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# INTRODUCTION TO GPSS

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## ABSTRACT

Summary information about key aspects of the simulation modeling language GPSS is provided. The class of problems to which GPSS applies especially well is described; commentary on the semantics and snytax 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.

The GPSS tutorial itself will delve into the fundamental details of GPSS and present examples of simple GPSS models. Copies of the transparencies used for the tutorial will be distributed to those in attendance. (These transparency copies are excluded from reproduction here because of page-count limits.)

## A BRIEF PERSPECTIVE ON GPSS

GPSS (General Purpose Simulation System) is a highly popular [1] simulation modeling 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 (systems in which discrete units of traffic compete for scarce resources), and 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 manufacturing systems, telephone companies, brokerage firms, computing centers, supermarkets, banks, steel mills, hotels, warehouse and distribution facilities, and general business.

## THE SEMANTICS AND SYNTAX OF GPSS

GPSS offers a rich set of semantics, and yet is sparse in its syntax. For example, only nine statements (plus 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 [2] 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 SLAM [3], SIMAN [4], SIMSCRIPT [5], and SIMULA [6].

Disadvantages of traditional GPSS are that it has weak input/output capabilities, weak computational facilities, and a static control structure. (Each of these disadvantages has been remedied in GPSS/H, however; see [7] and [8].) These disadvantages can be partially offset by interfacing a GPSS model with one or more FORTRAN subroutines, or with one or more PL/1 procedures. The GPSS HELP block is used for this purpose.

## THE GPSS LEARNING-ORIENTED LITERATURE

There are several books devoted to GPSS [2, 9, 10, 11, 12, 13, 14]. Introductions to GPSS can also be found in general simulation texts, e.g. [15, 16, 17, 18, 19, 20].

Articles demonstrating use of advanced GPSS features also occasionally appear. For example, articles illustrating HELP block use are in [21, 22, 23, 24]. The GPSS user's manuals may also contain good learning-oriented material. For instance, a suggestive set of examples of HELP block use appears in [8].

## VARIOUS GPSS IMPLEMENTATIONS

GPSS was originally released by IBM in 1961. It then evolved through a series of further IBM releases (GPSS II; GPSS III; GPSS/360; and, in 1970, GPSS V [25],) each release offering enhancements over its predecessor. Paralleling the IBM releases, a variety of GPSS implementations was made available both for IBM and non-IBM hardware by organizations external to IBM. The state-of-the-art GPSS implementation for IBM mainframe hardware is now GPSS/H, which became available in 1977 and is an upwardly compatible superset of IBM's GPSS V [5]. (Among the more significant advantages offered by GPSS/H over GPSS V are an improvement in execution speed by a factor of about five on average; the ability to interactively monitor an ongoing simulation, which greatly reduces the time required to build and debug models and achieve a detailed understanding of their behavior; the ability to read from and write to external files, which facilitates the incorporation of data into models and the passing of model outputs to post-processing software, such as graphical routines; the use of long symbolic

names in extended contexts, which enhances model readability and clarity; and vastly improved ease of assessing FORTRAN subroutines and functions during an ongoing GPSS simulation.)

GPSS/H is also available for VAX computers [5], and is being developed for microcomputers based on the Motorola 68000 chip (projected availability in December, 1984). Another VAX implementation of GPSS is GPSS/VAX [26], and GPSS/PC has recently been announced for IBM Personal Computers [27].

Most GPSS implementations for non-IBM hardware are based on IBM's GPSS V (or its IBM predecessor, GPSS/360). Known implementations in this category include GPSS V/170 (Control Data 170 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); and GPDS (a GPSS implementation for Xerox Sigma 5-9 computers). There does not seem to be anyone who maintains a complete list of available and actively supported GPSS implementations. In general, those who are not in a position to use GPSS/H, GPSS/VAX, GPSS/PC, or IBM's GPSS V must do their own spadework to determine if a reasonably current and actively supported GPSS implementation is available for their computing environment.

## 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 [28], APL GPSS [29], and PL/1 GPSS [30]. 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. For a paper on the embedding process, see [31].

## TIME-SHARING NETWORKS OFFERING GPSS

GPSS is available in the following networks: Boeing Computer Services offers GPSS/H; Computer Sciences Corporation offers GPSSTS in its Infonet System; University Computing Corporation offers GPSS/UCC on the Univac 1108; ADP-Cyphernetics offers GPSS-10 on the PDP 10; Control Data Corporation has GPSS in its Cybernet system; McDonnell-Douglas Automation Company (McAuto) offers GPSS; 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.)

## SHORT COURSES

Intensive public short courses on GPSS are available from three sources. A five-day course is offered each summer in The University of Michigan's Engineering Summer Conferences (contact Thomas J. Schriber). This course is also offered in October, February, and May in the Washington, D.C. area (contact Robert C. Crain, Wolverine Software Corporation, Annandale VA). A five-day course including GPSS is offered periodically at the State University of New York at the Center for Statistics, Quality Control and Design (contact Edward J. Dudewicz, Syracuse University, Syracuse NY). And a five-day GPSS course is given each summer at The Ryerson Polytechnical Institute (contact R. Greer Lavery, Ryerson Polytechnical Institute, Toronto, Ontario, Canada).

## THE GPSS TUTORIAL

In the GPSS tutorial at the Winter Simulation Conference, the rudiments of queuing systems logic and the corresponding modeling elements offered by GPSS to implement this logic will be introduced and illustrated through a series of examples. The tutorial will make use of transparencies, copies of which will be distributed to those attending the tutorial. (There are too many transparencies to include copies of them in these proceedings.) Interested persons unable to attend the tutorial can obtain a copy of these transparencies on request from Thomas J. Schriber (Graduate School of Business, The University of Michigan, Ann Arbor MI 48109; 313-764-1398).

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