

AUTOMATION IN THE FOOD INDUSTRY

Edited by C. A. Moore

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Automation in the Food Industry

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Automation in the Food Industry

Preface

This book is designed to be everything its title suggests—a practical guide to automation within the food industry. It is the first book to offer practical advice on what can be a most bewildering subject in an industry where the use of effective automation is of paramount importance. There are many books dealing with the theory and practice of control systems in both the food and other industries. However, these tend to offer too much detail in both areas to be classed as overviews, or cover too much of the more obvious detail and gloss over, or avoid, the elements where the decisions are hard—even though these are the areas which are fundamental to successful and expansive projects.

This book identifies those elements of any automation scheme which have to be considered first, and that form the foundations for any successful project. The editorial introduction outlines the content of the book and is a useful starting point. Examples are used, wherever possible, to show what can be done, how it can be achieved, and what to avoid. A glossary of definitions is included at the end of the book. All the chapters have been written by engineers, with many years' experience in this field, who have been able to express their views freely. The result is a book which covers the key areas of the subject, using a minimum of the technical jargon with which this subject abounds, in a readable, practical manner.

This book is intended for process engineers, electrical engineers and food technologists working in the food industry. It will also serve as an essential source of reference for production managers considering the purchase of new equipment.

Acknowledgements

I would like to pass my sincere thanks to all the contributors who have put in many hours of hard work to make this book not only possible but also useful. It is their breadth of knowledge and real engineering experience which makes their chapters valuable and enables this book to meet the objectives established right at the start.

I must also express my gratitude to AMEC Design and Construction Ltd. who have tolerated the inevitable disturbances that editing this book has created, and I thank them for their support during this venture.

C.A.M

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Tony Dodd read Mathematics and Philosophy at Oxford and then spent the years 1973 to 1978 doing research into set theory, gaining an M.Sc. in 1974 and a D.Phil. in 1978. From 1978 to 1983 he was a research fellow first of New College and then of Merton College in Oxford. He published a monograph on constructible sets in 1982. He first became interested in computing while doing research in logic and developed an interest in the theory of formal languages and compilation. He joined Expert Systems Ltd. (as it then was) in 1983 to work on Prolog-1. In 1984 he designed and led the implementation of Prolog-2, and in 1985 became Technical Director of the company. He led the design team that produced the Prometheus expert system shell, is an active member of the BSI Prolog standardisation committee and secretary of the UK Association for Logic Programming. His book 'Prolog: a logical approach' is due to be published by OUP in 1990. In 1989 Tony joined Chemical Design Ltd. as Expert System Product Manager, and early in 1990, together with three other employees, set up Expert Systems Ltd., of which he is Chairman and Managing Director.

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introduction of new plant and processes, running the facility for the development of new processes for existing and new products, having responsibility for in-house engineering research and development, and setting up and running a corporate systems engineering department with a special remit for packaging systems. In 1987 Tom and a senior colleague completed a buy out which gave Cambridge Consultants majority ownership of the Systems Engineering unit and has enabled the team of mechanical, electrical and software engineers to gain experience of solving production problems in a variety of industries, especially in consumer orientated industries such as food, confectionery, pharmaceutical and health care. Tom is able to draw on some 35 years' industrial experience.

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Derek Mack served an apprenticeship from 1960 to 1966 with the English Electric Company which later became one of the constituent companies of the General Electric Company. On completion of his apprenticeship he became a control engineer involved in the design of d.c. variable speed motor control equipment and also a.c. motor starter panels. The applications were concerned mostly with the heavy engineering industries. Following a period in the commercial world of sales and contracts he became a founder member of the GEM 80 Programmable Controller Division of GEC Industries Controls Ltd. concerned with both commercial and applications engineering. In this role he was involved in the engineering of programmable controllers across the whole range of industry including a number of applications in food processing. These covered various aspects of confectionery, brewing including maltings, beverages and milling. He is currently special assignments engineer for GEM 80 programmable controllers and is concerned with all aspects of the application of the range of GEM 80 controllers where unusual conditions exist or where special control activities are being under-

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Colin A. Moore graduated in Control Engineering and spent a number of years with the British Steel Corporation engaged on all aspects of the design and construction of multi-discipline projects throughout the Steelworks Division. During this time he expanded his understanding of business operations by gaining a diploma in Accounting and Finance. In 1981 he joined IDC Limited where he became involved with the design and construction of electrical and control systems for major projects. He was directly responsible for the successful completion of these, a large number of which were within the food industry. He was appointed Divisional Director—Engineering in 1985, and in this role has assisted the company to strengthen its standing in the food industry in particular, and in other industries in general. In 1990 he became responsible for all Process, Control and Systems Engineering aspects within IDC Limited (now AMEC Design and Construction Ltd.)

