INTERNATIONAL CONFERENCE ON

TECHNOLOGY TRANSFER IN INDUSTRIALIZED COUNTRIES

TECHNOLOGY TRANSFER IN THE UNITED KINGDOM
ROLE OF THE INDUSTRIAL RESEARCH ASSOCIATIONS

Brian E. King, BSc, PhD, FTI

HOTEL PALACIO
Estoril, Portugal
7-11 November, 1977

Presented By
United States Departments of the
Army, Navy and Air Force
in Cosponsorship with the
North Atlantic Treaty Organization

Presented By
United States Departments of the
Army, Navy and Air Force
in Cosponsorship with the
North Atlantic Treaty Organization

TECHNOLOGY TRANSFER IN THE UNITED KINGDOM
ROLE OF THE INDUSTRIAL RESEARCH ASSOCIATIONS

BRIAN E. KING

I suspect that I may be preaching to the converted—the list of eminent speakers here this week and yet the lack of promotion of the Conference, at least in the UK, indicates that few, if any, of those who really should listen to our words—the manufacturing managers of the industrialised countries—are here to hear!

I wrote that with my tongue in my cheek and not having a list of delegates, so I could be wrong but I will use the thought as my theme, that no matter how many conferences we have on the subject of technology transfer, we shall not benefit our standard of living, our national or international gross product or our industrial performance and productivity unless we talk to the man who makes something and ensure he does better and more profitably as a result of our talking to him.

This is the third technology transfer conference I have taken part in within the past 15 months. The first, in October last year took the form of the Annual Conference of FEICRO, the Federation of European Industrial Co-operative Research Organisations and was held in Turin. It proved a very useful exchange of ideas in TT and I have the benefit of drawing upon an excellent discussion paper of the Conference produced by Dr S.E. Rogers, Director of the Drop Forging RA—now available through CDRA. May own paper presented at that Conference details many TT activities of the UK RA's and again this is available through CDRA. The second Conference was held in May this year in London and was organised by CDRA with two primary aims (1) to convince government departments that we can deliver the goods—that we know whatwe mean by TT and that they should fund it and (2) to convince industry that they need us, should listen to us, must carry out our proposals and will benefit from them. I think we succeeded in the primary aim; we failed miserably in the second aim but achieved a useful exchange of methodology amongst ourselves, the converted, instead.

And here I am at the third Conference apparently trying to throw a spanner in the works. Before developing my theme let me say that the main body of my paper lists a substantial number of typical TT jobs carried out effectively by my colleagues, the directors and staff of thr UK RA's. They know what they are doing because they are intimately associated with their own industries and have a common aim to help to improve the performances of their member companies. I thank them for their contributions and apologise for any I have left out.

The UK RA's, some as much as 60 years old, obtain their income from government and industry. Government income is earned in the form of contracts for specific projects in which government contribution varies from 25% to as much as 100%—the latter for special cases only—and in at least one case for TT. Income for co-operative research is raised by subscription and in some cases by levy. Turnover, added value, wage bill are among the bases used for calculating the support level. The remaining income—often more than 50% of the total—comes from fee paid activities for industry including consultancy, contract research, equipment sales, Conferences and training courses.

Substantial increases in government support have been won in recent months following the introduction of Research Requirements Boards dealing with specific industries.

Undoubtedly increasing industrial and government finance is being channelled into TT to the benefit of all industries.

Every one of the UK RA's is listed at the back of the paper showing their name,function, particular R & D capabilities and technical services, their size and the names of the director and senior management—no matter what your technical problem is, one of them should be able to help—please use them.

Many here today will agree that there is a vast amount of technology which is just not being used by our industries and I am not referring just to space technology but to the much simpler technical and scientific knowledge that has been with us for many years. I have just realised I have been 25 years in industry and much of that time has been spent in research and development activities of one type or another. I recall writing at least eight years ago a paper entitled "Profit from Research" which was aimed at industrialists who didn't invest in the future and either were

introduction of Research Requirements Boards dealing with specific industries.

Undoubtedly increasing industrial and government finance is being channelled into TT to the benefit of all industries.

Every one of the UK RA's is listed at the back of the paper showing their name,function, particular R & D capabilities and technical services, their size and the names of the director and senior management—no matter what your technical problem is, one of them should be able to help—please use them.

