SGT NEWS

UNDERSTANDING OPTICAL FIBRE SENSORS

The transmission of data by optical fibres is accepted today. Less well known is their use as the actual sensing element. Dr Chris Elmsley of York Sensors described the fabrication of optical fibre sensors and their range of applications to a joint meeting of the North West Section and the Institute of Measurement and Control. Of particular interest to those working in the glass industry was the distributed temperature sensor.

Telecommunications use a modulation of the amplitude to convey a message down the fibre. Light is a waveform though and it possesses other attributes such as wavelength, phase, polarisation and direction which can give information on the effect the environment has on the fibre. Light of a certain form can be launched down the fibre at one end and analysed as it comes out. To get the best data requires a high quality fibre, tailored for the job.

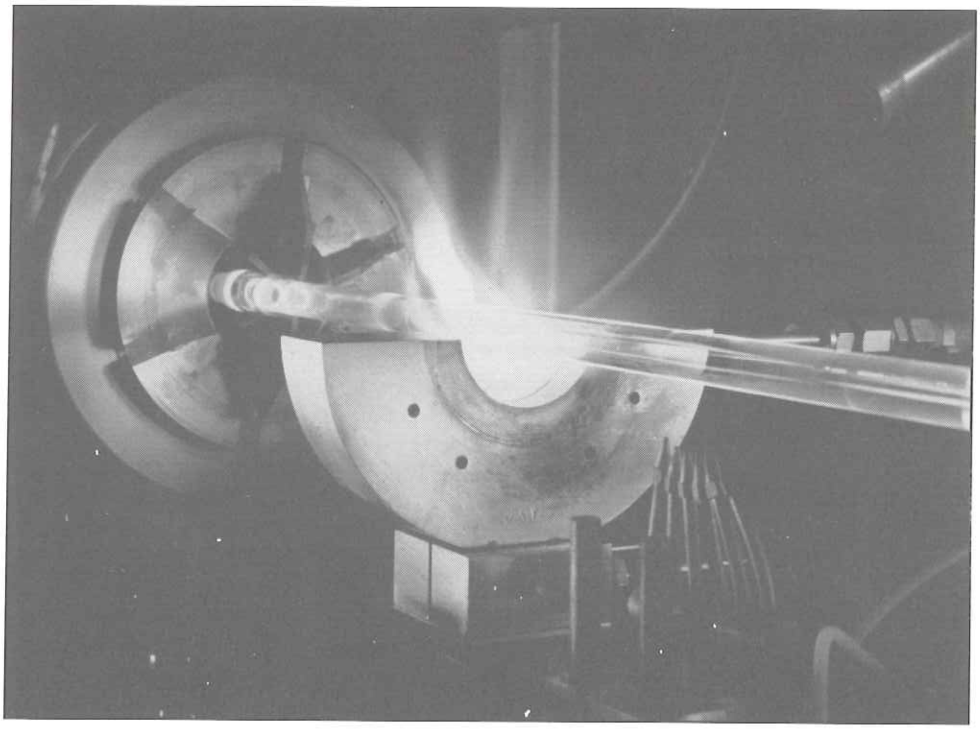
Optical fibres are made by depositing glass forming compounds on the inside of a rotating cylindrical blank. The cylinder is closed by heating with a pressure differential and the blank is drawn at a controlled temperature and drawing rate. Two fibre types are available for sensors; the polarising, high birefringence (Hi-Bi) and the polarisation transparent, low birefringence (Lo-Bi).

Birefringence can be introduced by replacing opposing points of a boron layer around the core with silicon. The difference in expansion or stress optic coefficients causes the subsequent effect. Rotating the blank at 3000rpm while drawing homogenises the stress coefficients and the resulting fibre is polarisation transparent (Lo-Bi).

Hi-Bi fibres can be used in coils, so that a long path length can be used to magnify any effects. They are used in gyroscopes, mainly for aerospace applications so far but with a large potential market as part of the board navigation systems for cars.

