Fulmer Newsletter

contract research and engineering in materials and process technology

No. 50 April 1983

D. Adamson

GOLDEN JUBILEE EDITION

This is the 50th edition of our Newsletter, which started in a very modest way in April 1968 with a single sheet quarterly insertion in the Physics Bulletin. As the more numerate of our readers will have swiftly calculated, we clearly have not succeeded in appearing four times a year in the fifteen years which have elapsed since our inception, but the Newsletter has expanded considerably in size and scope, and now appears three times a year.

Fulmer, too, has expanded considerably since our first edition appeared. In 1968 our income was £284,000 and profit £25,000; in 1982 our income was £3.22M and profit £145,000. In 1968 we depended heavily upon Government contracts; they now represent less than 25% of our income. We earn 25% overseas, and hence carry out more than 50% of our work directly for British industry. In 1968 we were still mainly based in metallurgy, physics and physical chemistry. Today, after adding Yarsley, Norseman, Aeon, Reform and IPEC to our Group we are much more involved in the total spectrum of product and process design, development and testing, and cover all aspects of materials technology.

This Newsletter, as have all its immediate predecessors, will emphasise not only our versatility but our in-depth appreciation of what needs to be done to bring viable products and processes to the market-place.

ROBOTICS - FRIEND OR FOE?

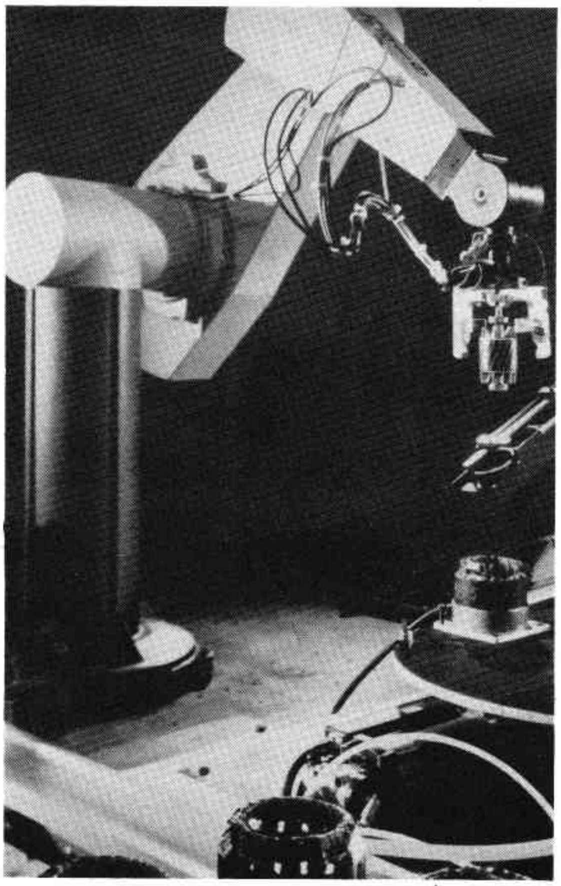
The U.K. government is anxious to see robotics used by industrial companies. To encourage this, a robot support programme was launched in April 1981 whereby the government would fund one-third the cost of installation. But the response has been somewhat disappointing, and only about one fifth of this monetary resource has so far been tapped.

Fulmer Research Institute has recently been appointed authorised consultants under this programme to promote the use of industrial robots. This means that feasibility studies and application projects carried out by Fulmer on behalf of clients are eligible for a Department of Industry refund of part of the cost.

Friend or Foe? It is largely dependent upon one's viewpoint as to the importance or otherwise of the robot on the factory floor. The robot has been with us for many years now, and can be likened to the capstan lathe in terms of industrial progression. Both require to be programmed by an experienced setter or "instructor"; after that it will set about its repetitive task without demanding tea or toilet breaks.

The old adage "If you can't beat them" is particularly pertinent in the robotic context, for all the signs seem to indicate that a large number of survivors of the present industrial gloom will owe their future security to current robotic investment.

In the Far East, plastics moulders and processors are installing robots at the incredible rate of 1000 a month. In W. Germany some 1200 were installed in industry within the last year compared to the U.K. figure of around 400.



At a time when the total unemployed in the OECD countries has been estimated at 33 million for 1983, it would seem somewhat illogic to endorse the case for more robotics, but the recessional climate worldwide has, of necessity, had a direct and forceful effect on competitiveness in the market-place and products must now be manufactured using the most cost-effective production method available.

