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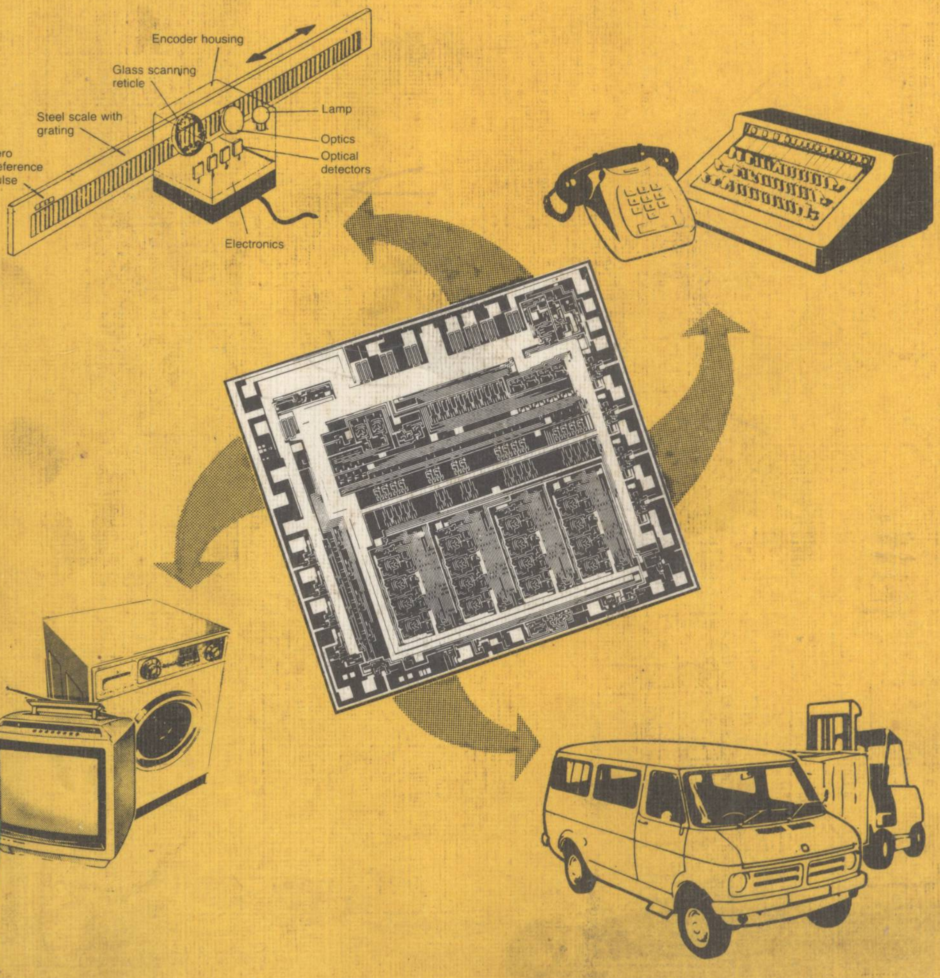
Microprocessors in Industry



Microprocessors in Industry

Selected Papers

PUBLISHED BY NCC PUBLICATIONS

British Library Catologuing in Publication Data

Microprocessors in industry.
1. Industry – Data processing
2. Microprocessors
620'.0028 T59.4

ISBN 0-85012-322-4

First published in 1981 by:

NCC Publications, The National Computing Centre Limited,
Oxford Road, Manchester M1 7ED, England

Typeset in 10pt Times Roman and printed by
UPS Blackburn Limited, 76-80 Northgate, Blackburn, Lancs.

ISBN 0-85012-322-4

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A Browes (SPL International)

INTRODUCTION

This article describes how a company with no previous experience of computing systems can implement a microprocessor-based system. It explains what sort of advice is available and where it can be obtained. The author describes a fictitious but true-to-life case history of a medium-sized chemical manufacturer with whom, it is hoped, the reader can identify.

The application discussed is a batch chemical process control system with plant state annunciation, logging and alarm. The procedures to implement this project should apply equally across the whole spectrum of industrial control applications.

Most of the commonly-encountered microelectronics and computing terms are explained in the glossary.