Many here today will agree that there is a vast amount of technology which is just not being used by our industries and I am not referring just to space technology but to the much simpler technical and scientific knowledge that has been with us for many years. I have just realised I have been 25 years in industry and much of that time has been spent in research and development activities of one type or another. I recall writing at least eight years ago a paper entitled "Profit from Research" which was aimed at industrialists who didn't invest in the future and either were

too busy to give the time or too troubled to spare the cash. Even in those days I suspect we scientists, technologists and planners failed to realise that no matter how good or cost-effective our invention or our development may have appeared to us, it was no use expecting the industrial manager to come rushing to our door clammering to use the results.

I remember taking part in an awe inspiring training course on communications—and thats what TT is all about—the thought that stayed in my mind at the time and has refused to budge ever since—was "tell them—tell them again, and then tell them you have told them". A very good piece of advice and yet totally inadequate—because you still don't know whether 'they' have listened or if your technology has been transferred.

Co-operative research organisations—some 42 in the UK and many similar ones in the rest of Europe, working for their respective industries—are "unequalled repositories of readily available information" so said Mr Adamowicz of CETIM and Chairman of FEICRO during his opening address at the Turin Conference. FEICRO represents 23,000 workers in this field of co-operative research—they must not wait to be asked for information, they must get out into their industries and push them into improving their performance.

And it can be done and it will be well worth while. The wealth of a nation and the employment of its people comes largely from its established traditional industry and to improve the performance and efficiency of such industry by even a relatively small percentage could be more beneficial than increasing that of new glamour industry by several orders of magnitude.

If these workers are to achieve success in TT they must have proper access to all technology relevant to their industries and they must spend a great deal of their time actually in the factories. This is very expensive indeed; the cost of exploitation of technology within industry is often at least as great as that involved in developing the technology itself.

The sources of technology are vast and include in house—e.g. the Research Organisations' own R & D work—universities and other higher educational establishments, government laboratories and even private industry. There is little difficulty in acquiring technology—the important thing is to ensure that all relevant information has been collected.

And so to industrial participation—the most important aspect of all and requiring more than just a technologist to ensure it. Today the technologist has to be a salesman and an economist and a psychologist and able to persuade top management and production personnel of the advantages this technology can offer.

Nationally and internationally economic performance depends largely on industrial performance. How can technology or rather technologists improve our performance? Only by individual companies having a clear understanding of their own performance and of the impact that technology can have on that. All companies must pay attention to these matters—indeed appoint specific people to seek out every conceivable advantage that technology can bring to them—that is how the transfer will begin to take place.

Hence we must have technologists in industry and they must move about among productive industry, government laboratories, universities, RA's at home and abroad, and back again—there is no better way of transferring technology than for the knowledge to be carried across by the people themselves. The obstacles to technology transfer must be tackled at all levels and this must be the aim of all of us present here at this Conference—a sort of mission—go to it!

just a technologist to ensure it. Today the technologist has to be a salesman and an economist and a psychologist and able to persuade top management and production personnel of the advantages this technology can offer.

Nationally and internationally economic performance depends largely on industrial performance. How can technology or rather technologists improve our performance? Only by individual companies having a clear understanding of their own performance and of the impact that technology can have on that. All companies must pay attention to these matters—indeed appoint specific people to seek out every conceivable advantage that technology can bring to them—that is how the transfer will begin to take place.

Hence we must have technologists in industry and they must move about among productive industry, government laboratories, universities, RA's at home and abroad, and back again—there is no better way of transferring technology than for the knowledge to be carried across by the people themselves. The obstacles to technology transfer must be tackled at all levels and this must be the aim of all of us present here at this Conference—a sort of mission—go to it!

TYPICAL EXAMPLES OF SUCCESSFUL PROJECTS CARRIED OUT RECENTLY BY UK RESEARCH ASSOCIATIONS

BGIRA

LOW-COST WASTE-GAS SAMPLING SYSTEM

A low-cost waste-gas sampling system which can be installed in the ports or downtakes of a glass melting tank furnace has been developed by BGIRA, fully evaluated in extensive production trials in a Member's factory and is now commercially-available from supplier Members of the Association under a specially-negotiated agreement.

