BRITISH IRON AND STEEL RESEARCH ASSOCIATION

LONDON GROUP LABORATORIES OPEN DAYS

THE British Iron and Steel Research Association recently held open days at its Battersea premises to show its members something of the current and continuing work of the London Group laboratories. Of the five Divisions and three Departments of the Association, the London Group comprises the Plant Engineering and Energy Division, part of the Iron-making Division, and the Physics, Chemistry and Operational Research Departments.

Notwithstanding the wide spread of interests represented, the displays clearly reflected the interest of the steel industry in automation and allied subjects. Not only has the Physics Department recently formed a new Section to deal specifically with the subject of automation, but also the Electrical Engineering Section of the Plant Engineering Division has pioneered several developments which, in effect, apply 'automation' in the handling of information.

Some years ago this Section developed a 'performance recorder' which recorded and stored production data, and processed it so that periodical tabulated totals would be available in printed form for office use. Equipment of this kind has since been installed in several British steel-works and other factories, and a development of the basic idea was designed and supplied for a big Russian contract for the erection and equipment of a giant tyre factory in the Soviet Union by a British consortium.

The Electrical Section of the Association has now completed a further development—the 'Tallimarker' system for conveying essential information in a steel-works. Starting from the premise that efficient production depends on accurate, easily accessible information, this automatic system represents a great advance on the traditional pattern of circulating data by paper chits or word of mouth. It consists basically of three essential units: 'push-button' desks, and display screens at key points along the production line, and a central 'memory'. As applied in a steel-works rolling mill, for example, the operators at the soaking pit, primary mill, primary shears, section mill and saw-bench, would all have press-button stations into which information is fed, and all stations after the soaking pit would have a display screen showing the previous history of the product as it is progressively reduced from the original ingot. As the ingot or subsequent bloom passes down the line, the operator at each point reads off the facts on his display screen, and feeds in more information as he completes his operation, for the following stations. When a section is being cut at the final saw, the 'Tallimarker' store holds the complete history of the section. Details are relayed to the mill office and recorded in the most convenient form; for example, on a teleprinter record, punched card or magnetic tape. The basic system can, of course, be adapted for use in any production line; in construction it is reliable, robust and accurate, reduces clerical work, and saves time and money.

The new Automation Section of the Physics Department is studying several possible applications of automation to steel-works production methods. Among these is a scheme for the automatic inspection and treatment of rolled billets, which often have surface defects which must be made good. The new plan is to dip the billet in a fluid which fluoresces under ultra-violet light, and which penetrates the flaws. The billet will then be washed and passed to an inspection chamber, where the flaws show up under ultra-violet lamps and can be detected by photocells. The photocells can be linked electrically with finishing tools such as grinders or de-seaming torches for automatic treatment. Billets without flaws would be diverted and stored, later rejoining the line in their original order.

The increasing use by manufacturers of steel sheet and strip has led to a growing pre-occupation with methods of quality control. Automatic gauge control was developed by the Association some years ago, and has been widely adopted in industry. On show at Battersea was a proposed new method of measuring small reductions in strip thickness, which can be integrated with automatic correcting equipment. The system is based on the fact that the reduced strip leaves the rollers faster than it enters them—the greater the reduction, the greater the change in speed. Therefore, by measuring the change in speed, the reduction can be calculated. It is proposed to do this by comparing identical signals obtained by photo-electric measurement of reflectivity at two points 'down the line'. The time-lag between the signals gives the time the sheet or strip takes to travel the distance between the points of measurement. One of these instruments before and one after rolling will give the change in speed, and therefore the reduction in thickness. This 'non-contact' method avoids any complications which would arise from the use of contact rollers or similar devices.

Because automatic control demands as an essential prerequisite exact information, instrumentation may be said to be the first step towards automation. An interesting new instrument is the 'bar section meter' displayed by the Physics Department. It has been designed to measure simultaneously four diameters of a hot solid bar at 45° intervals while it is moving at a high speed. This information is valuable not only for checking that the section is being rolled to the specified size, but also for early detection of such defects as finning.

The water-cooled viewing head forms images from the opposite edges of the bar across each diameter to be measured. These images are placed side by side in a single field of view, and are magnified and transposed so that the edges point towards each other. The instrument thus shows four parallel bands of light representing the four diameters measured. Each nominal diameter of the bar is set on the instrument by a micrometer adjustment; if this corresponds to the diameter being viewed, then the appropriate band is continuous across the field of view (that is, the fact that the edge images have been brought to coincidence in any band indicates that the diameter is as set). If there is a gap in the middle of the band, the diameter of the bar is less than the scale reading, while a bright central zone caused by the images overlapping indicates that the diameter is greater. First experiments show that deviations in diameter of about 0·005 in. can be detected.

