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On-line Development of Process Control Computer Programs

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ALMOST without exception, process control computer systems have been to some extent development projects. Most have been applied to commercially operated production units, for which the improved control of the process provides adequate financial justification for the computer installation. In such cases, conflict arises between the use of the computer for the basic control of a continuously running process and the development of new programs. One solution is to provide a comprehensive conventional standby control system so that the computer can be taken off line at any time; alternatively, to limit the system to supervisory set point control. This approach is very expensive and there is a tendency for the computer to become purely a research tool, imposed upon a rather unwilling production unit. Another common approach is to use a relatively expensive computer system with backing store and full time-sharing facilities. This second method is justifiable when the process ocntrol computer is required to carry out a large amount of off-line work such as scheduling and invoicing, but is unnecessarily expensive if the computer's principal task is process control.

On the Wiggins Teape Argus 400 system at Dartford, a different approach was adopted. The standby system is little more than the absolute minimum required to run the machine during the extremely infrequent emergency repairs to the computer hardware. This arrangement has had the advantage that the process operators have rapidly come to rely upon the computer system on a full-time basis, but the system is essentially a development project in which new control and logging programs are frequently tested. The conflict for computer time between routine process control and development work has been largely overcome by means of a miniature 'background' operating system. This monitor system enables spare processor time, core store and peripherals to be made available for running development programs without interruption of the on-line control function. Its current uses include program editing, translation and test runs.

The Argus 400 has 24 K of core store, two teleprinters and a high-speed tape reader and tape punch. There are no hardware multiprogramming protection facilities or backing store so the hardware costs are very low for a system of its size. Most of the programs were specially written for the system in Assembly language (machine level code). The on-line system has continuous use of all process inputs and outputs and one teleprinter. The other teleprinter, the tape punch and reader are used only intermittently (for operator demanded process logs and at grade changes). Normally, under 50 per cent of the available processor time is used for on-line control, which is almost entirely DDC. The basic monitor progıam is part of the interrupt timing organiser. In use, it seizes control of the teleprinter, tape punch and reader from the on-line system. Monitor-controlled programs then have exlusive use of these peripherals, a 4 K block of core store and all free processor time. They also have access to all process inputs.

The monitor system is controlled by a single key-operated switch, which causes it to read and execute a directive punched on paper tape. There are three principal directives—

(*a*) Load the following program from paper tape to store.
(*b*) Run the program currently in store.
(*c*) Terminate use of the monitor and return control of the peripherals to the on-line system.

Absolute safety of the on-line system is achieved by using a special self-checking binary code for all program loading and producing tapes of only thoroughly tested programs. These include special logging programs, tape editing and copying routines, the Assembly language translator (tape to tape) and a specially modified program loader that incorporates an interpretative guard tracer for safe trial of untested programs. This will halt a test if an order affecting the on-line system is encountered.

The monitor system has virtually supplied the development team with a second Argus computer. Its implementation took place in the two months immediately following the commissioning of the basic control system. It has since been in constant use in the development of a tape editing program, data logging routines and production logging and grade change systems. There are currently four programmers working on system development. If each required the computer for two hours a day, the on-line time would be reduced by 30 per cent in the absence of the monitor system. Such a requirement would conflict directly with the need to build up operators' knowledge of and a confidence in the control system. Other benefits include the rapid practical training of new programmers and easy access to the computer for established people. Such a system is surely an essential part of any dedicated DDC computer control system in a production unit for which any further systems development is envisaged.

Discussion

Mr R. G. Nagro May I congratulate you on your paper and your computer system. You stated some estimates of the expected system payout. After having had some working experience, would you like to modify those or support them or is it still too early to tell?

Mr H. D. Cyprus I take it you are referring to the estimates shown in Fig. 1. I would not change them, except possibly to raise them somewhat. We have certainly not yet achieved those returns. This is partly reflected in the troubles we had last year; it also affects our lack of expertise, which is still being developed. I cannot see why we should not achieve those levels.

Harking back to my comments on performance quantity, I am not convinced we did not do ourselves, the management and the project a disservice by looking at it in this light—by isolating the return on improved regulation of basis weight, proportions of the constituents, etc., yet I cannot think of an alternative.

Mr J. Mardon My first point on Mr Cyprus's paper is my great difficulty in accepting the idea that one first chooses a computer, then undertakes the planning preparation phase. This seems to me a negation of what I might term the classical approach. First of all, the planning phase; then one should choose the pieces of equipment suitable for the specification when it is drawn up. I would appreciate Mr Cyprus's comments on that.

The second point is to say to Mr Nagro that the idea of having on-line access to the computer without in any way impairing its functionality for control has been taken into account in the design of the Bailey 855.

Mr Cyprus There seems to be a measure of misunderstanding. The planning and preparation phase that I referred to under the heading phase 0 was in fact detailed preparations and detailed planning in line with the decision to go ahead with this particular system. Of course, the company, working with more than one manufacturer, did a preliminary preparation and planning phase. This went on for some time before the decision to buy this particular system and it decided for us the general detail, for example, whether or not to buy a computer, whether an analog or digital, whether small, large or medium sized, etc. Phase 0 was detailed planning and detailed preparation, which must be done after deciding what equipment to use. Otherwise, I agree with your comments.

Mr W. D. Hoath Mr Cyprus mentioned that they had their own learning to go through in computer installation. What were the problems experienced? Were they hardware, software and how well did they keep within their budget costs? On the standby equipment, he is having to cope with several manufacturers. Was this a problem in itself?

Mr Cyprus With respect, I will not go into the detail on the first part of the question, because the answer lies fully in the paper. The troubles we had did not affect our costing, but I think the reason for this is maybe the way we organised the budget initially.

We had no great embarrassment because of different manufacturers. We know our instrument suppliers well and there were no delays through them. Although our interface and standby equipment was manufactured by one firm, it came as part of the supply from another firm in a satisfactorily phased manner. To be fair, the hardware was delivered late and therefore this may well have hidden problems that we might otherwise have had.

Mr M. I. MacLaurin Some of you may have heard me speak on the subject of computer project assessment earlier this year in New York.* Since that time, we have gained further experience in this area and, were I to speak again on the subject, I would be less assured of the practicability of the method I described, despite its theoretical merit.

The basic problem is not so much in comparing how well the papermachine performs now compared with the pre-computer period, but more in identifying how much of this improvement may properly be attributed to the effect of the computer.

Mr Cyprus I agree totally with you. It seems to me pointless to compare the 1965 performance (when we did our initial study) with running today. As I have suggested, this has no meaning. We must define a parameter, the performance quantity (which takes into account all those factors influencing performance) and monitor it continuously. Normally, it should show a logarithmic rise and a step to a higher level if some factor contributes significantly to the well being of the process. We have developed this growth curve for No. 16 machine for the last six years or so and will maintain it, hoping to see an effect attributable to the computer.

An alternative might be to take the computer off for a month, then put it back on, hoping to show the improvement. I consider this to be an impracticable proposition.

* *Tappi*, 1969, **52** (8), 1 480—1 483