Both OECD and the Henley Centre for Forecasting in the U.K. have painted a gloomy picture of the U.K. economy in the next five years. This has also been endorsed by the C.B.I.

Apart from the consistent quality control and, in some cases such as paint spraying, material conservation which is achieved employing the robot, the initial investment costs are often amortised in a very short space of time.

On pages 2 and 5 of this issue we discuss the value of an investment in robots and what Fulmer can do to help you.

MORE ON ROBOTICS

The appointment of Fulmer as an authorised consultant under the government's robot assistance scheme provides the manufacturing industry with an independent body which can advise on all aspects of robotics with positive short- and long-term monetary advantages.

It has been suggested that with current capabilities, robots are generally justified for batch operations ranging from 200 to 200,000 parts p.a. Smaller jobs are best handled manually, and larger jobs by fixed automation, although this will alter as robot capabilities increase.

Since Fulmer is completely independent of any robot manufacturer, impartiality is assured in regard to equipment recommendations.

Engineers at Fulmer have the expertise to undertake the following:

1) design a workplace layout which takes account of cycle times, material flow, quality assurance and operator participation, 2) specify and procure the robot and ancillary equipment, 3) design and manufacture special purpose grippers, sensors and fixtures, 4) integrate the robot and its peripheral equipment to form a complete production cell, 5) provide flexible intelligence through the use of sensors, counters and other input/output devices, and 6) programme the robot and ancillary equipment, generating special-purpose software as required.

Fulmer offers the following services to organisations who are interested in exploiting the advantages of robotic automation:

SITE SURVEY

– a one-day visit to a specific factory to assess the potential for introducing industrial robots into manufacturing or service areas. This service is offered free of charge.

FEASIBILITY STUDY

– typically a 15 man-day study of the technical and economic feasibility of a particular industrial robot proposal. Eligible for 50% Department of Industry funding in most cases.

MULTI-CLIENT OPPORTUNITY STUDY

– a shared-cost study on behalf of several clients from a specific industry, which evaluates the opportunities for industrial robots.

APPLICATIONS PROJECT

– the procurement, development and commissioning of the equipment and software needed to implement the results of a feasibility or opportunity study. Eligible for 33% Department of Industry funding of capital and development costs in most cases.

Further information: Dr. P.A. Finlay
Fulmer Research Laboratories

A HELPING HAND ACROSS THE SEA – TECHNICAL ASSISTANCE TO TURKISH RESEARCH INSTITUTE

Fulmer Research Laboratories has completed successfully another assignment for the United Nations Industrial Development Organisation (UNIDO). This time technical training was provided for the Marmara Scientific and Industrial Research Institute (MSIRI) near Istanbul in Turkey.

MSIRI was established at its present location on the coast of the Sea of Marmara in 1972 to accommodate small units previously operating at various Universities. The Scientific and Technical Research Council of Turkey (TUBITAK) have gradually expanded the complex so that there are now over 32,000 square metres of laboratory area and a staff of over 500.

The fields of activity at Marmara Institute are very extensive. The eight departments include such topics as Applied Mathematics, Operational Research, Electronics, Nutrition and Food Technology and, of particular interest to Fulmer, Materials Science.

Over the last ten years UNIDO has provided assistance to MSIRI in three ways:

- Purchase of laboratory equipment. .
- Visiting consultants for in-house training.
- Travelling Fellowships for overseas training.

The laboratories are now generally very well equipped and manned by an enthusiastic staff. Several areas had been identified where additional training was needed to enable MSIRI to provide a better service to Turkish industry. UNIDO therefore engaged Fulmer to provide a specialist programme of assistance to the Materials Services Department of MSIRI.

Fulmer's brief covered a number of areas:

- Melting and casting of alloy steels.
- Rolling and extrusion theory and practice.
- Manufacture of rolls.
- Setting up a shell moulding facility using the Croning process.
- Manufacture of electrical steels.
- Electron microscopy and metallographic techniques.
- Texture analysis by X-ray diffraction.
- Setting up a corrosion laboratory and technical advisory service.