The BGIRA Oxygen Analysis System is capable of being operated for intermittent or continuous sampling of waste gas and for oxygen measurement in the range 0-21%. The system, which is based on oxygen detection by a stabilised zirconia probe, has been tested on several installations and proved to be very reliable.

Previous research results had demonstrated the potential energy savings that could be achieved by reducing the variation in combustion conditions in the furnace. Current results indicate that for every 1% reduction in the oxygen content of the waste gas resulting from the installation of the oxygen analysis equipment, at least 1% fuel to the furnace can be saved.

BHRA Fluid Engineering

DEVELOPMENT OF A NOVEL INDUSTRIAL DEGASSER

The dissolved gas content of a process liquid can be of critical importance. For example, in the food industry it is often necessary to reduce the dissolved oxygen content of a liquid product in order to prevent oxidation, which can result in undesirable colour and flavour and corrosion damage to metal containers.

Another major area of use for degassing equipment is for treating boiler feed water in order to prevent corrosion damage to steam raising plant.

Most industrial degassing equipment, in present use, relies on holding the liquid near to its vapour pressure for an extended period of time. Typically, the process liquid is pumped into a large vacuum tank in the form of a fine spray. The tank is of necessity large, in order to provide the surface area necessary for gas transfer, together with an appreciable liquid residence time.

BHRA has developed a novel, patented, degassing system which operates on an entirely different principle employing a cavitating jet. The residence time of the process liquid in the system is extremely short, resulting in a much more compact unit which is simple to operate and gives significant savings in both capital and operating costs.

development

A three year experimental/programme has been carried out by BHRA to optimise the various corrosion damage to metal containers. the scaling laws which apply in designing different sizes of

Another major area of use for degassing equipment is for treating boiler feed water in order to prevent corrosion damage to steam raising plant.

Most industrial degassing equipment, in present use, relies on holding the liquid near to its vapour pressure for an extended period of time. Typically, the process liquid is pumped into a large vacuum tank in the form of a fine spray. The tank is of necessity large, in order to provide the surface area necessary for gas transfer, together with an appreciable liquid residence time.

BHRA has developed a novel, patented, degassing system which operates on an entirely different principle employing a cavitating jet. The residence time of the process liquid in the system is extremely short, resulting in a much more compact unit which is simple to operate and gives significant savings in both capital and operating costs.

development

A three year experimental/programme has been carried out by BHRA to optimise the various design parameters and to determine the scaling laws which apply in designing different sizes of unit. As part of this programme, a 2500 GPH unit was built and tested by the A.P.V. Co. Ltd. of Crawley, to design drawings supplied by BHRA under a licence option arrangement.

The A.P.V. Co. Ltd. has subsequently been granted a licence covering the manufacture and

BLMRA

THESAURUS OF LEATHER DYES

This publication gives detailed information on the chemistry, reactivity, testing, performance of about 250 dyes used in the leather industry and sold under nearly 3,000 trade names by suppliers on a global basis. It bridges the gap between manufacturers' literature and the Society of Dyers and Colourists Colour Index. Detailed information on reactions between dyes of the same general classification (particularly metal complex dyes), metals and 'type' auxiliaries has enabled dye recipes to be re-formulated to reduce the chance of interactions and the development of off-shades. The Thesaurus is continually being updated to take account of name changes, withdrawals and additions; it is becoming a means of reporting results of new research and application studies. There is no comparable publications elsewhere and only a collaborative organisation could undertake work on this scale which is of value to users and suppliers, albeit for different reasons.

BSRA

CODE OF PROCEDURE FOR MARINE INSTRUMENTATION AND CONTROL EQUIPMENT

A sharp increase in the type and number of instrumentation and control systems being installed in ships in the early 1960's led BSRA to undertake the compilation of a standard code of procedure for the selection and installation of such systems. The first edition was published in 1969 and a second revised and updated edition was issued in 1976.

The new handbook defines the terms used in control engineering, describes the use of instrumentation and control equipment in ships and deals in detail with design, specification, tendering, installation, commissioning and setting up a spares policy.

