underground storage
Studio in the experimental building
Test bench cooling loop
Domestic hot water circuit
Recovery of a model of thermal behavior in the human body
Strategies for greenhouse operation
Methanation processes
Flue system (3CE)
Building heating boiler test bench
Combined heat and power station
Improvement of a boiler test bench

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DE FRANCE and does not cover the other large companies now equipped with the tool. We will give a brief description of two cases to illustrate the type of work involved.

4.1.1 Improvement of a collective boiler test bench

The goal of this study (Martin 92) was to improve the collective heating test bench of the Research and Development Division of Gaz de France. This test bench is used for the evaluation of control strategies for gas fired boilers plants.

The installation consists of a primary water loop equipped with a traditional boiler and a condensing boiler, a secondary loop or application loop, and an external cooling loop. This last loop is controlled so that the return temperature from the application loop is representative of the behavior of a real installation. So far, this behaviour has been physically modeled by a small scale model of a room with a radiator. The outside and inside temperatures used by the controller of the application loop are measured in this box. In order to widen the possibilities of the test bench, it was envisioned to replace the box by a numerical model of a building and of its heating and ventilation systems.

First, a building and equipment simulator was created by reusing models of former studies. We then used the ability of the ALLAN.Simulation/NEPTUNIX environment to produce the FORTRAN code of the model simulator. Then, the complete test bench and its controls were modeled. The FORTRAN simulator was first tested within this modeled test bench.

Finally, the building and equipement simulator was implemented in the real time environment. The use of numerical simulation and a user friendly environment enabled us to set up the specifications for a new boiler test bench.

The possibilities of including FORTRAN code in models and of generating FORTRAN simulators proved to be very useful.

4.1.2 The 3CE

Within the general framework of its work on air quality in homes, GAZ DE FRANCE has since 1988 focused on introducing room-sealed appliances in multi-family dwellings. To that end, GAZ DE FRANCE conducted studies to define a new flue system designed for multi-family buildings, known as 3CE (conduit collectif pour chaudières étanches or shared flue system for room-sealed boilers).

The 3CE is a sealed, natural-draft shared-flue system. In essence, it is composed of two shared vertical ducts terminating on the roof, the first (the combustion air inlet duct) supplies the combustion air (drawn in at roof level) required by the flued appliances and the second (the header duct) discharges the combustion products by natural draft. The two ducts are connected at their base by a by-pass to balance the pressures in the system.

In order to acquire a complete understanding of this system, the Research Center conducted parallel experimental and theoretical studies.

To implement the modeling approach presented, we identified the various technical components in the 3CE system (boiler, straight duct, elbow, tee, diffuser, etc.), as well as the discrete physical and behavioral phenomena involved (heat and warm-air transfers, boiler programmer). Through this approach, PROFORMA forms were drafted for each elementary model.

Each of the elementary models was validated qualitatively and, for certain compound models (boiler + primary flue), experimentally.

The elementary models were assembled to form the main 3CE model. The parameters of the latter are the characteristics of the warm-air heating system and the boilers, while the input consists of the outside conditions (pressure, temperature) and the status of the boilers on each floor (shut-down, start-up, operation); the output includes pressure, temperature and flowrate in the shared vertical ducts.

This model was validated experimentally at steady and transient flow, a validation mode that required specific test protocols.

By running various simulations, and thus reproducing tests, a greater understanding was achieved of the performance of the 3CE system. Through simulation of the model, the system could be studied under differing dimensions and subjected to outside conditions as well as a range of scenarios of boiler operation. In addition, certain dynamic phenomena not yet observed experimentally were demonstrated through simulation.

At present, the studies concerning the 3CE system having shifted toward the development of a system of concentric ducts, and work is under way to model such a system. Some of the elementary models (boiler, straight duct, etc.) for the 3CE system with separate ducts will be used in this work to build a model for the concentric-duct 3CE model.

4.2 BENEFITS FOR THE COMPANY

Not to mention the direct benefits due to the success of the previous studies, Gaz de France has taken particular advantage of its modeling experience especially in model re-usability. Hence, specific information has been collected on how to build and manage re-usable models libraries. Especially, a body of information on models has been compiled using both the models and inside documentation directly and the PROFORMA form. In the field of building simulation, the Gaz de France PROFORMA library is made up of over 120 forms.

4.3 BENEFITS FOR THE APPROACH

Previous studies gave us modeling experience, and we now know how a study can be conducted most successfully (or, should we say, what common errors need to be avoided). A guideline for modeling studies is thus under development to help new users in their studies.

The need to avoid errors implies diagnosis as early as possible during the model description process. In order to improve these controls, a pilot release of ALLAN.Simulation was developed in 1992 and is now being tested. After evaluation, some of these new ideas, and perhaps all of them, will be included in a new release of the software.

5 CONCLUSION

ALLAN.Simulation/NEPTUNIX fulfils the role it was designed to accomplish. Our experience has lead us to concentrate our efforts on the task of modeling. The essential features of this are the formulation of models and the breakdown. As a result, over the last two years, our work has been devoted to methodology and organization rather than to developing the computing tool. The current version, 2.41, was launched in early 1992, but the development of a 2.42 version is not yet scheduled. It is up to the users to decide whether further development is required.

Nevertheless, without modifying the program, we felt it was necessary to open it up to other environments. For that reason, we are currently testing its linkage with MAPLE, a formal mathematical software, and with BASILE, a control engineering software.

Today, ALLAN.Simulation is a commercial software tool, which, in its commercial version, can help the engineer in the process of modeling and simulating any kind of technical system. Given Gaz de France activities, this software has been used mainly on thermal studies such as explained previously in the paper. But in other companies this tool has also been used for other kinds of modeling studies such as : chemistry, electricity, mechanics, plasma physics, geology, etc.

In the future, we expect that ALLAN.Simulation will be used in all fields where performing modeling and simulation studies can be very helpful. We also expect that this open software will be completed with a variety of complementary tools to provide the engineer with a true study environment to perform such studies as control, signal processing, identification, model reduction, etc.

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