The overall programme entailed twelve man months of visits to Turkey by a team of ten specialists, and twenty-five man months training in the U.K. for twelve members of MSIRI staff. This whole operation was fairly complex as it was necessary to ensure that visits to Turkey did not coincide with U.K. training programmes for relevant people and that National Holidays and the summer closure at MSIRI did not interrupt the programmes.

During their visits to Turkey the team members provided training in the form of demonstrations and seminars in addition to more personal man-to-man discussions. Opportunity was also taken to visit industrial establishments for on-the-spot advice and trouble shooting and to demonstrate to MSIRI staff the importance of maintaining close links with industry. The Fellowship's training programmes encompassed laboratory training and demonstrations as well as tutorials and work visits.

Fulmer has carried out many training programmes for overseas organisations.

Further information: Mr. P. Caton or
Mr. R. Flint
Fulmer Research Laboratories

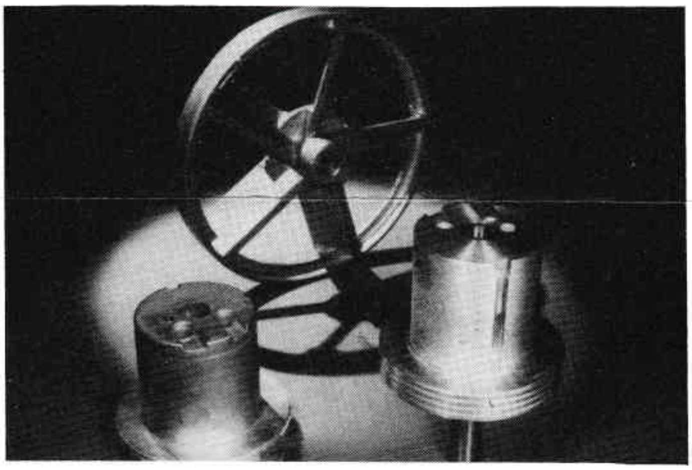
SEMI-SOLID INJECTION CASTING OF ALUMINIUM ALLOYS

Conventional pressure diecasting using superheated liquid metal entraps air and produces diecastings which cannot be heat-treated without distortion.

A pressure diecasting process has been developed which uses a semi-solid aluminium alloy slurry in a thixotropic condition. Such alloys can be handled as if a rather soft solid, but when sheared in the shot sleeve of a conventional diecasting machine, they will flow without turbulence as a non-Newtonian fluid. Because the alloy can be handled as a solid, conventional solid metal handling equipment can be used and the design of dies can be simplified. Because the alloy is forced into the die as a slurry, less turbulence occurs and sound diecastings are produced. The lower temperature of the slurry compared to liquid metal means that half of the latent heat and all the superheat has been removed; thus the lower die temperatures result in less thermal shock and faster cycle times so improving the productivity of the diecasting process.

The process uses conventional diecasting alloys such as LM21 and LM24 which are continuously cast as bar of the diameter required to enter the shot sleeve of the diecasting machine. The pilot plant constructed enables bar to be cast at commercially attractive rates to produce a structure which is thixotropic on reheating to the temperature at which 40-50% of the structure is liquid. This can be handled easily as a solid but can be injected into conventional dies for liquid pressure diecasting to make sound diecastings in quantity which have satisfied the standards of the two industrial users. Whilst the success of the process will enable simplified dies to be made, it has been demonstrated for several dies that sound and accurate components can be made in quantity using dies designed for liquid metal casting. Some of these castings are now in full operational service.

The feasibility of the semi-solid injection process has been demonstrated and the project is now devoted to successful transfer of the process to industry.



One of the castings now being regularly produced with the Semi-Solid Metal Injection Casting Process.

Further information: Mr. G.B. Brook
Fulmer Research Laboratories

OVERCOMING THE PROBLEMS OF THE HIGH FLYERS

The Wycombe Kite Company has been manufacturing High Performance Kites for two years and during that time the products have been selected for the Design Centre. However, the original injection moulded winders were bending under the tension created on the line by the kites. Changing the material from ABS to glass-filled nylon did not overcome the problem because the winder then fractured rather than deformed.

At this stage the Wycombe Kite Company approached Yarsley Technical Centre for advice on the most cost-effective solution to the problem. Yarsley Technical Centre recommended simple changes to the ribs to increase the component stiffness and modification to the gate to minimise weld-line weakness. Assistance with problems of this type can be carried out within Yarsley's 'Design Evaluation Service', where a budget of £75-£150 is usually sufficient to provide advice to overcome problems with plastic product design and manufacture. This service is particularly relevant to companies with in-house design expertise in their own product area.