The 400 page publication stresses that instrumentation and control schemes must be considered as an integral part of ship board systems and that meticulous attention to design, installation, testing and commissioning will result in increased reliability and a reduction in installation and maintenance costs. Sales of the first edition totalled about 500. Nearly 250 copies of the revised handbook have been sold to date and it is in wide use all over the world.

BSRIA

MICRO BORE CENTRAL HEATING

In the middle 1960s BSRIA realised there were possibilities for cost reductions in central heating systems based on the use of very small bore pipes made from either metal or plastic. These ideas were developed to include special distributive manifolds and radiators which could be "plugged in" to flow and return water pipework almost as easily as plugging in an electrical connection, thus facilitating modification or expansion of the central heating system. The system was described in Laboratory Report No. 49/1968 and was widely publicised amongst members.

It was subsequently further developed by manufacturers and applied extensively in the domestic central heating market from about 1970 onwards, although one item, the "plug in" radiator has only just appeared in 1977.

BSRIA example illustrates the appreciable delay between the initial expose and the ultimate

MICRO BORE CENTRAL HEATING

In the middle 1960s BSRIA realised there were possibilities for cost reductions in central heating systems based on the use of very small bore pipes made from either metal or plastic. These ideas were developed to include special distributive manifolds and radiators which could be "plugged in" to flow and return water pipework almost as easily as plugging in an electrical connection, thus facilitating modification or expansion of the central heating system. The system was described in Laboratory Report No. 49/1968 and was widely publicised amongst members.

It was subsequently further developed by manufacturers and applied extensively in the domestic central heating market from about 1970 onwards, although one item, the "plug in" radiator has only just appeared in 1977.

This example illustrates the appreciable delay between the initial expose and the ultimate marketing of an innovation.

CIRIA

DYNAMICS OF MARINE STRUCTURES: METHODS OF CALCULATING THE DYNAMIC RESPONSE OF FIXED STRUCTURES SUBJECT TO WAVE AND CURRENT ACTION

A guide (Report UR8) has been written to assist designers of inshore and offshore engineering structures in determining the loadings that lead to dynamic, as well as static, response. It is not intended to be a detailed design manual for all classes of structure but to help engineers to decide whether or not a more detailed (and inevitably computer-based) dynamic analysis is required. Nevertheless, considerable design detail is given, together with many valuable references.

Chapters of the Report deal with:

- Basic features of dynamic loading and response
- Physical properties for dynamic analysis
- Waves as an external exciting force
- Flow-induced oscillations
- Calculation of the dynamic response of typical structures
- Effects of structural vibrations
- Uses of models to predict dynamic loads and the response of structures

CATRA

ROTARY HEARTH FURNACE

Reduced fuel costs, improved working conditions and increased productivity are the outstanding advantages of this development.

The furnace was specially developed for the cutlery forging industry but it is equally suitable for other small drop forgings.

A high intensity gas burner based on designs developed by the Gas Council produces a high velocity flame that heats up the stack very rapidly. The furnace temperature is pyrometrically controlled but the temperature allowed by the blank is controlled by matching the furnace temperature to the required output which in turn is controlled by the speed of the rotating hearth.

Despite its small size (about 1m x 1m) it has a capacity of 96 kg/h and uses less than one third of the fuel consumed by conventional slot furnaces of comparable output. Table knife forgings can be heated to 1150°C at the rate of one every three seconds.

The low heat capacity of the furnace together with hot face insulation enables the furnace to be used within 10 minutes of lighting up.

advantages of this development.

The furnace was specially developed for the cutlery forging industry but it is equally suitable for other small drop forgings.

A high intensity gas burner based on designs developed by the Gas Council produces a high velocity flame that heats up the stack very rapidly. The furnace temperature is pyrometrically controlled but the temperature allowed by the blank is controlled by matching the furnace temperature to the required output which in turn is controlled by the speed of the rotating hearth.

Despite its small size (about 1m x 1m) it has a capacity of 96 kg/h and uses less than one third of the fuel consumed by conventional slot furnaces of comparable output. Table knife forgings can be heated to 1150°C at the rate of one every three seconds.

The low heat capacity of the furnace together with hot face insulation enables the furnace to be used within 10 minutes of lighting up.

The development's success was not due to any single new innovation but was the result of combining several existing principles—rotary hearth feed, low heat capacity furnace chamber, and rapid heating with a high intensity gas burner.