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Mauro Novaresio attended the University of Turin, where at the age of 22 he was awarded a degree in Computer Science following a dissertation about simulation. His first working experience was in the offices of Fiat in Turin. He then moved to factory automation and participated in some of the first innovating projects in both Northern and Southern Italy. His main role was the analysis of complex systems using the most advanced hardware/software technology for the automation of material handling lines and AS/RS systems. He has been in charge of the automation projects carried out by the FATA European Group in both the USA and USSR for over four years, and is involved in the preparation of the templates for the CIM projects. Furthermore, he coordinates the activities of the Group Task Force appointed to CAD/CAM development and CAD/simulator interfaces.

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application of d.c. based control systems for electric vehicles. Upon completing four years with that company, he joined Thames Board Mills Ltd. and commenced his career in project engineering. At Thames Board Mills he was involved with the application of d.c. drives, a.c. motor control equipment and general electrical distribution schemes. During this time he was part of a large project team involved with the design and installation of a new card-board machine. He joined IDC Ltd. (now AMEC Design and Construction Ltd.) in 1984 as a Senior Engineer, working on control systems for process applications. He is currently Technical Manager, responsible for all the Control and Systems Engineering operations. Roger Pilkington has had considerable experience on food industry projects involving complex control systems.

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Derek Spencer joined the English Electric Company as a technician apprentice in 1957, working in the Relay Development Laboratory on electronic distance protection. Later he joined Field Engineering to work on power-station commissioning and then computer-systems commissioning. Since 1968 he has been firmly committed to automation. He became Head of Engineering of the Automation Division at GEC Electrical Projects Ltd. in 1982 and Divisional Manager in 1984. In 1988 he transferred to GEC Industrial Controls Ltd., Kidsgrove as Manager of the newly formed Control and Process Systems Division.

Editorial introduction

The food industry has been a major investor in control systems over recent years and predictably will continue to be so. This investment is driven to a great extent by the need to continually market new product lines, and also by the need to increase throughput and efficiency. In practice this means the industry wants to, or has to, apply sophisticated control techniques to provide repeatable and automatic controls which allow accurate records to be kept and fewer operators to be used to produce the same or an increased amount of product.

This book contains contributions from highly experienced engineers who have spent many years working within and for the food industry. Some have spent their working life with manufacturing companies, others have supported manufacturers for many years as suppliers of control systems. By combining their views on the various topics covered it has been possible to express a highly representative view of the industry in a way which no single author could hope to achieve. This book sets out to be not only factual and useful, but also:

- to be *real*, with the information put forward based on practical experience combined with practical examples;
- to be *readable*, with the minimum of jargon, theory and formulae so that those with a minimum of knowledge, or some understanding and those with a more general interest are able and will want to follow it;
- to improve *opportunity* for people in the industry, by indicating what can be achieved now, what is likely to be possible in the future, and how these goals can and should be achieved.

By meeting these objectives this book is appropriate for readers drawn from a number of different situations. This includes students studying the subject at college or university, who are rarely exposed to practical problems or real life knowledge: there are very few books available which offer a *real* view of controlling a process plant or how to apply the theory which has been learnt. Also there are many practising electrical engineers who know how to design elements of the control scheme but would benefit if they understood how the *total* system might be put together.

Within the project teams implementing these schemes are those who understand the process well enough to know how it works but do not know what computers are capable of, and those who understand computers but do

not have the experience or knowledge required to use them to their full advantage. Furthermore, people such as the plant or production engineers may have a wealth of experience of how the process works or how the product is really made but may not understand how modern controls can help them (and maybe do not want to admit it?). Lastly (but not least) are those who are being asked to invest on average 30% of the total project cost in sophisticated control systems. It is easy to imagine that they might like to know what they will get for their money.