Further information: Mr. R.N. Trubshaw
Yarsley Technical Centre

ABRASIVITY MONITOR FOR FLUIDS

With financial support from the Department of Industry and NRDC, a project is under way to develop a device for monitoring hard particles in fluids. It is intended that the device will be manufactured and marketed by Fulmer Components Ltd.

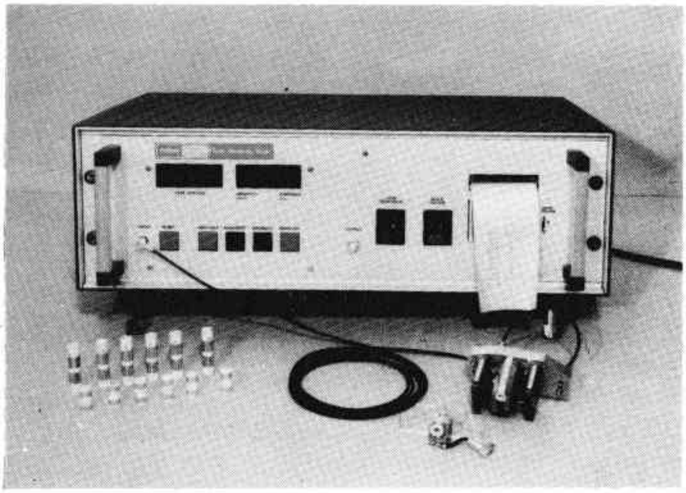
In, for example, lubricating oil, fuel oil, hydraulic and cutting fluids, hard particles may accumulate as wear debris, originating within the fluid-washed system. In this form they may serve as a useful indicator of the degree of progressive wear within the system, or their generation may herald a serious component failure. In some circumstances the particles may further reduce the effectiveness of the fluid in its operation, compounding the wear processes. Alternatively, hard particles may be present as contamination originating outside the system, perhaps being introduced during the production or transportation of the fluid. Thus, they may cause damage to an otherwise clean system. There are advantages to be gained with the ability to monitor the presence of particles in these fluids.

The method being developed is based upon the abrasion, by particles in suspension, of a thin film of electrically resistive material upon which the fluid impinges. In the prototype, the thin film is incorporated in a sensor plumbed into the equipment under test. Progressive changes in resistance are measured and processed by an electronic control system. Compensation for temperature changes can be accommodated. Initial experiments have shown that the device is very sensitive. It has the capability of on-line operation, and responds specifically to the abrasive nature of the fluid-borne particles. There are clear potential advantages over methods involving for example sample collection, chemical analysis, particle dispersion, electrical induction or ultrasound.

Some examples of applications where use of the device can be envisaged are in engines for motive power, electrical power generation or gas compression, in gears and transmission systems, in road transport, ships, aircraft and railways, and in the machine tool industry. Contacts in many of these fields have shown an encouraging response to our enquiries.

The present development programme consists of two major parts. Further laboratory study will enable us to investigate fully the response of the device as a function of physical variables, such as flow-rate, viscosity, particle size and concentration, likely to be encountered in service. Field trials, with the cooperation of interested parties in industry, will enable us to study the operation of the device under service conditions. The objective will be to produce for the market instruments readily compatible with the intended applications. The control system will be designed either to initiate automatic reactions to the condition being monitored or to provide information in a form easily usable by the engineer whose responsibility it is to maintain machinery in efficient running order.

Further information: Mr. R. Freeman
Fulmer Research Laboratories



CUSTOM ALLOY OR PRODUCT MANUFACTURE – A COMPLETE SERVICE
INGOT–BAR–SHEET–WIRE–SHAPES

Fulmer's Materials Processing section was established many years ago to meet the demands for the specialised alloys needed by various research programmes being carried out around the Institute. However, it soon became recognised by industry and University departments that this facility could also provide a valuable service to a much wider market.

The list of customers is now very extensive and it is not just unusual compositions which have been supplied but also standard alloys in small quantities or forms which are otherwise not commercially available. Over the years the repertoire has spread both in the range of materials and in their form. Alloys range from lithium to uranium and products include powder, sheet, wire, shaped castings, etc.

