

MEMORANDUM

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A GUIDE TO THE GENERAL  
PROBLEM-SOLVER PROGRAM GPS-2-2

Allen Newell

PREPARED FOR:

UNITED STATES AIR FORCE PROJECT RAND

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PREFACE

This Memorandum provides a detailed account of the internal structure of a problem-solving program, the General Problem-Solver (GPS). This program in its various versions has been one central part of work at RAND on artificial intelligence and simulation of cognitive processes during the past five years. Although GPS has been reported on many times, there has never been a completely adequate account of its detailed structure. This Memorandum attempts to fill this gap.

This guide will be of use only to those who are deeply and technically concerned with the problems of programming complex systems. It is essentially a reference document which provides a level of description which is normally unavailable in the field of complex programs.

The general field of artificial intelligence and information processing psychology, to which this Memorandum is contributory, aims at understanding the complex information processes that underlie man's ability to solve problems, learn, adapt, and create. From a scientific viewpoint, such activities are intrinsically worthwhile; from an applied viewpoint they form the essential basis for increasing the sophistication and eventual effectiveness of our large command and control systems.

GPS in its various forms and guises is the joint work of J. C. Shaw of RAND, H. A. Simon, and the author. The latter two are members of the faculty of the Carnegie Institute of Technology, and consultants to The RAND Corporation.

## SUMMARY

The General Problem-Solver (GPS) is a computer program being used for explorations into both the general mechanisms involved in problem-solving and the way humans solve problems. The program has existed in several versions since it was first developed in 1957. This Memorandum is a guide to the detailed structure of one of the versions, GPS-2-2. It assumes a substantial knowledge of IPL-V, the programming language in which GPS is written, and a general knowledge of GPS as it has been described in the published literature. It is also meant to be used in conjunction with an assembly listing of the program, but can be used alone.

After the Introduction, Sec. II gives the gross topography of the program. It also includes a run-through of a simple problem to put the parts in context. Section III discusses the various data structures used in GPS: goals, expressions, derivation lists, operators, location programs, and differences. Section IV is devoted to a detailed description of the subroutine hierarchy, working from the top executive down through the technique of method interpretation to a consideration of each method and method segment. Section V describes the Experimenter; i.e., the embedding program used to put GPS into operation and to output selected aspects of its performance. Section VI takes up the information provided for each task environment. For GPS-2-2 these are Logic, and Missionaries and Cannibals. In addition there is a description of how a new task environment might be added to GPS. Four appendices provide additional specific data on the program.

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