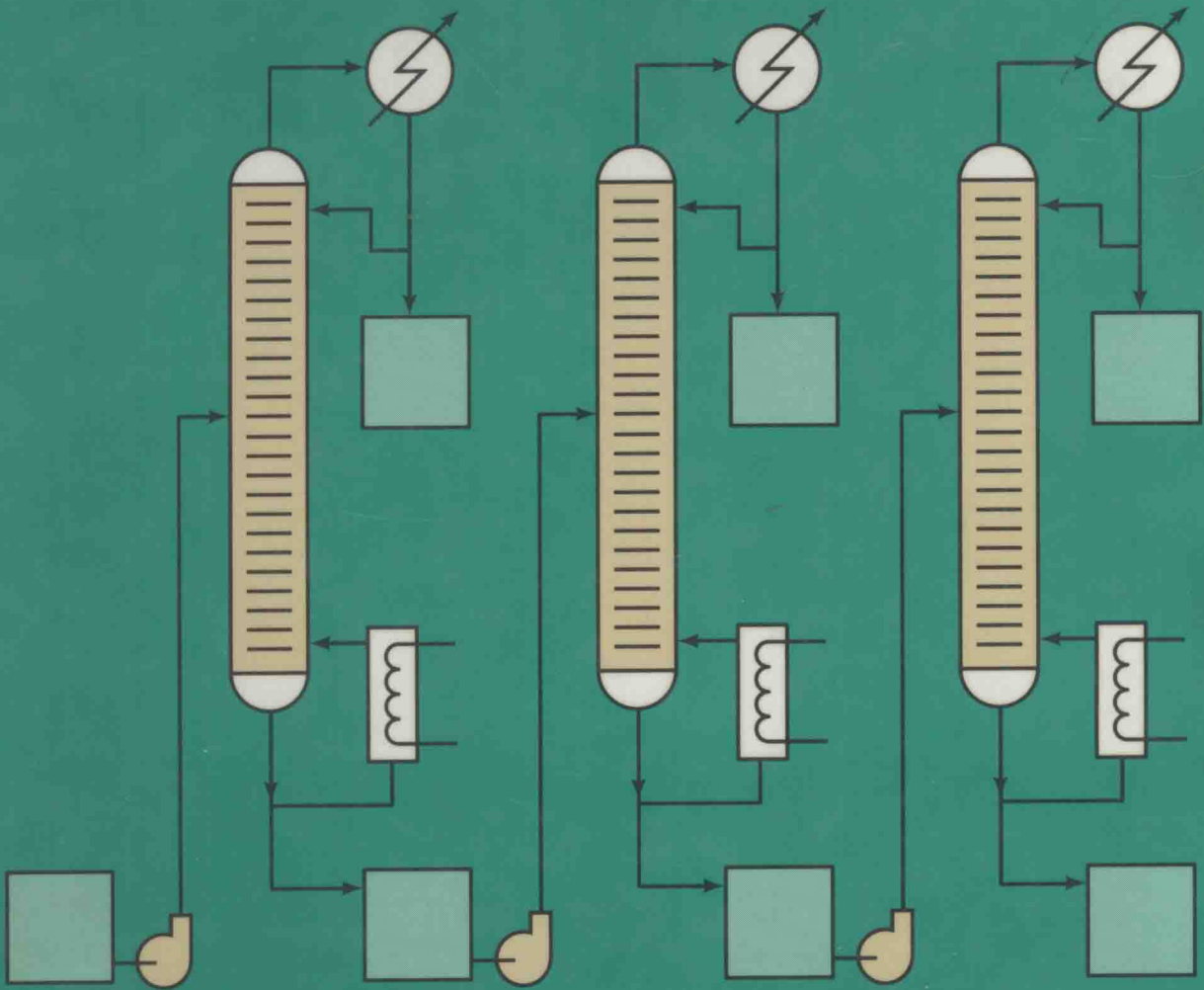


COMPUTER CONTROL STRATEGIES FOR THE FLUID PROCESS INDUSTRIES

by Albert A. Gunkler and John W. Bernard



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Computer Control Strategies for the Fluid Process Industries

*An Independent Learning Module
from the
Instrument Society of America*

PREFACE

ISA's Independent Learning Modules

This book is an Independent Learning Module (ILM) as developed and published by the Instrument Society of America. The ILMs are the principal components of a major educational system designed primarily for independent self-study. This comprehensive learning system has been custom designed and created for ISA to more fully educate people in the basic theories and technologies associated with applied instrumentation and control.