In many cases novel melting or processing techniques have had to be developed to produce the material in its desired purity or form and a number of specialised pieces of equipment have been designed and constructed to fulfil these demands. Once these techniques have been demonstrated, industrial versions have been built and supplied to clients to enable them to continue production in-house. A typical example is the Fulmer Durvac Furnace (illustrated) which enables around 1½kg. of material to be melted and cast under vacuum or inert gas conditions.

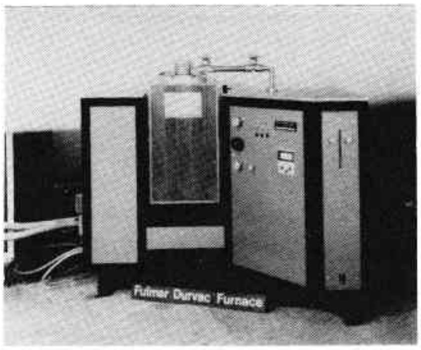
As the demands placed on engineering materials have become more and more exacting a greater emphasis has been placed upon materials prepared under vacuum or inert gas. In addition to the 'Durvac' furnace referred to above, Fulmer also has a range of facilities to suit quantities from a few grams to many kilograms. Extensive use is made of vacuum induction melting but facilities also include arc furnaces for preparing quantities around 100 grams. This process is particularly useful for refractory metals or metals which need crucible-free melting. Another application is in preparing highly enriched 'master-alloys'. For quantities around 10kg in steels or superalloys (more in denser materials) a tilting crucible induction furnace is used.

Whilst these furnaces are needed for the refractory metals or alloys with easily oxidised additions, less demanding alloys can be air melted. Steels or copper base alloys in quantities up to 150 kg can be prepared in a tilting induction furnace and over 500 kg of aluminium alloys can be handled by a tilting resistance heated furnace which can be linked to a horizontal continuous casting line.

Having produced the alloy a number of subsequent operations are available. Heat treatment, forging, rolling and wire drawing can all be carried out on site, as also can compositional analysis on microstructural examinations, or machining operations. In addition, extrusion or swaging can be arranged where needed.

Should it not be possible or appropriate to prepare a material by melting and casting then a number of powder metallurgical options are still available. Custom alloys can be manufactured using attritor milling techniques or powder blending and dense products obtained by pressing and sintering, extrusion or hot isostatic pressing.

Whilst the early demands were just for a specialised melting and casting service, Fulmer's clients can now take full advantage of the range of services from initial advice on materials selection and production processes, to alloy preparation, working, machining, etc., through to prototype samples of small runs of products. This is therefore a truly complete service.

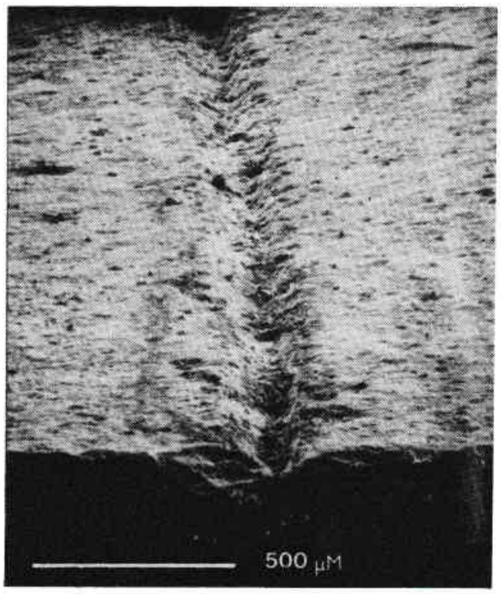


HIGH RESOLUTION ULTRASONIC EXAMINATION

For several years Fulmer has been involved in research and development in the field of nondestructive examination. This work has revealed the need for a method of examining specimens, and features within specimens, which are small by normal nondestructive examination standards. Consequently, a facility using unconventionally high ultrasonic frequencies is under development at Fulmer.