Leaving the theme of automation, an interesting sidelight on the technique of research was provided by the Ironmaking Division. Although the blast furnace is a remarkably efficient vessel for the large-scale exercise in physical chemistry which iron-making represents, there is still much to be learned about the course of the reduction process. There are severe limits on what can be deduced from experimental work on a blast furnace, and the Division therefore developed laboratory apparatus to simulate the reactions taking place in the blast furnace. The *Scice* apparatus (stationary charge in controlled environment) metaphorically turns the blast furnace 'inside-out'. In the blast furnace the charge moves down the stack, encountering changing conditions and undergoing various reactions; in *Scice* the charge is held stationary while gas of varying compositions and temperatures corresponding to these changing conditions is passed through it and reacts with it. By controlling the conditions continuously, the ironmaking process can be reproduced and its reactions studied with relative ease.

The practicability of this approach was originally proved in the laboratory by experiments using a charge container of three inches diameter. A much larger and more elaborate version has now been installed at the Battersea Laboratories. It incorporates a gas producer, gas absorbers, gas booster, electric heater for the gas, a reaction chamber 20 in. in diameter by 24 in. high, dust cyclone, and a gas cooler. Instrumentation has been provided for flow-rates, temperatures, pressures and gas compositions, with provision for easy control of the variables. This scaled-up version of the original bench conception provides a unique tool with which to solve some of the remaining unknowns about blast furnace operation.

Also housed at Battersea is the Association's Operational Research Department, which now consists of three Sections: Computer Applications, Operational Investigations and Human Factors.

The first of these is primarily concerned with helping the steel industry to make use of the electronic computer. This involves the use of the computer not only as a research tool but also as an administrative and/or production aid. Using the Ferranti *Pegasus* computer installed at Battersea in 1958, the Section has carried out extensive studies of the feasibility and economics of using computers for such familiar problems as production scheduling, stock control, wage calculation, plant and process control, and allocation of materials, and already much valuable data have been collected.

The Operational Investigations Section is operating a service—at present confined to the Association's member firms—whereby the Department's experience and facilities can be used to supplement managerial experience with forecasts of the effects of alternative policies. A typical problem, involving a decision on stock control methods, was illustrated by displays. The example taken was a company keeping large stocks of billets to ensure against production hold-ups. This involved problems of locked-up capital and periodic rises in storage and transport costs.

The first step was to analyse existing order and stock control methods. From this, and from quantitative records, the main characteristics of production and raw material delivery over a long period were mapped out, and the effects of different control methods simulated on paper and carefully studied.

Eventually, a set of 'ordering rules' was drawn up which in practice proved so successful as to release £100,000 of working capital by reducing the average stock-level, and a further saving of some £6,000 annually by reduced labour and transport costs.

The Human Factors Section of the Department is concerned with such things as accident prevention, protection against heat and injury, and the broad subject of ergonomics, or 'fitting the machine to the man'. In this latter field, displays showed many advances in control equipment design, aimed at reducing operator fatigue, eliminating strain and increasing efficiency. An experimental control point was on display incorporating variable hand (and foot) controls, which has proved the genesis of a series of improvements already being adopted in production practice.

It is, of course, impossible to give other than an arbitrary selection of the features of the display which, in any event, was representative of a part only (about one-third) of the whole programme of the British Iron and Steel Research Association. This account, however, provides an indication of some types of problem being tackled and of the methods of approach. D. U. HUNT

COMPUTER LABORATORY AT THE UNIVERSITY OF LIVERPOOL

THE University of Liverpool has had a Mathematical Laboratory for more than twenty-five years—it was established by Prof. L. Rosenhead in 1934 shortly after he became head of the Department of Applied Mathematics. The primary object of the Laboratory was always to train students in the honours school of mathematics and research students in other schools in the basic methods of numerical analysis applied to all branches of science.

The Laboratory has always been well equipped with accounting machines as well as desk calculating machines. An important feature of the teaching in the Laboratory has been the insistence on the fullest possible exploitation of all types of calculating aids, and much effort has been spent on not only investigating the possible uses of machines but also on developing methods suitable for them.

The spectacular post-war growth in the demands for numerical analysis has led to very greatly increased demands being made on the Laboratory; the problems received for solution have been growing more numerous, more complex and greater in scope. At first, the need was met in part by making use of punched card accounting machinery, and later by