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Introduction

The advent of powerful and friendly integrated software has moved advanced process control (APC) from the realm of consultants into the arena of the average process control engineer. The obstacles of infrastructure and special skill requirements have started to disappear and we are poised for an accelerated application of APC.

It is well known that APC seeks to discover, incorporate, and exploit knowledge about raw materials, process, product, equipment, instrumentation, and final elements. What is not often recognized is the significant increase in the knowledge base of both plant and field operations that occurs as the APC system is developed. In fact, an appreciable portion of the benefits are achieved by improvements made in operating procedures, set points, sensors, and control valves as a result of the methodical analysis, testing, modeling, and prototyping that are part of the best practices used in the implementation of APC systems.

Until recently, most of this knowledge ended up with consultants, and the success of the application often deteriorated once they departed. There is now an opportunity for the engineers closest to the process and daily operations to take a much more active role in the development and support of APC applications. It is a win-win situation in that the cost of APC can be reduced by using consultants primarily in a higher-value-added role of conceptual design and optimization. Even more importantly, greater understanding, support, and involvement of onsite engineers can increase the success rate, the on-stream time, and the longevity of an APC application. This decrease in the cost and increase in the benefits will in turn lead to a larger number of successful APC installations and a greater interest in APC as a method of improving process efficiency and capacity.

However, much of the purpose and use of APC has been clouded in theory. The theory is scattered among many books written for graduate school programs in advanced process control. Application papers typically concentrate on the benefits of specific APC projects and serve more as advertisements for particular consulting or software firms than as implementation guides. Little if anything has been written for the practicing engineer on how to select, design, configure, commission, and tune APC systems. The purpose of this book is to demystify APC and make it more accessible. To that end, the book focuses on practice and applications backed up by enough theory to insure a deeper understanding.

Each chapter is organized to provide concise practical information that a user can readily explore and reference to start and complete a successful implementation. Each chapter has three major sections, entitled *Practice*, *Application*, and *Theory*.

The *PRACTICE* section starts with an *Overview* that provides a concise explanation of the technology and its importance. It provides the motivation and basis for investing more time in learning and pursuing the technology. Next is an *Opportunity Assessment* subsection that offers a simple approach to determine whether the technology is applicable to a particular unit operation. It consists of a set of concepts and questions to start the thought process and discussions to find potential applications. The *Examples* subsection rounds out the section. The sample of applications presented here help to instill a better practical understanding of the use of the technology in the process industry.

The *APPLICATION* section starts with a *General Procedure* subsection that presents a “go-to” checklist to introduce the user to the normal sequence of events for a successful application. This list provides a good reference to make sure all bases are covered and is useful for planning, scheduling, estimating, and monitoring APC projects. Next there is an *Application Detail* subsection that summarizes most of what a user needs to know. A building-block approach is used wherever possible, starting with a basic “bare-bones” application and adding successively more capabilities to end up with a full complement of advanced features. Next is a series of *Rules of Thumb* concisely phrased to be readily referenced and remembered. A brief explanation with any notable exceptions follows each rule. The section ends with a *Guided Tour* to give the reader a feel for how advances in software have made implementation easy enough that the user can focus on the opportunity offered by these APC tools to discover, incorporate, and exploit plant knowledge.

The *THEORY* section presents the major facets of selected approaches to the deployment of each APC technology as part of a state-of-the-art tool set.

For brevity, the section does not survey all the possible methodologies and techniques, but focuses on those that are innovative and simple enough to be integrated into a distributed control system.

This book covers a great deal of ground. Each of the technologies discussed here could easily fill a book in itself. However, users today don't have the time or inclination to read a lot of material. Lists, hints, rules of thumb, and concise explanations are employed to save the reader time and to provide both a better perspective on the whole picture and an improved ability to drill down to obtain specific implementation guidance. The book concentrates on what is most important. Users can quickly get to the heart of the matter without getting lost in the details associated with a specific tool or suffering from information overload.

While a user can go directly to a given chapter to learn about a particular technology, the authors recommend that Chapters 2 and 3 be read first. They provide the necessary foundation on which to build an APC application and the logic to select the most appropriate technology.

Included with the book is a compact disc that contains a set of examples of the technologies discussed in the book. They demonstrate, by means of a step-by-step procedure and a detailed dynamic process model, how to configure, test, and run each APC application. Configuration and case files use a virtual plant that has a complete scalable Distributed Control System (DCS) with a suite of APC tools and a high-fidelity plant simulation.

A companion set of Power Point slides that illustrates all of the major Figures, equations, tables, lists and rules included in the book is on the CD.

These slides and the hands-on exercises make the book practical as a textbook for courses on both basic and advanced process control. Chapters 2 and 6 receive the most extensive treatment because introductory courses are most common. Also, students and users alike need to first concentrate on getting the basic regulatory control system designed correctly and tuned properly before moving on to more advanced topics. Most of the material has been tested in an introductory course on process control for junior and senior chemical engineers at Washington University in Saint Louis. These students have demonstrated the ability to immediately apply these APC tools to example problems after a brief tutorial, using their computer skills and a powerful integrated Windows® environment. The sound mathematical foundation of APC makes it easier to learn than basic control, which is more heuristic.

The tutorials and presentations on the CD do not require any special software or hardware beyond a PC with a media player, speakers, and a display with a screen area of at least 1024 by 768 pixels.

This book with its appendices and CDs should enable the average process engineer to develop a good understanding of the representative principles and techniques of APC. This knowledge will be helpful in setting objectives, evaluating potential APC opportunities, and applying the most appropriate APC technologies. Readers should feel free to contact the authors at their e-mail addresses if they have any questions about the use of the book, exercises, demos, slides, or APC tools described.

All royalties from this book will be given directly to universities, consortia, and educational programs to promote and enhance the development and use of advanced process control. A beneficiary of each year's royalties will be chosen by the authors.