

INTRODUCTION TO GPSS

Thomas J. Schriber
Graduate School of Business Administration
The University of Michigan
Ann Arbor, Michigan 48109

ABSTRACT

Summary information about key aspects of the simulation programming language GPSS is provided. The class of problems to which GPSS applies especially well is described; commentary on the semantics and syntax of the language is offered; the learning-oriented literature for GPSS is summarized; various GPSS implementations are commented on; the time-sharing networks offering GPSS are cited; and public courses on the language are listed. Finally, the source of a tutorial introduction to the fundamental semantics and syntax of GPSS is given. Copies of this tutorial material, excluded from reproduction here because of page-count limits, will be distributed at the session and provide the basis for the session itself.

1. A BRIEF PERSPECTIVE ON GPSS

GPSS (General Purpose Simulation System) is a simulation programming language whose use greatly eases the task of building computer models for certain types of discrete-event simulations. (A discrete-event simulation is one in which the state of the system being simulated changes at only a discrete, but possibly random, set of time points, called event times.) GPSS lends itself especially well to the modeling of queuing systems, but is generally applicable when it is of interest to determine how well a service organization will respond to the demands placed on it. For example, GPSS has been applied to the modeling of telephone companies, brokerage firms, computing centers, supermarkets, manufacturing shops, banks, steel mills, hotels, warehouse and distribution facilities, and general business.

2. THE SEMANTICS AND SYNTAX OF GPSS

GPSS offers a fairly rich set of semantics, and yet is sparse in its syntax. For example, only nine statements (excluding several control statements) are required to model a simple one-line, one-server queuing system in GPSS. These statements take such simple forms as "GENERATE 18,6" and "QUEUE LINE". No read, write, format, or test statements appear in the model. And yet when a simulation is performed with the model, fixed-form, fixed-content output is produced, providing statistics describing the server (number of times

captured; average holding time per capture; and percent utilization) and the waiting line (average line content; average residence time in line; maximum line content; percent of arrivals who did not have to wait in line; and so on). This limited example is roughly suggestive of the character of GPSS.

The sparse syntax of GPSS, coupled with its block-diagram orientation, makes it possible for the beginner to learn a highly usable subset of the language quite quickly. This does not mean, however, that it is easy or straightforward to master the full set of GPSS capabilities. Considerable effort and study are needed to learn the language thoroughly.

The GPSS world view involves visualizing units of traffic ("transactions") which move along from block to block in a model as a simulation proceeds. This world view is so natural to the modeling of queuing systems that several other notable simulation languages now also offer a similar view. The effect of this cross-fertilization can be found in SIMSCRIPT (Russell 1981), SLAM (Pritsker and Pegden 1979), and SIMULA (Birtwistle 1979).

Disadvantages of GPSS are that it has weak input/output capabilities, weak computational facilities, and a static control structure. (Each of these disadvantages has been remedied to a considerable extent in GPSS/H, however; see Henriksen 1981.) These disadvantages can be offset to an important extent by interfacing a GPSS model with one or more FORTRAN subroutines, or with one or more PL/I

procedures. The GPSS HELP block is used for this purpose.

3. THE GPSS LEARNING-ORIENTED LITERATURE

There are several books devoted to GPSS (Bobillier, Kahah, and Probst 1976; Donovan 1979; Gordon 1975; Greenberg 1972; Schriber 1974; Sulzer et al. 1970). Brief introductions to GPSS can also be found in general simulation texts (e.g. Maisel and Gugnoli 1972; McMillan and Gonzalez 1973; Fishman 1978).

Articles demonstrating use of advanced GPSS features also occasionally appear. For example, articles illustrating HELP block use are Andrews and Schriber 1978; Degen and Schriber 1976; Lefkowitz and Schriber 1971; and Schriber and Andrews 1979. The GPSS user's manuals may also contain good learning-oriented material. For instance, a suggestive set of examples for HELP block use appears in Henriksen 1981.