HATRA

GEOMETRY OF KNITTED STRUCTURES

The problem of dimensional variations occurring in most types of knitted goods has been overcome as a result of Hatra's studies of the geometry of knitted structures.

The findings of these basic investigations established the need to ensure precise control on the length of yarn knitted into each loop. For this purpose a series of manual and automatic devices have been developed and marketed and their use has led to improved regularity and appearance of the knitted products, reduction of waste, better quality control systems and reliable methods of specifying knitting quality. In this latter context, the loop length parameter is now used internationally.

Extensions of this work include a computerised system of determining knitting specifications for full fashioned articles, an automatic lay marking technique and new approaches to fabric engineering.

MTIRA

COMPUTER-AIDED DESIGN AND MANUFACTURE OF ROLLS FOR COLD-ROLL-FORMING MACHINES

Cold-roll-forming is a process in which a strip of flat sheet metal, either from coil or cut to length, is passed through a series of pairs of shaped rolls which progressively deform it to a desired cross-sectional shape. The process thus requires the manufacture of sets of rolls contoured to give the desired deformation at each stage in the rolling process. In co-operation with one of its Members, MTIRA has developed a set of computer programs to aid the processes of design and manufacture of the rolls.

These programs enable the material shape at each stage of forming to be depicted on a computer plotter and, when the designer is satisfied with his method of successive forming, he can then have fully-dimensioned manufacturing roll drawings produced on the plotter as well. The use of these computer programs cuts the time required to design a set of rolls from weeks to an hour or so and, even taking into account the full cost of computing, reduces the cost of design to at least one quarter of that of previous methods.

As the same time as roll drawings are produced on the computer plotter a paper-tape output of the geometry of each roll is obtained. This geometry description is then used as input data to a special-purpose N.C. turning processor which automatically generates part-program tapes to enable the rolls to be made in an N.C. lathe. It should be realised that most of the rolls made are non-repeating one-offs and the special feature of this processor is that it makes N.C. manufacture economic even under these circumstances.

As well as working on a continuing basis with the particular Member company, MTIRA has designed and manufactured rolls for several other machine builders and strip rollers in the UK and would be pleased to offer the same profitable co-operation to other companies in similar fields of business.

are non-repeating one-offs and the special feature of this processor is that it makes N.C. manufacture economic even under these circumstances.

As well as working on a continuing basis with the particular Member company, MTIRA has designed and manufactured rolls for several other machine builders and strip rollers in the UK and would be pleased to offer the same profitable co-operation to other companies in similar fields of business.

NCC

DOCUMENTATION STANDARDS

In 1967 NCC set out to provide Standards for Systems Documentation, Programming and Operations. Working parties were set up with Member companies. The Working Parties investigated current practice, devised the best methods and commented on draft standards. NCC published the following manuals:

Systems Documentation Standards	October 1969
Programming Documentation Standards	November 1972
Programming Techniques	November 1972
Standards in Operations	December 1975

The latest position on the number of manuals issued is:

Systems Documentation Standards	10,000
Programming Documentation Standards	2,500
Programming Techniques	2,250
Standards in Operations	1,500

The Systems Documentation manual has formed part of NCC Basic Systems Analysis course and is in use in many countries.

Recently the Systems and Programming Documentation manuals have been combined into Standards for DP.

PAINT RESEARCH ASSOCIATION

PAINT-ON-ELECTRIC-HEATING

The excitement of PRA inventions of "Paint-on-electric-heating", resins from mineral polysilicates, resins from sugar, new metal-free biocides, etc., is tempered by slow exploitation, generally recognised these days to take 8–10 years from completion of the research for even low to medium technology.

Pride of place in having greatest impact on the paint industry international still goes to PRA work in pioneering the use of instrumental and computer methods for colour control of production in paint making (and other colour-based industries). This too did not happen "over night". The RA's pioneering study of the colour of pigment mixtures was reported by Dr D.R. Duncan in proceedings of the Physical Society in 1940 (an achievement later recognised by the Bruning Award of the US Federation of Societies for Paint Technology.) With the coming of reasonably priced computers in the 1960s, Miss D.L. Tilleard and her colleagues at the RA used this basic physical theory to develop programmes for calculating pigment formulae to match any given colour and factors for batch colour correction; they also defined suitable colour measuring

The excitement of PRA inventions of "Paint-on-electric-heating", resins from mineral polysilicates, resins from sugar, new metal-free biocides, etc., is tempered by slow exploitation, generally recognised these days to take 8–10 years from completion of the research for even low to medium technology.

