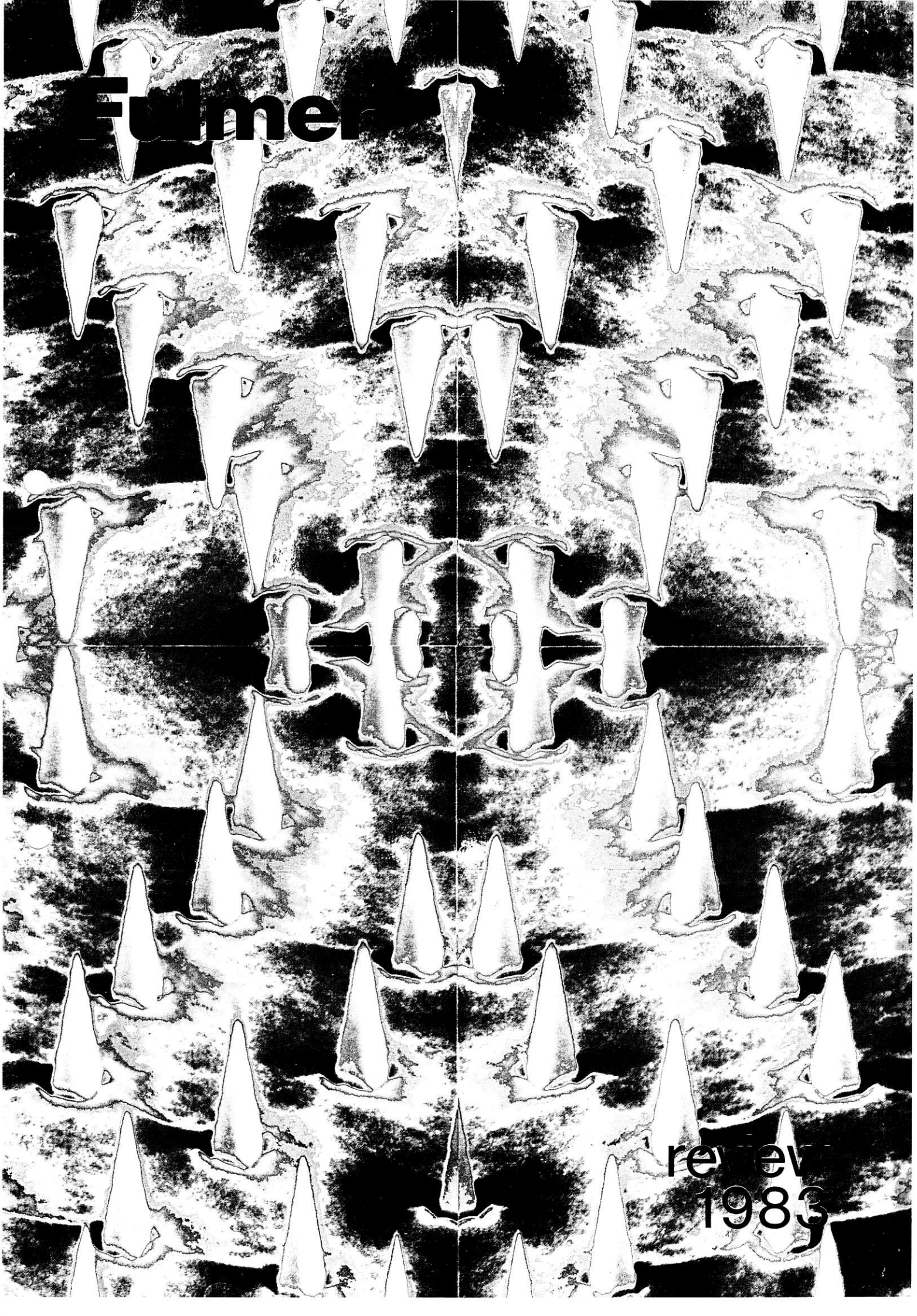

Fulmer
re ev
1983

CHAIRMAN'S FOREWORD

It is most gratifying to report that in the year when most industrial companies were making only a modest return to profitability the Fulmer Research Institute profit has increased 3 times to £419,000 on turnover up by 26%. In these times of high unemployment it is also pleasing to report that staff numbers increased by 19 to 243.