Lo-Bi fibres can be used as a sensitive magnetic field sensor using the Faraday effect, in which light is rotated by a magnetic field. The other exciting application is as a distributed temperature sensor. A small magnitude of the light sent down a fibre is temperature-dependent and this component can be analysed to give a heat profile.

An optical fibre could run the length of a tunnel or be passed through a building and any hot spots could be noted, backing up smoke detection and improving safety. The sensitivity of a distributed temperature sensor is ±1°C averaged 1m for a fibre length of 500m to 4km and depending on the coating, operational in the range -140°C to 460°C.



Specialised coatings are being developed to raise the durability to 1000°C. For annealing lehrs, this would mean a continuous temperature profile could be obtained with only one cable, not the many hundreds of thermocouples and the associated trailing electrical wires which would be needed to produce a similar result.

LOCAL SECTION CONTACTS

For details of forthcoming local section events in your area, contact the appropriate Honorary Secretary. All SGT members and non-members welcome.

London
– Mr M C Brew, United Glass Ltd, Porters Wood, St Albans, Herts AL3 6NY. Tel 0727 59261.

Midlands
– Dr G R Mattocks, 'Whitemead', 18 Blakebrook, Kidderminster, West Midlands DY11 6AP. Tel 0562 824153.

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– Mr J Henderson, 44 Woodside Ave, Throckley, Newcastle upon Tyne NE15 9BE. Tel 091 264 4775.

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– Dr D Martlew, Pilkington Technology Centre, Hall Lane, Lathom, Ormskirk, Lancs L40 5UF. Tel 0695 54210.

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– Mr D A Rennie, United Glass Ltd, Glasshouse Loan, Alloa FK20 1PD. Tel 0259 218822.

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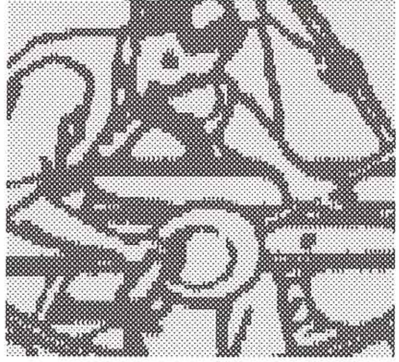
–Miss R M Sales, 20 Blackbrook Drive, Sheffield S10 4LS.



EXPERT SYSTEMS – THE WAY AHEAD

Freeing operators on a modern production line of repetitive monitoring tasks has been one of the advantages of recent developments in technology. Computer expert systems enable the capture and exploitation of expert company knowledge into new fields where solutions to simple problems can be found. Computers are not taking over the factory; they are however contributing to the available knowledge base, reducing the workload of key staff and promoting a greater understanding of the manufacturing process. Peter Firth of Beatson Clark presented an overview of the potential applications of expert systems in the modern glass container factory to the Yorkshire Section.

Computer expert systems in the factory use the fast processing capacity of modern personal computers and information from sensors to monitor and control equipment.

The simplest expert system uses a set of rules which supports a 'decision tree' type path, eg if belt speed is more than 500, then turn off. The types of decision are clear cut and the system works well within the parameters as long as there is enough information and it matches the core knowledge. Diagnostics are good examples of their use in optimising performance. An example was given of a compressor diesel engine monitoring system. Other examples include glass defect correction advice, production scheduling, critical plant monitoring, furnace optimisation and fault diagnostics.

Even the simplest expert system needs to be maintained in order to cope with, say, changes in shift patterns or extra production demands. Responsibility for its operation is also an issue in safety-critical areas: Who caused a bad decision... the programmer, the expert system or the initial set-up? System development takes time and effort, it is continuous although it is termed 'rapid prototyping'!

Where a decision is not clear-cut, more sophisticated programmes are needed to weigh up the available information, assess its relation and assign a value. If this value crosses a threshold, a decision can be made. One such system uses fuzzy logic *(see fig 1)*. This could be applied to forehearth control, furnace control and gob weight control. The Japanese have adopted fuzzy logic processors in many commercial products, eg in camcorders to steady images and washing machines to balance spin speed with water content.