IN THE BEGINNING

The first question we must ask when considering a microprocessor-based project is "why?" This is the question that Bill Meadows, Works Director of The ABC Chemical Company, put to Tim Field, his young enthusiastic development engineer, when asked to approve the purchase of a Supercosmic Micro MKIII for use on the company's polyester resin production unit. "Well," said Tim "we simply have to get up-to-date. We've been established since 1862 and our current plant was installed in 1960. Anyway you must have seen these microprocessor chips on television and read about them in trade journals". "Yes, I have," said Bill, "but that is no answer. You want me to let you spend £7,000 of our hard-earned money on a box of microelectronics and for what? What will it do?

How much money will we save? What will be the real cost of implementation? Who will install it? Who will operate it? The very reason this company is still going strong after 117 years is it never does anything unless it knows exactly what it is going to do, how it is going to do it, how much it will cost, and how much it will benefit. I admire your enthusiasm but this submission is, quite frankly, nowhere near good enough for me to make a decision on."

Tim walked out quietly. He was sure he had a good idea. The salesman from Supercosmic had thought so too. The MKIII only costs £7,000. But Tim resolved to have another go and realised he was going to need some help.

MAKING A PROPER START

His first step was to analyse the basic motives in even considering a microprocessor installation. Yes, he could see that better temperature control and a programming capability must lead to reduced batch cycle times and fewer spoilt batches with a resultant increased throughput and improvement in production economics. If they could increase the thoughput per reactor to 3000 tons per year from 2500 tons then the cost per ton would be £10 less. That would mean a saving of £30,000 per year per reactor, and they would have four reactors. So savings of the order of £120,000 per year are possible and the initial capital investment in the Supercosmic Micro MKIII is only £7,000. But what about all those other questions?

Could he really program the system himself? He had never done any programming before but accepted that any graduate engineer should be capable of using a high-level language. He then realised that any computer, whether it be a mainframe, mini or micro, will only do what the programmer tells it to and this Supercosmic MKIII was going to do an awful lot. He was going to have to spend well over 700 hours writing computer programs. This was one thing he had overlooked and he had to admit that even if he had the capability he did not have the time. Never mind, they could hire a programmer for £100 per day. 700 hours equals 100 days equals £10,000. Not an inconsiderable sum to have overlooked!

What else had he overlooked ? Let us consider the general principles of the proposed scheme. Polyester resin is made in a vertical cylindrical batch reactor heated indirectly by passing a hot liquid-phase medium through an arrangement of external half-pipe limpet coils. It is cooled by passing water through a separate internal coil and has a packed fractionating column, with independent cooling, mounted directly on top. The reflux rate from this column is a contributory factor in batch contents temperature control. In the existing system a field-mounted pneumatic controller forms part of a continuous closed temperature control loop varying the indirect liquid-phase heat-transfer medium supply in response to measuring the batch temperature with a liquid filled capillary. The cooling water supply is manually applied and varied by the operator as he views the indicated batch temperature. Another field-mounted TIC measures the temperature at the top of the fractionating column and controls it by varying the supply of water to a shell and tube section. The batch temperature controller also records the temperature on a 24-hour circular chart. There are four such systems in the polyester production unit.

The microprocessor-based system will replace these conventional controllers since it has 8 Direct Digital Control (DDC) blocks with Proportional, Integral and Derivative (PID) actions pre-programmed into Programmable Read Only Memory (PROM). One control block will control the batch temperature by split phase action on both heating medium and cooling water. The other will control the fractionating-column head temperature. Both temperature control loops on each reactor will have set points programmable to give any time/temperature profile, and there is provision for interaction of the two control blocks by cascade control to take account of the reflux effect on batch temperature and vice versa. The system will log both temperatures on each reactor and additionally have alarm annunciation and temperature trend display on a reactor selective basis.

The cost of 8 programmable temperature recording controllers would probably be around £10,000, depending on the equipment selected. So in a rudimentary bid analysis the Supercosmic MKIII wins hands down. But this rudimentary approach is totally unrealistic. The microprocessor system already has a total cost of £17,000 for basic hardware (£7,000) and basic software (£10,000). Not so readily quantifiable but no less valuable benefits of the microprocessor system are its ability to handle stock inventory control, formulation storage and advice, and the generation of plant management records. The system is also enhanceable to include plant sequential control, leading ultimately to full automation. The company can cope with the system – which is not too complex but powerful and flexible enough to do a useful job, to earn its keep, and to give plenty of scope for expansion.

So all seems well. The bones of a feasibility study are taking shape, benefits still vastly outweigh capital costs, the project looks viable and attractive. However, other points need to be considered.