New contracts and renewals arrived at a very satisfactory rate during the year. The total financial value was in excess of £3.9M, nearly twice the level achieved in any previous year. The prospects for further advancement in 1984 are therefore good, with a strong order book in most parts of the organisation.

Fulmer's future, and the continuation of its successful record of service to its clients, depends not only on maintaining strength in its well established areas of technology, but also in developing expertise in appropriate major growth sectors.

One of these is undoubtedly sensors, and with the help of finance from Cogent Limited, the British Technology Group, the Department of Trade and Industry and the Ministry of Defence, Fulmer is becoming established as a Centre for sensor development particularly related to the electronics and process industries.

Many sensors are being developed and manufactured, including a continuously poled, high quality polyvinylidene fluoride (PVdF) piezoelectric and pyroelectric film. Another is an abrasivity meter for monitoring fluids (a development of the successful Fulmer magnetic tape tester).

Fulmer is also engaged in the development of devices using PVdF, especially related to its non-destructive testing expertise. The latter has made substantial progress during the year, and has established Fulmer's position as one of the main sources of advanced ultrasonic testing technology.

In view of the growing concern with product quality and fitness for purpose, Fulmer has established a quality assurance and design audit unit at its Yarsley Technical Centre subsidiary. In conjunction with Product Safety Limited and Stewart Wrightson International Limited, Yarsley has developed a new scheme, known as Testguard, which offers the manufacturers of building materials and components a unique package of product evaluation, quality assurance, risk analysis and insurance.

Fulmer's skills in materials processing continues to grow. The continuous casting line for the MIDAS PROCESS (Metal Injection into Dies As Semi-solid) is now capable of casting about 350 - 400 kg per hour, and the range of alloys cast has been extended to include alloys normally used in the forged condition. Components produced by the process are now in commercial use.

Hot isostatic pressing continues to develop. Several projects have led to clients requiring their own HIP machines, and Fulmer is assisting Vacuum Generator Instruments Limited to produce a British machine. Hitherto only US equipment was available. This is an example of how Fulmer improves and allows replacement of imported technology for the benefit of British industry.

In chemical vapour deposition a production facility is being established for infra-red transparent zinc sulphide, and for complex shapes in boron nitride which are required for cells used in molecular beam epitaxy.

The unique polymer skills of Yarsley Technical Centre are being increasingly recognised by companies needing expertise in thin films, membranes, adhesives and coatings. A major success during the year has been the development for LRC Products Limited of a coating for starch-free surgeons' gloves. The hydrogel interior coating of the gloves now allows dry or damp hands to slip easily into them. They are in full-scale production and the worldwide market is expected to be some 40,000,000 pairs annually. Robotics is becoming increasingly important at Fulmer. A pick-and-place unit has been designed to enable aluminium tubes to be ultrasonically tested and sorted, and robots are being used in the prototype manufacture of consumer durables.

Technology transfer studies were completed in Hong Kong and Jamaica, and a substantial EEC funded contract on the development of new methods of fabricating magnetic alloys of specific orientation has been started.

After an uncertain start, the Singapore laboratories are now receiving substantial contracts on a regular basis, and local staff have been recruited to replace expatriate Fulmer members.

With the loyalty and devotion of our dedicated staff, which I gratefully acknowledge, and the increasing recognition of established and new clients of the vital role that Fulmer can play in their own business success, we look forward with confidence to 1984 and beyond.

Sir Ieuan Maddock

Frontispiece: Fulmer's work on electronic devices is epitomised by the montage showing the structures produced for field emission cathodes, see page 4.

FACTS ON FULMER

Fulmer Research Institute Limited is an independent contract research, design and development organisation mainly concerned with the science and technology of engineering materials, processes for their manufacture, and products and components making the optimum use of material properties. Current projects include:

- The development of new materials such as high strength, tough, wear resistance steels for arduous applications.
- New magnetic alloys.
- Tailored polymers for critical uses such as the lubricious inside coating of surgeons' gloves.
- Devices incorporating new materials such as PVdF transducers and low voltage field emission cathodes.
- The development of new material shaping processes involving robotics and automation.
- Novel energy conversion and storage systems.
- New types of coating and their means of application.
- The development and testing of building materials for internal and external use.
- The manufacture of special chemical compounds and components.