Standard ultrasonic examination methods operate in the 0.5MHz to 20MHz frequency range. Even the upper limit of this range does not provide sufficient spatial resolution for many applications and consequently equipment operating at 30MHz and 50MHz has been assembled. Two types of operation are available; a manual mode using a 50MHz hand-held contact transducer and a scanning immersion mode using 30MHz or 50MHz focussed transducers. The contact transducer produces sound pulses of approximately 60ns duration. It will detect features as small as approximately 0.5mm diameter and 0.2mm below the specimen surface. This system has been used extensively to examine the diffusion bond between a metallic cladding and a substrate; the cladding is 0.25m thick. Failures in the bondline are readily revealed and examination of the shape of reflected waveforms enables sound bonds to be characterised, for instance for the presence of intermetallic compounds.

The 30MHz and 50MHz focussed transducers have focal spot diameters of 0.15mm and 0.1mm respectively. These transducers will detect extremely small features (by normal examination standards). This capability is particularly valuable for structural ceramics, an increasingly important class of material. In one study at Fulmer, irregularly shaped inclusions of 0.075mm diameter and cracks and scratches of 0.05mm depth were identified in a ceramic tube of 2mm wall thickness.



Two scanning systems are planned. The first, currently being converted to computer control, provides large area scanning (1000mm x 1000mm). The second will be more limited in scan range but will provide the high resolution (+0.012mm) necessary to make maximum use of the resolution of the transducers. Both systems will run under full computer control of scanning and data storage. Facilities already exist for considerable types of signal processing including quantisation frequency analysis and digitisation of waveforms for computer storage. Various types of output and displays are available via the computer system.

The very high spatial resolution of these facilities coupled with computer control and data storage provide a hitherto unavailable service to industry. Important successes in bond examination and ceramic quality control have already been demonstrated. These techniques will, with continuing development and growing experience, reduce many "uninspectable" requirements to routine procedures. The photo shows one of the scratches so identified which could not have been found by any other ultrasonic system.

Further Information: Mr. R.L. Crocker
Fulmer Research Laboratories

FEATURE ARTICLE NO. 2

The second in a series by one of our staff on a topic of current interest and in which the role of R. & D. is of particular significance.

Robots in Manufacturing by Dr. W. E. Duckworth

Every manufacturer of volume goods and components must be examining whether the next stage in the evolution of his manufacturing technology must be the use of robots. In this brief article we attempt to take some of the emotive content out of the current debate and provide the manufacturer with a few objective guidelines to help clarify his thinking. If the result of this thinking is a wish to examine in more detail potential use of robots then Fulmer, as authorised consultants under the UK Department of Industry Robot Assistance Scheme, will be able to assist in a feasibility study, 50% of the cost of which will be borne by the UK Government.

The first essential point to understand about robots is that it is just not economic to simply replace a person by a robot. For the cost saving to be worthwhile the whole relevant part of the manufacturing process must be looked at afresh. The advantage of robots is that their actions are precise, repeatable and untiring. These are almost the opposite characteristics to those of human operators.

When current manufacturing operations are studied, especially those involving the type of manual dexterity at which robots excel, it is found that the consequences of bad design, poor prior process control and inadequately maintained plant, are minimised in the final product because of the experience and inherent skill of human operators. To all three of these bad practices robots are totally intolerant.

One of the main advantages of using robots is that they force a discipline of design and manufacture, which has for too long been anathema to many Western producers. It is no surprise that robot technology has fitted so well into the Japanese highly disciplined, manufacturing culture. Once this discipline has been accepted, and the right action taken, the consequent improvement in product quality and throughput time, coupled with the replacement of, on average, two workers per robot, the average payback period for robot installations is eighteen months. There are very few capital investments which yield such a rapid return, but the price to pay, it must be emphasised, is greater discipline of manufacturing technology.

The payback continues long into the future. When product changes, or even complete redesign, are necessary, this can be achieved in a robot station for typically only 10% of conventional retooling costs. Companies which do not seriously investigate robot use now will probably not be in a position so to do in five years time.

Where then, should the manufacturer look first of all for potential robot applications? The most common ones at present are:

- Spot and Arc Welding
- Injection Moulding
- Paint Spraying
- Surface Coating
- Machine Servicing
- Inspection
- Assembly
- Packaging

Having chosen the application one then has to choose the robots. Those available differ in articulation, control method, drive system, number of axes, payload, accuracy, working envelope and price. Choosing the right robot is only half the story; the selection of grippers, sensors and part presentation devices are equally important, as is the integration of the robot into the manufacturing cycle.