The ILM System is divided into several distinct sets of Modules on closely related topics; such a set of individually related Modules is called a Series. The ILM System is composed of:

- the ISA Series of Modules on Control Principles and Techniques;
- the ISA Series of Modules on Fundamental Instrumentation;
- the ISA Series of Modules on Unit Process and Unit Operation Control; and
- the ISA Series of Modules for Professional Development.

The principal components of the Series are the individual ILMs (or Modules) such as this one. They are especially designed for independent self-study; no other text or references are required. The unique format, style, and teaching techniques employed in the ILMs make them a powerful addition to any library.

The published ILMs are as follows:

Fundamentals of Process Control Theory—Paul W. Murrill—1981

Controlling Multivariable Processes—F. G. Shinskey—1981

Microprocessors in Industrial Control—Robert J. Bibbero—1982

Measurement and Control of Liquid Level—Chun H. Cho—1982

- Control Valve Selection and Sizing*—Les Driskell—1983
- Fundamentals of Flow Measurement*—Joseph P. DeCarlo—1984
- Intrinsic Safety*—E. C. Magison—1984
- Digital Control*—Theodore J. Williams—1984
- pH Control*—Gregory K. McMillan—1985
- FORTRAN Programming*—James M. Pruett—1986
- Introduction to Telemetry*—O. J. Strock—1987
- Application Concepts in Process Control*—Paul W. Murrill—1988
- Controlling Centrifugal Compressors*—Ralph Moore—1989
- CIM in the Process Industries*—John Bernard—1989
- Continuous Control Techniques for Distributed Control Systems*—Gregory K. McMillan—1989
- Temperature Measurement in Industry*—E. C. Magison—1990
- Simulating Process Control Loops Using BASIC*—Greg Shinsky—1990
- Computer Control Strategies for the Fluid Process Industries*—Albert A. Gunkler and John W. Bernard—1990

Most of the original ILMs were envisioned to be the more traditional or fundamental subjects in instrumentation and process control. Clearly, with the publications planned over the next few years, the ILM Series will become much more involved in emerging technologies.

ISA's commitment to the ILM Series is to publish a minimum of four modules each year. Obviously, this growing Series is part of a foundation for any professional library in instrumentation and control. The individual practitioner will

find them of value, of course, and they are a necessity in any institutional or corporate library.

There is obvious value in maintaining continuity within your personal set of ILMs; place a standing purchase order with ISA.

Paul W. Murrill
ILM Consulting Editor

Comments about This Volume

This ILM, *Computer Control Strategies for the Fluid Process Industries*, is designed to provide an understanding of the importance of the role that computers are playing in the control of fluid processes. Many real-world case examples are included to illustrate the compelling opportunities for taking advantage of computer control technology.

This material will be useful to process engineers, control engineers, programmers, researchers, plant supervisors, managers, executives, and all others who need a basic understanding of computer process control. In addition, technical school, college, and university students will find this course useful in gaining insight into all the practical issues that must be resolved in computer control projects.

Acknowledgments

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**Unit 1:
Introduction and Overview**

UNIT 1

Introduction and Overview

Welcome to ISA's Independent Learning Module *Computer Control Strategies for the Fluid Process Industries*. The first unit of this self-study program provides the information needed to take this course.

Learning Objectives — When you have completed this unit, you should:

- A. Understand the general organization of the course.
- B. Know the course objectives.
- C. Know how to proceed through the course.

1-1. Course Coverage

This is an Independent Learning Module (ILM) about the application and benefits of the use of computer control in the operation of industrial processes. This course covers:

- A. A basic discussion of the functions required for the control of process operations.
- B. The capability of computers in carrying out many of these control functions, and the enabling technologies that make this possible.
- C. The benefits of computer control of processes, with many application examples.
- D. Computer control system architecture, including those now in operation as well as the state-of-the-art systems now being installed.
- E. Computer control concepts for new and existing processes with consideration of their economic impact.
- F. Control fundamentals, including basic control algorithms and their digital implementation.
- G. The essential steps in planning for a new computer control system.
- H. The implementation of a computer control system.
 - I. Growth of the enabling technologies and their impact in future plant operating concepts.

The use of computer systems for the control of production processes is widely practiced and is likely to be universally applied in the near future. This enhancement of the control systems used extensively in industry has been brought about by the significant improvement in computer capability over the last decade. It can truly be said, and this is the basis for this book, that a computer can be programmed to perform any function that engineers might request for process control. It is the responsibility of the engineers to make maximum use of this capability.