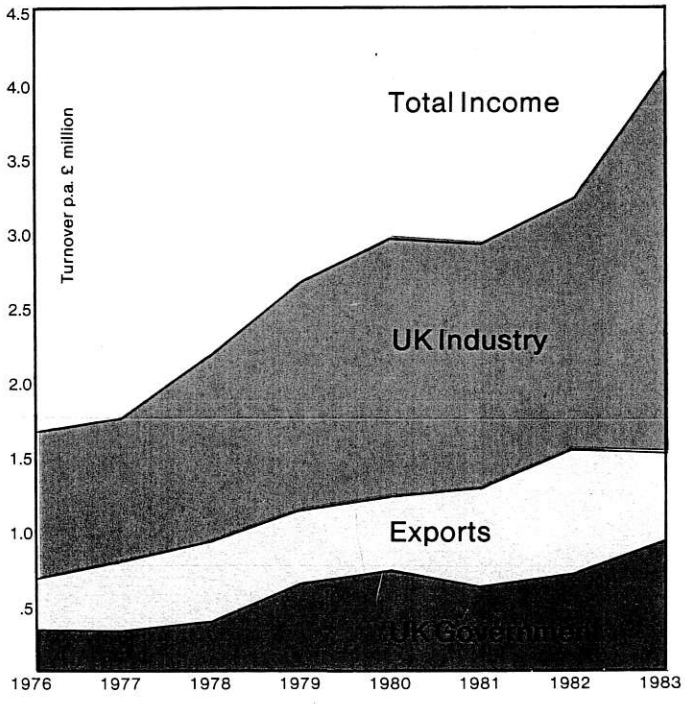
In this review 1983 achievements in our main areas of activity are described under the headings listed below, which illustrate how Fulmer can assist clients throughout all stages of the development and manufacturing process.

Contents Page

Consultancy and Technical Services assignments include a full quality assurance and design audit service, novel non-destructive testing technology, materials selection, failure diagnosis, as well as routine testing and analytical services. Technical advice is available relating, for example, to patent and other forms of litigation, technical/economic studies and market surveys.

Fulmer was founded in 1946, and since 1965 has been owned by the Institute of Physics. The Company and its subsidiaries employ more than 240 people, including 100 professionally qualified scientists, technologists, and engineers. Fulmer is fully self-supporting financially and the operating surplus is used to finance further development. Ownership by the Institute of Physics guarantees that Fulmer is completely independent of any commercial or industrial affiliation. The main proportion of Fulmer's income comes from U.K. industry. Exports accounted for about 15% of the 1983 income of £4M, and contracts from government sources approximately 20%.

Fulmer Income Distribution 1977 – 1983



GROUP TRADING REPORT

	Turnover, £		Profit (Loss), £	
	1982	1983	1982	1983
Fulmer Research Laboratories. (including Fulmer Technical Services)	1,845,000	2,150,000	176,000	184,500
Yarsley Technical Centre Ltd. incorporating Yarsley Research Laboratories Ltd.	1,252,000	1,763,000	(17,000)	230,500
Fulmer Components Ltd.	206,000	335,000	(5,000)	12,000
Reform Manufacturing Co. Ltd.	21,000	25,000	(8,000)	(8,000)
GROUP TOTAL (less Inter-Company Trading)	3,223,000	4,065,000	145,000	419,000