As stated above, the important principle maintained throughout this book is that it is practical and easy to follow. There are many books around which offer pages of formulae and complicated control engineering theory which are rarely used by most practising engineers, let alone those who operate on the fringes of the business, or who have yet to experience the vagaries of a food processing plant for the first time. Of course control theory is very important if you need to study the detailed operations of a process, but most food processes do not require this level of detail. What is required, and most fundamentally so, is a good, common sense, pragmatic view of what can and should be achieved. This book is aimed at developing this by indicating the key areas where attention must be directed if a successful project is to be the result.

It is inevitable within a book covering such a wide subject that not all aspects of automation can be covered. Equally, not all food industries can be represented by example. However, it is fair to say that automation systems are reasonably general in their suitability if the problem is defined correctly. It is this definition which is usually the major contribution to the application of advanced systems, not the systems themselves. Given a meaningful examination and understanding of the processes, and how they relate to the other process stages and the overall factory operation, a full automation strategy can be identified and implemented.

This book identifies those issues which make a fundamental contribution to the success or failure of a project. It is worth noting that few automation schemes 'fail' as such, but all too often they do not deliver the potential they are capable of.

Within this book, therefore, the scene is set in Chapter 1 by examining food processing as an industry, and the role of automation within this. This chapter indicates how, by looking at the stages of food preparation through to final product, this is not such a daunting task, as long as it is considered as several elements.

Whilst it is necessary to identify separate modules or stages within the process itself it is essential to maintain a total view of what is to be achieved. This suggests a 'total systems' approach, where not only the automation of the plant is considered but also the way the factory is run. This may not only require a review of what automation is appropriate, but also how production is scheduled, how management structure their operations and so on. The need for this approach is expanded in Chapter 2.

The next two chapters look at how integrated factories can work, what is possible if this approach is adopted and how one can prepare specifications in such a way as to ensure that the final project achieves the ambitions set.

In order to ensure a good background of understanding, the various types of computers available are examined in Chapter 5, with an insight into what they can achieve and how. This is followed by reference to a most important part of any automation scheme: the interface with the people who will work the plant once built. Operator interfaces must be designed for operators and managers, and not just to satisfy the engineers who design them. This demands a good ergonomic approach and Chapter 6 highlights some of the main features to consider.

Having examined what is possible by adopting the right approach the book then looks at how these objectives can be achieved. Important factors which have to be considered are that the accuracy of the final system must be good enough, and that the components of it must be reliable. Unfortunately the automation industry abounds with loosely defined terminology and these two elements fall within this area. Chapter 7 looks at what these terms mean in practice, and how to assess what is required, and what is achievable. There is a need to include some formulae in this area, which tends to make this chapter appear somewhat mathematical, but as both of these subjects rely heavily on mathematics and statistics some presentation of this was unavoidable. However, to maintain some sanity the formulae presented have been kept brief, and examples have been used to illustrate the point. Furthermore, lengthy proofs of the final formulae have been excluded in the interest of keeping the book readable.

Chapter 8 reviews how food processes can be automated in practice with examples of how, or how not, to approach the problems encountered. It develops the themes established in the earlier chapters and illustrates the fact that automating a food factory need not be a daunting task.

It is essential within any project to keep a realistic view of what needs to be achieved, and this will normally mean using currently available technology—tried and tested—to satisfy this. However, if the plant is to be expandable in the future it is vital to maintain a longer term view, and an understanding of future developments must be retained whilst applying 'today's' technology. In this way updating with new techniques or equipment will be relatively easy. The final two chapters look at the direction in which the industry is moving, and Chapter 10 in particular identifies what could become an advanced technique in creating friendly, controllable process plants within the food industry.