Analogue inputs and outputs (I/O) are specified by Supercosmic to be 4-20mA. How will these signals be generated (temperature measurement) and received (control valve modulation) by the plant? What are the problems in using electrical transducers in a hazardous (flameproof) environment? (This problem never arose with pneumatics.) Can the Supercosmic MKIII do the job it has been selected for? Does it have the basic computing power? Tim is a mechanical engineer, familiar with process plant operation, and not an electronics engineer or computer technologist. Professional help on microprocessor applications is needed.

GETTING HELP

In a positive and powerful way the government has made it possible for most companies to get professional advice, via MAPCON, on the application of microprocessors at little or no cost to themselves. MAPCON (Microprocessor Application Project – Consultants) is just one part of MAP, a multi-million-pound government investment to encourage the use of microprocessors in industry. A team of six people at the Department of Industry's Warren Spring Laboratory have compiled a list of consultants who are authorised to effect consultancy work on applications approved by MAPCON. For approved applications, MAPCON will reimburse consultancy fees up to a maximum of £2,000. In most circumstances £2,000 will be adequate to cover the entire cost of a consultancy.

The scheme is straightforward and simple to use. A copy of the list of authorised consultants and explanatory notes are readily obtained by contacting MAPCON. The client then has to select a suitable consultant. (See the following section entitled 'Choosing a Consultant'.) The selected consultant is required to provide a written offer – covering the aims, scope, duration and costs of the consultancy – to carry out the work. A short application form is completed and forwarded to MAPCON along with a copy of the consultant's offer and a few notes (brochures will do) on the client's activities. Ordinarily, permission to proceed will be given within three weeks of application.

The author has been assured that the MAPCON team take great care to maintain confidentiality of all documents and so companies should not hold back from using the service through fears of losing good ideas or technological advantage. At the time of writing, more than 300 companies have taken advantage of the scheme and bona fide applications are seldom refused.

Tim Field has already done quite a lot of work on his project and he will be using a consultant to prepare a fairly detailed study (to satisfy Bill Meadows). It is not, however, necessary for ideas and plans to be quite so firm before using MAPCON. Nor is it likely that the consultant's report will be quite so detailed.

As the works development engineer, Tim Field's signature on the MAPCON application form should be perfectly acceptable but he would be well advised to have Bill Meadow's foreknowledge and approval of his plan to use a consultant.

The MAPCON list of authorised consultants identifies the consultancies by type and size. The author recommends that the client confines his search to those currently identified as Category B, Category C or Category D. Size, as defined by MAPCON, need not be regarded as too important. For example, an organisation classified as small may have four full-time staff acting as microprocessor consultants and an unlimited complement of electronic engineers, programmers and systems personnel familiar with minicomputer systems.

CHOOSING A CONSULTANT

The list of consultants registered with the adminstrators of MAPCON (Warren Spring Laboratory) runs to more than 400 different organisations of varying size, capability and experience. The list includes individual consultants, microprocessor equipment suppliers, software houses (ie companies that specialise in applications programming) and systems houses (ie companies that specialise in the design and implementation of complete computer systems, usually including hardware and software). Other organisations and individual consultants exist but should a company wish to claim the reimbursement of fees (up to £2,000) under MAPCON they will have to satisfy the administrators that the chosen consultant is adequately qualified. This should not prove a major problem and so companies need not necessarily limit their consideration to a consultant on the MAPCON list. It is, however, important to stress that companies must clarify their position regarding reimbursement of fees *before* authorising fees allowing work to begin.

So whom to choose? Geographical proximity may figure highly in an initial search, but this may be neither necessary nor wise. Today commercial organisations are so mobile that a company based in Manchester has little difficulty in dealing with clients in London, Birmingham, Cardiff, Glasgow or wherever. However, it may be time-consuming for a consultant to serve a distant client and there are a limited number of hours in a working week. So in any comparison of potential consultants, geographical closeness should be considered, "all other things being equal".

The author does not advise the use of individual consultants except when strongly recommended or the holder of very special relevant expertise. Though consultants are usually well qualified and with many years' experience, they cannot hope to compete with a commercial organisation having fifty qualified personnel, each with several years' different experience and collectively, a good working knowledge of the many systems available to the potential user. Even if an individual consultant has the necessary knowledge and experience the client must still be vulnerable to situations such as sickness, domestic calamity and workload peaks. Perhaps the most important characteristics of the individual consultant are impartiality and independence from specific equipment manufacturers.