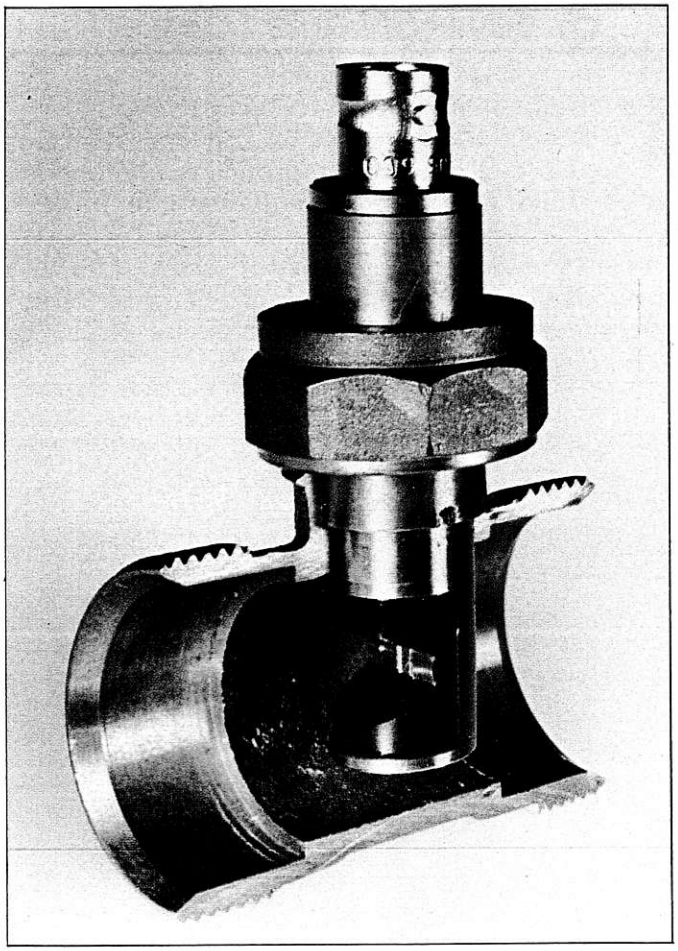
PROCESS AND PRODUCT MONITORING

SENSORS

Substantial progress has been made during 1983 in developing Fulmer as a Centre of expertise in sensor technology. Fulmer is engaged in the development of inexpensive, robust, high precision sensors for many arduous applications, in the manufacture of material from which advanced sensors can be made, and in the production of devices using sensors.

ABRASIVE FLUID MONITOR

This monitor is a development from the Fulmer magnetic tape abrasivity monitor, now being sold worldwide. Prototypes for field trials are being routinely manufactured at Fulmer Components Limited. These field trials encompass a wide range of industrial applications in which it is necessary, to ensure the security of continuous service operations, to monitor the abrasivity of circulating fluids. The abrasivity sensor head is simple to incorporate in an established fluid circuit. Enquiries to participate in these field trials are welcome.



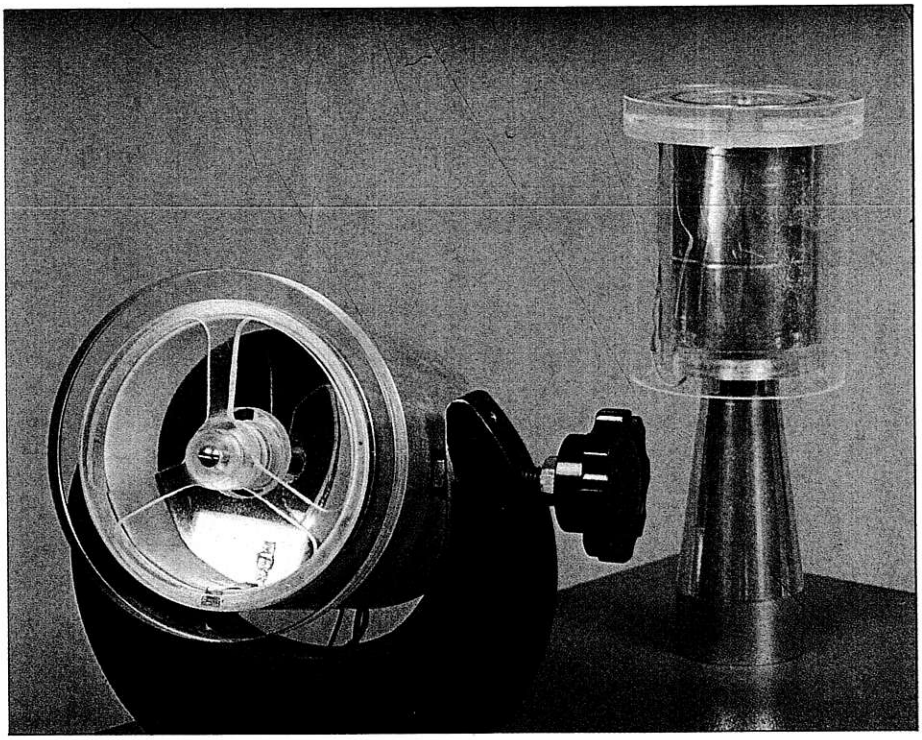
A sectional view showing the sensor element of the abrasive fluid monitor inserted into a circulating system.