Contents

Editorial introduction

xvii

1 Introduction to food processing

1

Tom Greeves

1.1	Introduction	1
1.2	Raw materials handling and storage	3
1.2.1	Categories of materials	3
1.2.2	Identifying incoming materials	4
1.2.3	Control and information requirements	5
1.2.4	Example of tank farm	5
1.2.5	Example of flour blending	7
1.2.6	Example of milk reception and storage with CIP system	9
1.3	Primary processing	11
1.3.1	Batch versus continuous processes	11
1.3.2	Modularity	12
1.3.3	Mixing	12
1.3.4	Evaporators and heat exchangers	13
1.3.5	Vacuum and pressure cooking	14
1.3.6	Variable flowrates	14
1.3.7	Effluent	15
1.3.8	Dispensing and container handling	15
1.3.9	Shaping and forming	16
1.3.10	Example of a confectionery assortment	17
1.4	Secondary processing	18
1.4.1	Packaging systems	19
1.4.2	Machine control and coordination	20
1.4.3	Assembly automation	21
1.4.4	Example of confectionery assortment packing	22
1.4.5	Finished goods storage and despatch	23
1.5	Weighing and metering	24
1.5.1	Weighing	24
1.5.2	Metering	25
1.5.3	Example of a 'loss in weight' metering system	26
1.6	Summary	27
	Further reading	28

2 Total systems

29

John Holoway

2.1	Introduction	29
2.2	Current systems concepts	30
2.3	General requirements	31

2.3.1	The pragmatic approach	31
2.3.2	Utilise existing technology	31
2.3.3	Identify measurable benefits	31
2.3.4	Commonality of use	32
2.3.5	Transfer of information	32
2.3.6	Utilise a modular platform	32
2.3.7	Resilience	32
2.3.8	Adaptability and expandibility	33
2.3.9	Use industry recognised vendors	33
2.3.10	Maintainability	33
2.3.11	Allow for external factors	33
2.4	Food processing industry issues	33
2.4.1	Conversion factors	34
2.4.2	Quality	34
2.4.3	Safety	34
2.4.4	Cost	35
2.4.5	Repeatability	35
2.5	Manufacturing process system	35
2.5.1	Pre-production issues	36
2.5.2	Production issues	36
2.5.3	Post-production issues	36
2.6	Total systems	37
2.6.1	Functional blocks	38
2.6.2	Method of implementation	38
2.6.3	Benefits of total systems	38
2.6.4	Engineering the facility	39
2.6.5	Training and education	39
2.7	Examples of total systems approach	40
2.7.1	Example 1: the design phase	40
2.7.2	Example 2: the planning phase	42
2.7.3	Example 3: the implementation phase	44
2.8	Summary	46
	Further reading	47

3 Integrated factory systems **48**

Mauro Novaresio

3.1	Introduction	48
3.2	Integration objectives	48
3.3	Integration phases	49
3.4	Process control and factory automation	52
3.5	Human interface	57
3.6	Summary	57
	Further reading	58

4 Specification for success **59**

Roger Pilkington

4.1	Introduction	59
4.2	Control system concepts	59
4.3	Hardware requirements	63
4.4	Software requirements	66
4.5	Case studies	70

4.5.1	Soft drinks plant	70
4.5.2	Edible oil plant	72
4.6	Summary	73
References		74

5 Computers in control 75

Derek Mack

5.1	Introduction	75
5.2	Types of computer	75
5.2.1	Programmable controller	75
5.2.2	Personal computers	77
5.2.3	Mini- and mainframe computers	78
5.2.4	Summary of computer types	79
5.3	SCADA and DCS systems	79
5.3.1	SCADA system	79
5.3.2	DCS equipment	80
5.4	Stand-alone controllers	81
5.5	Three term control	82
5.5.1	The purpose of three term control	82
5.5.2	Algorithm based three term control	85
5.5.3	Auto tuning	85
5.6	Hardware configuration	86
5.6.1	Single system	86
5.6.2	Single controller with remote I/O	87
5.6.3	Hierarchical system	87
5.6.4	Intelligent field sensors	89
5.7	Secure system configurations	89
5.7.1	Dual processor single I/O	90
5.7.2	Dual channel	90
5.7.3	Triple (or more) channels	91
5.7.4	Single channel with non-computer back-up	91
5.7.5	Safety considerations	92
5.7.6	Reboot and auto synchronising	93
5.8	Operator interfaces and maintenance aids	93
5.8.1	Operator interfaces	93
5.8.2	Maintenance data	95
5.9	Summary	95