At this stage it is important not to become single-minded about which equipment to use and from which manufacturer. Indeed the newcomer to computing will often do better not to deal directly with an equipment manufacturer: for example, they are rarely able to provide applications software. Exploratory talks with several equipment suppliers can be helpful to test an idea, particularly since a great deal of time and effort will be consumed in the full project evaluation. In selecting a consultant avoid, where possible, using an actual equipment manufacturer, thus avoiding the fairly obvious bias of such an organisation.

An important step in this decision-making process is to visit the premises of the organisation where the consultancy work will be carried out. This is good practice throughout engineering and commerce and its value in this context cannot be overstated. Talk to the senior men in the organisation, have a good look round, ask to be introduced to the people who could be assigned to the project, and ask about similar application contracts. Many people do not have the courage or aptitude to contact a reference client but the benefits of a simple telephone call are obvious. Do not ask for a suitable reference, select a client at random from those mentioned during discussion or in literature and only then ask for the name of a suitable person to contact.

PROCEEDING WITH THE EVALUATION

Having selected a consultant and resolved the scope of his work and the commercial agreement, the first point to consider is that he will need assistance from his client's personnel. Let us assume that he has been commissioned to prepare 1) a feasibility study covering all predictable costs and 2) a functional/equipment specification which can be used as the basis for an invitation to tender and subsequent system procurement. This is probably the most likely arrangement and the most useful. It will also include the requirement to suggest several makes of equipment and, if possible, a similar number of organisations who can supply the system on a basis commensurate with the client's capabilities as the consultant sees them.

Like all new plant developments, especially those of an innovatory nature, a sophisticated control system needs to be introduced and explained to the people who will operate and maintain it. If operators, for example, feel they are playing a valuable role in the evolution of a project, then implementation will proceed so much more smoothly. The consultant needs to spend some time talking to operators, supervisors, maintenance men, union representatives and other people, to be able to assess the company's capabilities and to identify areas of weakness. This should take two or three days and so both tasks can be effected simultaneously – personnel participation and assessment.

The consultant will need a full briefing on the (eg chemical) process, existing plant, and the requirements of the microprocessor control system. This is where the choice of a medium-to-large-size organisation can help since they will probably be able to select a member of staff with some experience in the same branch of industry. This avoids wasting valuable time and lessens the chance of misunderstandings.

To prepare for the evaluation, the client should compile a package of information for the consultant. This should include drawings, particularly system flow diagrams; if a simple easy-to-read diagram is not already available, then one should be prepared showing the existing plant units, their interaction and any proposed modifications when the microprocessor project is implemented. A typewritten process description, it need only be brief, including reference to manning levels by grade and number and a listing of standard costs for both manning, raw materials and services (electrical power, steam, cooling water, fuel, etc) should also be made ready in advance. A company (or department) organisation chart with names and positions will be very useful not only as a guide to sources of information but also as an aid to the assessment of staffing levels. (Figure 1 gives the example of the ABC Chemical Company.)

With two secretarial staff, the works has a total staff complement of thirty-two. Sales and administration are handled at the London Head Office, which does not include any central engineering support. This division of skills and effort into two main streams – process or production management and maintenance/development engineering – is fairly commonplace. *Process management* will indicate what is wanted of the microprocessor system – what will it do, how do we use it? – and *engineering* will be concerned with system implementation and support, this latter group more often being the one that needs close attention and modification.

In an ideal world the consultant would look at the organisation chart, see the weak spots, the missing disciplines, and specify several new members of staff; for example:

— An instrument technician with electronics experience to work under the Foreman Electrician;

— An electronics engineer with computer hardware experience to work alongside the Development Engineer;

— A process engineer with programming experience to slot in between the Works Manager and the Process Supervisor.

This would still not give the works unit sufficient capability to implement the installation without the help of a main contractor. Apart from recruitment costs, these three new men would add anything between £20,000 and £30,000 a year to the works overheads. This extra overhead could, arguably, be directly charged to the microprocessor project.

Companies opt for a mixture of taking on new staff, retraining existing staff and throwing down the challenge to existing staff. Many microelectronics companies offer a variety of support services including 24 hours-à-day emergency call-out, but it may not be wise to rely too much on promised maintenance support. In practice, after-sales service seldom