PVdF

Piezo- and pyro-electric polyvinylidene fluoride film (PVdF) is now being manufactured and marketed by Yarsley Technical Centre. In 1983 some 180 firms expressed interest in these films, and a high proportion purchased samples for evaluation.

Novel production processes have been established and technically Yarsley PVdF films are at least equal in properties to other commercial films. They have the added advantage of exhibiting superior ageing properties in terms of piezoelectric property retention.

In 1983 a further development was the production of film up to 100 microns in thickness in large area sensors where robustness and strength is needed. As well as producing the film to the most advanced specifications required, Fulmer is using the unique properties of PVdF film in the development of devices.



Experimental PVdF intruder detector (left) and PVdF loudspeaker.

PROCESS AND PRODUCT MONITORING

NON-DESTRUCTIVE TESTING

Fulmer's growing expertise in novel ultrasonic NDT has been increasingly recognised by the placing of contracts for special equipment manufacture. Fulmer Research Laboratories has produced a scanning ultrasonic system, setting new standards for precise detection and measurement of defects in a variety of materials. The system was designed primarily for the inspection of engineering ceramics in which the presence of flaws a fraction of a millimetre across can be catastrophic. Many other types of inspection can now be performed, including diffusion bonds, surface profile measurements and electronic component bonds. The instrument has a resolution of 10 microns in 2 axes, and will accept specimens up to 300 millimetres square. The movement of the probe head is computer controlled and ultrasonic data can be stored on computer disk or used to provide a fascimile output on electro-sensitive paper. The equipment is available for contract hire. Custom built models can also be made at Fulmer. Enquiries are welcome. The equipment is shown below.

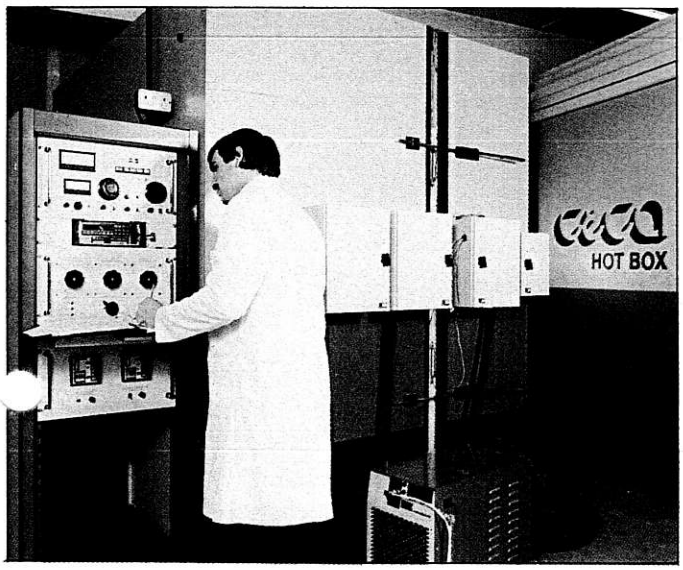
Fulmer's expertise in NDT was combined with its increasing experience in robotics to produce a pick-and-place unit for the non-destructive testing of aluminium tubes. These tubes are placed sequentially between rotating centres underwater, an ultrasonic scanning probe is passed along the length of each tube, and on conclusion of the scan the tubes are unloaded to either a pass or fail bin.

High resolution ultrasonic scanning equipment. The inset shows inadequate bonding between a silicon microprocessor device and its heat-sink substrate.

MATERIALS AND PRODUCT TESTING

HOT BOX

A collaborative manufacturing project between Yarsley Technical Centre and the Cement and Concrete Association has resulted in the successful production of an improved Guarded Hot Box. The apparatus is designed for the determination of thermal transmittance and conductance of masonry, other building materials and structures up to 2m x 2m. Temperature control of the guard systems which is vital to precision measurement is now automatic and controlled by a thermopile on the metering box to an accuracy of 0.01°K. Inside the metering box the air is circulated uniformly using the variable speed fans, with the heat contribution of the fan blades taken into account in the measurement. The Guarded Hot Box can test all vertically mounted building components and structures as well as being used horizontally for ceiling measurement. Prototype apparatus has proved very successful and sales of the system have commenced. The Guarded Hot Box is also available under contract hire from Yarsley.