Neural networks, which simulate the connections in brain cells, are also used in assessing the area between black and white. Network interconnection 'weightings' are adjusted in the software according to the information presented. This represents the knowledge learnt by the network. The more information presented, the firmer the learning and more accurate the final decision. Automatic inspection equipment could use neural networks to help discriminate between stones and blisters.

Genetic algorithms use evolutionary forces to adapt an equation or model to the information on hand. Mutation is introduced and genetic crossover promoted to optimise the decision making process, feedback is then required to decide on its survival to the next generation.

Hybridisation of different expert systems is also seen as a way of optimising their overall performance.

The computerisation of expertise serves a company in many valuable ways. It helps retain knowledge that may otherwise be lost; it formalises the expertise, getting rid of anomalies and linking with quality-associated documentation; the system can be used to give advice or monitor and control plant; and computers work 24 hours and do not complain. A simple rule-based expert system is very specialised. It can only deal with a dedicated task and cannot work outside of it.

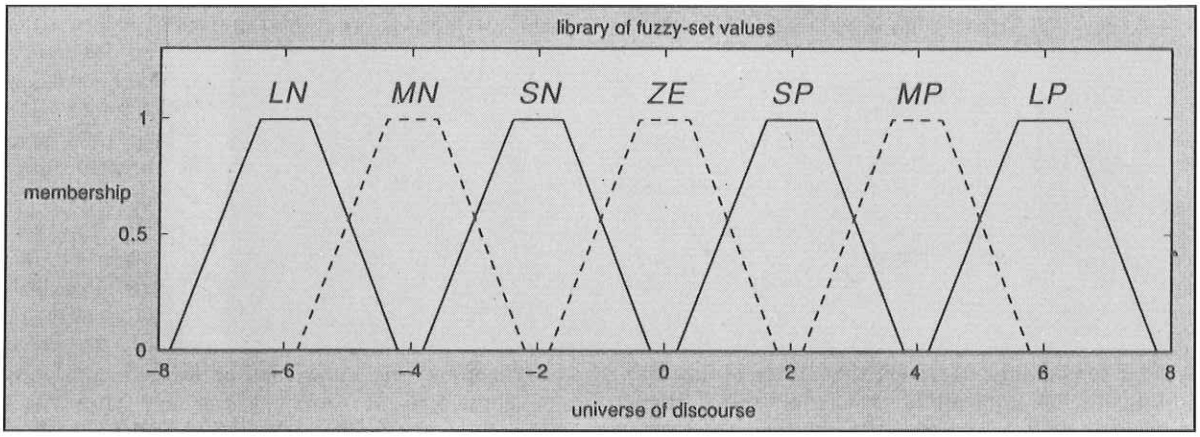
All systems are limited in their scope, however and cannot be used as a general problem solver. It is best to keep operations within a manageable size. If this becomes too big, split the task rather than make a programme more sophisticated.

The successful deployment of an expert system demands full understanding of the task in hand. This on its own can serve as a valuable asset for any manufacturing industry.

EXPERT POSTSCRIPT

The Department of Trade and Industry has set up a Manufacturing Intelligence Team to promote the application of knowledge-based systems to the challenges of manufacturing. The team's activities include the organisation of an annual award, visits to companies, regional clubs, grant-assisted joint ventures, research projects and a quarterly newsletter. Further information can be obtained from DTI Manufacturing Intelligence Team, MTDle, 1/028, 151 Buckingham Palace Rd, London SW1W 9SS, UK. Tel 071 215 1533.

Fig 1. Library of overlapping fuzzy set values, defined on a universe of discourse. Membership = degree of truth to which variable belongs to particular set(s). Universe of discourse = process variable. (Illustration reproduced from 'Intelligent Engineering Systems', Vol I, No 1, Autumn 1992, page 4.)



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