# ONGOING DEVELOPMENTS IN GASP

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During the past two years, the many applications that have been made using GASP IV (16) have resulted in the need for new developments. In reviewing the applications, it has been found that the organizational structure provided by GASP IV for building combined continuous/discrete models has been of tremendous aid to analysts. The ability to superimpose a discrete event structure on a state variable model of a system in an efficient and effective manner has been demonstrated by diverse applications. Although GASP IV is used for the normal discrete type of problems such as the study of inventory and queueing systems and for the analysis of continuous systems, it is the area of combined simulation where it has had its greatest impact. Specifically, applications to the process oriented industries have been significant. For example, GASP IV has been used to study steelmaking operations (11,21,22), electroplating procedures (8,9,10,20), the manufacturing of plastic tubing (3,4), and the production of corn syrup (19). In this last application, discrete events were used to optimize process settings using a linear programming algorithm embedded within the simulation. Other areas where combined simulation is receiving extensive attention is in crop planning and harvesting (12,13,14), environmental pollution analyses (23,27), ecological planning (7), transportation (15) and computer studies (1,26), and computer aided manufacturing.

The first type of ongoing developments relate to modifications, adaptations and extensions for GASP IV. Although these developments are straightforward, they do indicate the types of support requests that are made with regard to the GASP program. A partial list of such developments is given below.

1. A free form input package written in ANSI FORTRAN is now available for GASP IV (17). All GASP input can now be inserted by field number where fields are separated by commas. Thus, inputting GASP variables from a terminal is facilitated.

2. An option has been added to allow the output from GASP to be in a 72 or 131 column format. Thus, all output from a GASP program can be presented on a terminal.

3. New sampling routines have been added to the standard list of random deviate generators available and documented for GASP IV. In addition, more efficient procedures for sampling from probability mass functions are available upon request.

4. Additional routines for monitoring and tracing a simulation by the user have been developed.

5. Programming modules for different file structure designs have been developed. These include:
   a. pointers to the middle entry of each file;
   b. capability for having a different number of attributes per entry in the file structure;
   c. the non-core storage of some of the GASP files.

6. Outputting simulation results on different devices such as the CALCOMP plotter, GOULD printer, and TEKTRONIX terminal.

As can be seen by the above list, the users' of GASP IV main concern is with input and output developments. During the first few years of a new language, I think this will normally be the case. Let us now turn our attention to other developments in GASP which are of a more long term nature. To begin with, there is a PL/I version of GASP IV which is referred to as GASP_PL/I. GASP_PL/I is a direct translation of GASP IV with the added feature of using the based variable capability of PL/I in the design of the file structure. GASP_PL/I is documented in a recently published book (18).

Another ongoing development in GASP involves the design and implementation of an interactive version of GASP IV (5,6). Interactive GASP IV has been implemented on a General Automation SPC 16/65 minicomputer. In addition to implementing GASP IV on a minicomputer, this development has included interactive features that allow a simulation modeler to include an operator directly in the simulation model. Thus, in those situations where it is not practical or desirable to model the human element, he can be placed directly in the simulation. The placing of a human in a simulation model requires additional input/output features to be included in the language. In Interactive GASP IV, the

capability for the simulation program to prompt the operator (a programmed decision event) and for the operator to stop the simulation (an interrupt) are included in the language design. To accomplish these features, a command language was included in Interactive GASP IV as well as a menu of displays from which the operator could select the type of information he required. Although Interactive GASP IV is a working program, further design on the procedures for including a human element in a simulation are continuing.

Currently, at the Federal Institute of Technology, Zurich, Francois Cellier is adding new continuous simulation features to GASP IV. This ongoing development, referred to as GASP V, involves the inclusion of different integration algorithms which can be user selected, procedures for handling partial differential equations, and additional subprograms normally available in continuous simulation languages (2).

The last new development to be discussed involves the inclusion of a process modeling orientation (24,25). A process modeling orientation allows a modeler to include within the GASP organization the flow of transactions through a process. Processes are modeled in terms of four resources: facilities, storages, gates and signals. Queues for these resources and statistics on resources and their queues are automatically maintained. The flow of a transaction through the process is modeled in blocks where each block can contain at most one decision that could delay the transaction. Support routines for initiating transactions, killing transactions, holding transactions and for accessing information concerning the status of transactions and resources are provided. GASP IV with its continuous and event oriented organization combined with this process modeling capability is the basis for GASP VI.

As can be seen from the above description, there are many ongoing developments relating to GASP. The extensive applications being made of GASP IV provides the fuel for continuing the developments described above.

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