Hot box equipment.

I.F.W.I.M.

IFWIM testing of a complex moulding.

Over the last few years research on plastics materials and components has been aided by the employment of Instrumented Falling Weight Impact Machines (IFWIM's). The IFWIM recently developed by Yarsley is now extending the range of tests and analysis available to the industry. Extensive use of this IFWIM can be made in quality control and material suitability tests by the analysis of failure modes and of the energy levels required for fracture. Problems of repeat testing requirements are reduced as ten impact properties are determined from one strike, with detailed statistical and graphical analysis from the associated computer program. In response to a more restricted testing requirement, Yarsley have also developed a 'micro' bench-top model. The 'micro' version provides the same data and analysis as its full sized relative while performing tests on a wide variety of plastics materials and products that do not require substantial force to fracture. Work is now in progress to incorporate a transient recorder capable of a time frame of 2ms to provide the 'micro' model with a unique capability in brittle failure analysis.

QUALITY ASSURANCE

The development of Quality Assurance has arisen as a direct result of the failure of components, plant and equipment in service and the consequential costs of downtime and loss of commercial and possible public acceptance. Yarsley provides consultancy services to develop cost effective quality systems and procedures within industry to satisfy the requirements of national, international and certifying authority standards. Quality management systems, procedures and documentation may be designed to satisfy standard requirements through all departments of a company, within a cost effective scale for the company structure and products. Quality documentation includes the development of quality manuals and procedures to satisfy both internal company and external requirements.

DESIGN AUDIT

Design audit is a cost effective technique which has been developed, and industrially proven to minimise the inherent risks of equipment 'fitness for purpose'. The audit consists of an independent evaluation of proposed designs by a multi-disciplinary team of appropriate specialists. Yarsley now offer Design Audit services to give assurance that a design has taken into account both plant experience and the latest technology. The service may be offered to plant and equipment purchases at two levels, namely:

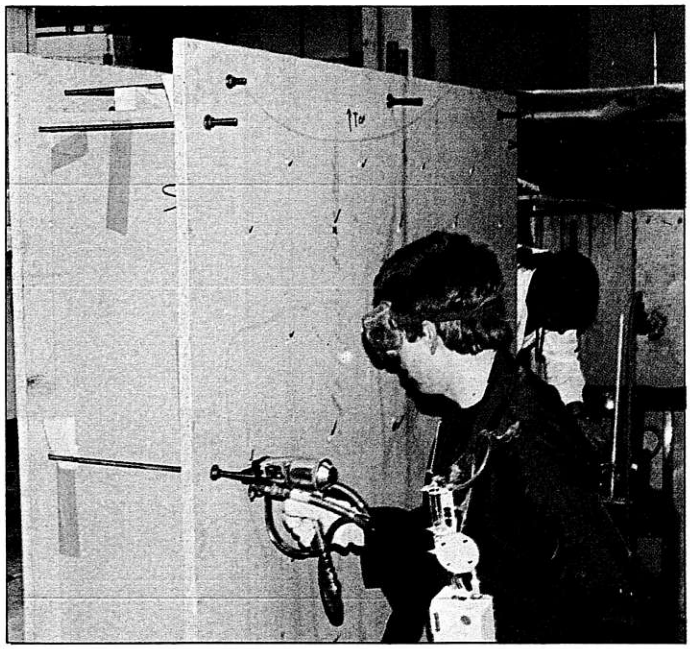
SYSTEM AUDIT – an evaluation of the overall scheme and layout, and the reliability and interfacing between its prime components.

COMPONENT AUDIT – a more detailed, in-depth examination of individual component design to ensure fitness for purpose within its in-service operation and environment.

TESTGUARD

In conjunction with Product Safety Limited and Stewart Wrightson International Limited, Yarsley Technical Centre has devised a new scheme, known as TESTGUARD, which offers the manufacturers of building materials and products a unique package of product testing, quality assurance, risk analysis, hazard assessment and insurance.