The basic technology of automatic control used throughout the application of control computers is not explicitly discussed; other ILMs provide this information (see General References). However, some of the basic control concepts and their digital implementation are explained in a non-mathematical manner.

This course focuses on relating the many individual technologies that must be applied, as well as the project and organizational impacts, for the successful implementation of process computer control systems.

1-2. Purpose

The purpose of this ILM is to provide a basic understanding of the use of computers in the control of industrial processes. Throughout this text many real-world examples are included, with the benefits of computer control described. These illustrate the positive operating and economic impact of using computers in process control.

This ILM is not written for the purpose of advocating the use of computers for process control, although it will do so by its content. It simply postulates that computers are in place, and applications are explored to make optimum use of them. Some of the examples included could have been accomplished without a computer, but the complexity of doing so with hard-wired instrumentation would assure that would not be done; the availability of the computer is what prompted the application.

Other processes can be approached in a similar fashion to take advantage of this rapidly growing technology for significant benefits in their design and operation.

1-3. Audience and Prerequisites

This ILM is designed for those who want to work on their own to gain an understanding of the impact of using computers in process control systems. The material will be useful to engineers, programmers, system designers, planners, senior technicians, managers, executives, and others who need a basic understanding of computer control concepts. The course will also benefit students in technical schools, colleges, or universities who wish to gain some insight into the practical issues that must be resolved in applying computers in process control systems.

There are no prerequisites to this course, though some knowledge of industrial process operations would be helpful. No mathematics are used in this ILM. It is expected that this course will create enough interest in learning more about the underlying control fundamentals that further study will be undertaken.

1-4. Study Material

The only study material required in this course is this textbook; it is one of ISA's ILM System. It is an independent, stand-alone textbook that is uniquely and specifically designed for self-study.

Suggested references are given in Appendix A for more detailed understanding of the technical and human issues involved in applying computers in process control systems.

1-5. Organization and Sequence

There are eleven separate units in this textbook. The next unit is designed to give an understanding of the control functions required in the operation and management of industrial processes. Unit 3 explains the capability of computers in fulfilling many of these control functions. The next unit discusses the benefits of computer control. Unit 5 discusses control system architecture, including the impact of digital technologies. Units 6 and 7 discuss control concepts, economic considerations, and computer control fundamentals. Units 8 and 9 explain the important aspects of planning and implementing a computer control system. Unit 10 covers the directions of the enabling technologies and their future impacts

in process operations and management. The last unit presents practical considerations learned from the application of many computer systems to process control.

The method of instruction used in this ILM is self-study. Basically, you will work on your own in taking this course; you select the pace at which you learn best.

Each unit is designed in a consistent format with a set of specific learning objectives stated in the very beginning of the unit. Note these learning objectives carefully; the material that follows will teach these objectives. At the end of each unit you will find exercises that amplify and illustrate specific concepts. All student exercises have solutions contained in Appendix C, against which you should check your solutions.

Since this ILM belongs to you, we encourage you to underline and make notes in the textbook and to take free advantage of the ample white space provided on each page for this purpose.

1-6. Course Objectives

When you have completed this entire ILM, you should:

- A. Understand what computer process control is and the many technologies involved in it.
- B. Be aware of the many different functions that can be performed by computers and the benefits in process operations and management.
- C. Understand where computers are used in control system architectures and the many facets in the planning, design, and application of such systems.
- D. Be aware of the future directions of these rapidly changing technologies and how they might impact process operations and management in the future.
- E. Comprehend how applying process computer control systems will benefit your company.

In addition to the overall course objectives, note the specific set of learning objectives for each unit. These objectives are intended to help direct your study of that particular subject area.

1-7. Why Learn about Computer Process Control?

You are in the middle of the biggest technology change in industrial control in the whole history of manufacturing—the use of computers in all aspects of process control systems. Every industry is being affected by the use of computers to automate large and small operations and integrate these with business functions.

Those people who are familiar with a production process are in a unique position to make a major contribution to the economic utilization of this tool in their operations. Control engineers, computer vendors, and others are a necessary part of the implementation, but it is expected that people knowledgeable about the process and schooled in the process principles involved can make innovative decisions that will provide significant benefits.

The survival of many industries is at stake, but most do not have enough trained people to understand and implement these new technologies. This ILM will provide you with an organized exposure to the many issues in applying computers so that you can better understand their use in improving your operations and enhance your career growth in this exciting new area.