4. VARIOUS GPSS IMPLEMENTATIONS.

GPSS first became generally available when it was released by International Business Machines Corporation (IBM) in 1961. Since then, IBM GPSS implementations have evolved through several versions (GPSS II; GPSS III; GPSS/360, Versions I and II; GPSS V; APL GPSS; and PL/1 GPSS). The current de facto standard for the language is IBM's GPSS V, although GPSS/360, Version I, is still frequently used in colleges and universities (GPSS/360, Version I, was IBM's last pre-unbundled ["free"] version of the language). There are also non-IBM implementations of GPSS for IBM hardware, e.g. GPSS/H (Henriksen 1981) and GPSSTS (Computer Sciences Corporation 1973). Most GPSS implementations for non-IBM hardware are based either on IBM's GPSS V, or on GPSS/360. These versions include B7700 GPS and B6700 GPS (Burrough's 7700 and 6700 hardware); GPSS V/6000 (Control Data 6000 Series computer systems); GPSS/66 (Honeywell Series 60 Level 66 hardware); GPSS-10 (Digital Equipment Corporation's PDP-10 hardware); GPSS/UCC (University Computing Corporation's GPSS for Univac 1108 hardware); GPSSX8 (a high quality Univac 1100-series GPSS implementation maintained at Florida Atlantic University); GPDS (a GPSS implementation for Xerox Sigma 5-9 computers); and GPSS/VAX (a GPSS implementation for any hardware configuration supported by VAX/VMS; Martin 1981).

5. ALTERNATIVE LANGUAGES WITH GPSS EMBEDDED.

The functions performed by the various GPSS blocks have been embedded in other languages on some occasions. Notable here are GPSS-FORTRAN (Schmidt 1980), APL GPSS (IBM 1974, and PL/1 GPSS (IBM 1981). Briefly, embedding takes the form of implementing the functions of the GPSS blocks and control statements in a host language as subroutines which augment the power of the existing language. Calling these subroutines then has the effect of simulating the behavior of the corresponding GPSS blocks and control statements. A paper on the embedding process is being given at this conference (Rubin 1981).

6. TIME-SHARING NETWORKS OFFERING GPSS

GPSS is available in the following networks: National CSS offers GPSS/H on IBM System 370 and 370-compatible hardware; Computer Sciences Corporation offers GPSSTS in its Infont system; University Computing Corporation offers GPSS/UCC on the Univac 1108; ADP-Cyphernetics offers GPSS-10 on the PDP 10; Boeing Computer Services offers GPSS, as does McDonnell-Douglas Automation Company (MACAUTO); Control Data Corporation has GPSS in its Cybernet system; and American Management Systems (AMS) has a version of GPSS which can be accessed via Telenet. (This list is thought to be exhaustive, but may not be.)

7. SHORT COURSES

Intensive short courses on GPSS are currently known to be available from only two sources. A one-week summer course is offered as one of Georgia Institute of Technology's continuing education courses. (Contact Jerry Banks or John Carson at the Georgia Institute of Technology.) And a one-week course is offered each summer in The University of Michigan's Engineering Summer Conferences (contact Thomas J. Schriber at the above address). It is tentatively planned to offer the Michigan course quarterly.

8. THE GPSS TUTORIAL

The GPSS tutorial will present a basic set of GPSS blocks, then illustrate their use in a series of three graduated examples:

(1) a one-line, one-server queuing system with uniformly distributed interarrival and service times, no customer balking, and simple stopping conditions (the simulation stops after eight simulated hours, whether or not there are customers in the system at that time),

(2) a one-line, multiple-server queuing system, modeled by simple extension of the one-line, one-server system, and

(3) the one-line, multiple-server queuing system extended to include nonuniform interarrival and service-time distributions, a customer balking condition, and realistic stopping conditions (no new customers are permitted into the system after eight simulated hours, but the simulation is permitted to continue until there are no remaining customers in the system).

These examples, and supporting explanatory materials, are contained in a 77-page tutorial chapter on GPSS written by Thomas J. Schriber for McMillan and Gonzalez 1973. The Winter Simulation Conference GPSS tutorial will be based on transparencies taken from figures appearing in this source. The chapter is too long to reproduce here, but copies of the chapter will be distributed to those in attendance at the tutorial. Those not attending the tutorial are referred to McMillan and Gonzalez 1973. Interested persons who do not have access to McMillan and Gonzalez can obtain single copies of the chapter on request by writing Thomas J. Schriber at the above address.

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