The three sponsors have combined their individual spheres of expertise and experience to provide a unique combination of product performance evaluation, and identification and management risk. Consequently, as part of the TESTGUARD package, the most positive and cost effective form of insurance protection can be arranged.



Operator injecting foam into boxed cavity wall. Standard air monitoring tests are carried out at all stages.

The TESTGUARD SCHEME will significantly help all those involved in the development, manufacture, specification, distribution and use of building products. It enables manufacturers to offer their products to the building and construction industry with confidence, knowing that the inevitable risks associated with the product are reduced to a minimum. The Scheme also aids the introduction of completely new products into the market, through the extensive testing and fitness for purpose evaluation to which the product is subjected.

INFORMATION SERVICES

RECENT PUBLICATIONS

As well as its Annual Review, Fulmer publishes a Newsletter three times a year which contains major articles describing significant Fulmer advances, as well as news of other recent activities. The issues published in 1983 descibed Fulmer's expertise in composites, robotics, metallurgical processing, and CVD technology. Issues to be published in 1984 will discuss tailored polymers, sensors, finite element analysis, and design expertise. If you wish to be included in the regular mailing list for this Newsletter, please write to the Editor.

TECHNICAL SURVEYS

Fulmer carry out a wide range of technical and commercial surveys which in many cases are an essential preliminary to a technical development programme. For example, such surveys may analyse the market potential for a new product, assist in company diversification programmes or consider the relative economics of in-house verses sub-contract products.

THE FULMER MATERIALS OPTIMIZER

The Fulmer Materials Optimizer continues to enjoy world-wide sales and recognition as the most comprehensive materials selection system on the market. The Optimizer was extensively revised in 1979 and since then over 600 pages of new and updated information have been added to the system. These additions have included new sections on Materials for Marine Applications, Magnetic Materials, Acoustic and Vibration Materials and Refractory Materials. Sections on Steels, Nickel Alloys, Cobalt Alloys, Precious Metals, Ceramics, Polymeric Materials, Adhesive Bonding and Fabrication of Metallic Components have been fully updated.

Sales of the Optimizer have been made in over 30 countries world-wide. The largest markets have been in Europe and Scandinavia, North America, Japan and Australasia. However, the developing countries in Africa, South America, the Middle East and South East Asia have accounted for about 10% of total sales.

The Optimizer has found wide acceptance as a teaching aid in universities and technical colleges, the libraries of which form the largest customer group. In such locations it is often used as a materials information system, but is increasingly used as the basis for course work on materials selection and specification in design and engineering.

CLIENT INFORMATION SERVICE

Yarsley Technical Centre has recently inaugurated a free technical information service in respect of its current clientele. The service is in the form of information bulletins on specific sectorial subjects which are sent free of charge to the client at regular intervals for so long as work continues on their behalf at the Centre. Twelve titles are produced, and the client is asked to select any three relevant to their field of interest. The bulletins, produced by the Information Centre at Ashtead, give brief details of major developments in abstract form in the following sectors:

Engineering Plastics	Plastics in Transport
Special Polymers	Building
Foamed Plastics	Electronics
Coatings	Packaging
Adhesives	Biomedical
Plastics Processing	Plastics in Sport

RESEARCH PLANNING DIAGRAMS

For the past twelve years Fulmer has been running a successful series of seminars on Project Planning and Control for Research Managers, based on the RPD (Research Planning Diagrams) system developed at Fulmer.

These seminars take the form of an interactive discussion group of between 10 and 25 participants. RPD methods are explained in the context of network analysis and their applications in R & D management are discussed. Some 90 seminars have been held over the last twelve years.

Project Network Analysis techniques such as CPM and PERT, despite their success in planning well-defined engineering projects, are inadequate in R & D. Quantative analysis of RPD plans is also different from that of conventional networks. Traditional network concepts such as that of critical path are retained, but the main feature of RPD analysis is that answers to questions of project cost, benefit and duration are all given in probabilistic terms. RPD also provides powerful decision analysis facilities.

FULMER RESEARCH INSTITUTE LTD.