It is thus essential to use a specialist project team to study, first, robot feasibility for the type of manufacturing operation envisaged; second, the design, manufacturing and quality control discipline which will have to be introduced to make robot use possible and, third, the choice of robot and ancillary equipment.

Fulmer is already providing such specialist services across a wide range of different technologies, from machine loading to spraying and automatic assembly. We are currently engaged on proposals representing some 3% of the current UK robot population. The wide range of different disciplines which Fulmer embraces, together with our independence from robot manufacturers, enables us to offer a turnkey service which is completely adaptable to suit manufacturers' requirements.

Fortunately for the UK's economic future the full potential of robot based manufacture is beginning to be grasped by engineers and production managers. Perhaps the most persuasive argument in favour of robots is that the great majority of users who have introduced one unit have since installed more, and the UK robot population is currently growing at over 60% per annum. Another persuasive argument could be that Japanese robots will work no faster or harder than British ones. There is no excuse for delay. Government financial help and Fulmer expertise are available to everyone.

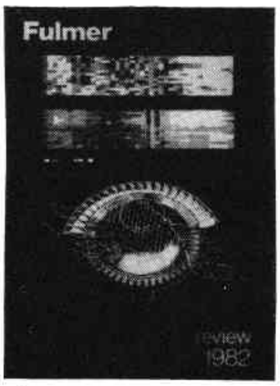
for further details contact: Dr. P. A. Finlay, Fulmer Research Laboratories

FULMER ANNUAL REVIEW 1983

Copies of this Review are now available. The striking front cover illustrates some of our most advanced work in novel non destructive testing technology. The Review also describes advances made during the year in our product and process research, particularly semi solid metal injection casting and PVdF, advances in hot isostatic pressing technology and in many new product developments. Fulmer's wide range of other research, testing and consultancy services are described in the Review.

Fulmer's financial performance in 1982 is also reviewed. Income increased by 10% to a record level of £3,22M, and profit increased 32% to £145,000.

If you wish to receive a copy of the Review please contact the Managing Director, Dr. W. E. Duckworth, Fulmer Research Institute.



HOT RUNNER MOULDING

A new company, Hot Runner Systems Ltd., has been created to manufacture and market a full range of hot runner systems and accessories, starting with the Yarsley Hot Runner System previously licensed to Lucas Logic Ltd.

The Managing Director of Hot Runner Systems Ltd., Jeff Coulling, has been associated with the development and manufacture of the Yarsley system for the last seven years. His knowledge and expertise of manufacturing hot runner systems and moulds will ensure that the system continues to be easy and reliable to install and operate.

Hot Runner Systems Ltd. will continue to supply the Yarsley system as an assembled, pre-wired and electrically tested 'package', so that the user is provided with an easily installed system. The inherent advantages provided in the Yarsley system include clean flow paths, precise gate control and leak-proof design.

Further information: Mr. J. Coulling, Hot Runner Systems Ltd.,
Woodcote House, 55 Tally Ho Rd., Stubbs Cross,
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Tel: 0233 22864

DELETE: YARSLEY RESEARCH LABORATORIES
INSERT: YARSLEY TECHNICAL CENTRE

The Research facilities of Yarsley have now been merged with the Processing and Testing division under the name of YARSLEY TECHNICAL CENTRE.

Both divisions will continue to operate on their respective sites – Research at Ashtead; Processing/Testing at Redhill, with Mr. M.A.P. Dewey as Managing Director of the combined Yarsley facilities.

BILL FLAVELL

Mr. W. (Bill) Flavell died at his home during the New Year weekend. His sudden and unexpected death came as a great shock to his colleagues, many of whom had worked with him for 20 years or more.

Bill joined the Yarsley organisation in 1952, and was subsequently appointed to the Board of Directors. Following the retirement of Dr. Yarsley, he became managing director of Yarsley Research Laboratories and continued in this position after the Fulmer-Yarsley merger.

He will best be remembered for the quiet and efficient way he went about the technical and administrative business at the Ashtead Division.

He was essentially a chemist by profession, but quickly assimilated a knowledge and understanding of macro-molecular chemistry and technology and took an active role in the work of the Plastics Institute.

Those who knew him out-of-office hours will remember him as a family man with a very keen sense of humour. He was good company both at work and play, and a very fair and conscientious man in every respect. He leaves a widow, two sons and a daughter.

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