6 Operator interfaces 96

Håkan Morän

6.1	Introduction	96
6.2	Operator functions	98
6.2.1	Supervision and alarm handling	99
6.2.2	Process overview	100
6.2.3	Production control	102
6.2.4	Maintenance	103
6.2.5	Which system?	103
6.3	Serving the person behind the machine	104
6.3.1	Ergonomics	104
6.3.2	Picture hierarchy	105
6.3.3	The need to know and the need for speed	105
6.3.4	How much information?	107

6.3.5	Alternatives to keyboards	107
6.3.6	Control-room design	108
6.4	The right system on the right level	109
6.4.1	The local operator interface	109
6.4.2	Centralised operator interface systems	111
6.4.3	Mimic panels	112
6.4.4	Monochrome VDUs	112
6.4.5	Printers	112
6.4.6	Interaction devices	113
6.4.7	Colour graphics	113
6.4.8	Management-level operator systems	114
6.5	Future operator interface systems	116
6.5.1	Presentation, simulation, evaluation	116
6.5.2	Back to the mimic, down to the process level	118
6.5.3	Integrated functions	118
6.6	Summary	118
	Further reading	119

7 System accuracy and reliability 120

Iain Lindsay

7.1	Introduction	120
7.2	Accuracy	122
7.2.1	General concepts	122
7.2.2	Why is accuracy important?	122
7.2.3	Terminology	123
7.2.4	System configuration	126
7.2.5	Processor arithmetic capability	127
7.2.6	Analog and digital signals	128
7.2.7	Digital integration	129
7.2.8	Example of weigh system accuracy	129
7.2.9	Example of metering accuracy	130
7.2.10	Example of level measurement accuracy	132
7.2.11	Estimation of overall system accuracy	134
7.3	Statistical quality control	136
7.3.1	Automated data acquisition	136
7.4	Reliability	137
7.4.1	General concepts	137
7.4.2	System reliability analysis	140
7.4.3	Mean time between failure (MTBF)	140
7.4.4	Failure rate	140
7.4.5	System availability	140
7.4.6	System configuration	141
7.4.7	Failure mode analysis	142
7.4.8	Series system	143
7.4.9	Redundant system	143
7.5	Software quality assurance	145
7.5.1	Software failure	145
7.5.2	Software error rate	146
7.5.3	Assuring software quality	146
7.5.4	Software quality assurance policy	147
7.5.5	Analysis and design methodology	147
7.5.6	Programming standards	148
7.6	Summary	148
	Further reading	148

8 Achieving integration 150

Ian Baker

8.1	Introduction	150
8.2	Integration	150
8.2.1	Background	150
8.2.2	Why integrate?	150
8.2.3	Information transfer requirements	152
8.2.4	System coordination	152
8.2.5	Connecting elements together	154
8.2.6	Defining integration	155
8.3	Feed forward	156
8.4	Feed back	158
8.5	Production management information	159
8.5.1	Resource optimisation	159
8.5.2	Manufacturing information	160
8.5.3	Material audit	160
8.5.4	Quality assurance	162
8.5.5	Telemetry systems	163
8.6	Summary	163

9 Computer enhancements 165

Derek Spencer

9.1	Introduction	165
9.2	Background	165
9.2.1	Why do you want a computer anyway?	165
9.2.2	Technology is well in advance of what you can buy	166
9.2.3	Who is going to specify and program the automation?	166
9.2.4	Who is going to maintain the system?	166
9.2.5	The push behind current developments	167
9.2.6	State of the art: what does it mean?	167
9.3	Hardware enhancements	167
9.3.1	Miniaturisation at operator and plant level	168
9.3.2	The rate of development for speed and size of processors	169
9.3.3	Transputers	170
9.3.4	Parallel processors	171
9.3.5	Multi processors	172
9.3.6	Dual systems	172
9.3.7	Dual standby systems	172
9.3.8	Dual and triple redundant systems	173
9.3.9	Inventions still waiting for technology to catch up	174
9.3.10	Production methods	175
9.3.11	Adaptive control	176
9.3.12	Opto electronics	177
9.3.13	Intelligent peripherals and input/output	178
9.4	Software enhancements	178
9.4.1	Standardisation	179
9.4.2	Software developments	180
9.4.3	Management information systems	180
9.4.4	Data acquisition and SCADA packages	180
9.4.5	Computer-aided process engineering	181
9.5	Hardware and software together	183
9.5.1	Reduced instruction set computers	183