Dr. W.E. Duckworth
Stoke Poges, Slough, SL2 4QD
Tel: Fulmer (02816) 2181 Telex: 849374

This is the holding company of the four main operating divisions and the part-owned Singapore company. Fulmer's total activity embraces the science and technology of all engineering materials; processes for their manufacture; and products and components making the optimum use of material properties.

FULMER RESEARCH LABORATORIES LTD.

Dr. W.E. Duckworth
Stoke Poges, Slough, SL2 4QD.
Tel: Fulmer (02816) 2181 Telex: 849374

The facilities and expertise cover all aspects of research, development and evaluation of metals and advanced engineering materials, including composites, the structures and components manufactured from them, and the processes used. Special facilities include chemical vapour deposition equipment for special ceramic coatings and components; comprehensive X-ray and electron microscopic investigation equipment; novel non-destructive testing methods; ballistic facilities; radiation testing; advanced metal processing plant and production engineering expertise, including robotics and automation. Prototype equipment manufacture is undertaken as are energy studies and other types of technological surveys. Technology training is provided.

FULMER TECHNICAL SERVICES

Dr. W.H. Bowyer
Stoke Poges, Slough, SL2 4QD
Tel: Fulmer (02816) 2181 Telex 849374

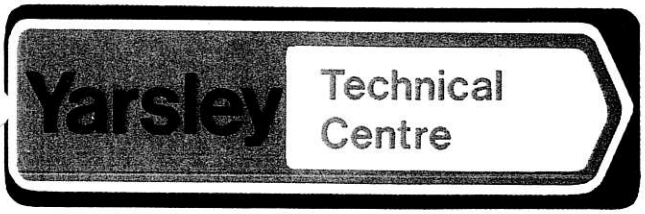
This provides a testing and consultancy service on all aspects of advanced engineering materials, particularly metals and advanced composites. The services include mechanical and non-destructive testing, chemical analysis, corrosion testing, failure diagnosis and trouble shooting, materials information and selection, physical property assessment, litigation, technical management services.

FULMER COMPONENTS LTD.

(including REFORM MANUFACTURING)

Dr. G.I. Williams
232 Berwick Avenue, Trading Estate
Slough, Berks. SL1 4QT
Tel: Slough 35996 Telex: 849374

Product manufacture including abrasivity monitors, special sensor systems, pyrolitic boron nitride in the form of crucibles, tubes and coatings for crystal growth of ultra high-purity semiconductors, and plates for heat transfer in travelling wave tubes; delay units for computers. High precision engineering items such as specimen stages for electron microscopy and filament repair service. Small batch production of engineering items such as automatic paint spray unit and 'clip-on' meter for measuring tension in ropes and stays.



YARSLEY TECHNICAL CENTRE LTD.

(Including Yarsley Research Laboratories)

M.A.P. Dewey
Trowers Way, Redhill,
Surrey, RH1 2JN
Tel: Redhill (0737) 65070
Telex: 8951511

The Street, Ashtead,
Surrey, KT21 2AB
Tel: Ashtead (03722) 76391
Telex: 8951511

The facilities and expertise cover all aspects of the development and evaluation of non-metallic materials, and products and components which use plastics, rubbers, composites, paints, adhesives, timber, thermal insulating materials, floor coverings, building materials. Particular expertise exists in "tailored" polymer technology, including polymer design and synthesis coatings, film technology and composite materials. Small scale manufacture of special polymers and organoflourine compounds is also undertaken. Special test facilities include fire testing, pollution monitoring, mechanical and chemical testing, thermal conductivity testing. Materials test equipment and special processing machinery are also designed, developed and manufactured.

FULMER RESEARCH & DEVELOPMENT (SINGAPORE) PTE LTD.

D.C. Foreman
Fulmer R & D (Singapore) Pte Ltd.,
Unit 06-01, 6th Storey,
520 Balestier Road, Singapore, 1232.
Tel: 2501082 Telex: RS 23988 Kampmas

M.A.P. Dewey
Fulmer Research Institute Ltd.,
Stoke Poges, Slough, SL2 4QD
Tel: Fulmer (02816) 2181
Telex: 849374

Polymer engineering, including mould design, processing troubleshooting, and product and process design and development. Turnkey installations. Engineering metallurgy, including failure investigation, corrosion protection consultancy, and process development. Materials testing and analysis of metals and polymers. Materials and machinery selection studies.