Pride of place in having greatest impact on the paint industry international still goes to PRA work in pioneering the use of instrumental and computer methods for colour control of production in paint making (and other colour-based industries). This too did not happen "over night". The RA's pioneering study of the colour of pigment mixtures was reported by Dr D.R. Duncan in proceedings of the Physical Society in 1940 (an achievement later recognised by the Bruning Award of the US Federation of Societies for Paint Technology.) With the coming of reasonably priced computers in the 1960s, Miss D.L. Tilleard and her colleagues at the RA used this basic physical theory to develop programmes for calculating pigment formulae to match any given colour and factors for batch colour correction; they also defined suitable colour measuring instruments for obtaining the necessary in-put data. These instrumental and computer methods are now in routine use by most major paint makers and give faster and more precise colour control of paint production.

PERA

THE PERA CUTFAST PROCESS (PLASMA-ASSISTED HOT MACHINING)

PERA, now the world leader in the field of plasma-assisted hot machining, invented and patented the PERA CUTFAST Process in 1970. The Process, which is suitable for lathes, vertical borers and planing machines, uses a high-temperature plasma arc to pre-heat the chip material removed by the cutting tool, thus enabling high machining rates to be achieved.

The Process is eminently suitable for the traditionally 'difficult-to-machine' metals such as hardened alloy steels, nickel irons and hard surfacing materials, used in applications such as roll-making, pumps and valves, iron and steel manufacturing plant, mining and quarrying equipment, machinery maintenance, bearings, textile machinery, electrical generating plant and many others. Machining rates of up to 40-times the conventional machining rates have been achieved, corresponding to overall floor-to-floor savings of typically 30% to 80% in production.

Operator training and knowhow are included in the sales package and the equipment, which is produced by PERA, is installed and commissioned either by the Association's own engineers or, in certain countries, by its local sales distributors. The Process is now being widely used in the UK and also W. Europe, S. Africa, Japan and N. America.

PIRA

COMPUTERS IN NEWSPAPER PRODUCTION

An interesting example of exploitation by Pira occurred in the newspaper world. Computers have been used for a number of years to improve the efficiency of typesetting for printing. Local newspapers were in the van of developments, when Pira were called in to advise on the possibility of applying computers to their total system, not just the typesetting part of the operation. Pira did in fact succeed in designing a totally new computer system which at the time was unique from the following points of view:

1 Use of multi programming
2 A total systems design

The heart of the system is an on-line system to deal with classified advertisements. However, it is possible to simultaneously input advertising material, text, and to make text corrections at the same time as, for example, carrying out the normal phototypesetting operation.

The project lasted 2½ years and in the end cost the client £¼m which included consultancy costs and all hardware costs. Having successfully achieved the technical development, the problem then was how to transfer this technology to the rest of the local newspaper industry. In the event the solution was to set up a separate company called Press Computer Systems Ltd, staffed almost entirely by the original Pira staff.

then was how to transfer this technology to the rest of the local newspaper industry. In the event the solution was to set up a separate company called Press Computer Systems Ltd, staffed almost entirely by the original Pira staff.

RAPRA

CONTINUOUS VULCANISATION OF RUBBER EXTRUSIONS USING A FLUIDISED BED

The fluidised bed method for vulcanising unsupported rubber extrusions was developed by RAPRA in the early 1960s, with the object of overcoming deficiencies in existing batch processes. A continuous system offers advantages in increased production and reduced costs. This method, for which RAPRA received the Queen's Award to Industry in 1968, is now well established both in the UK and overseas.

The treating bath developed consists of inert particles such as sand or small glass spheres, kept in a constantly fluidised state by the passage of air or other gas. The extrusion floats on the surface of the boiling particles, by which it is uniformly heated. The bed, which operates at temperatures up to 250°C, consists of a long, narrow steel trough with gas inlets at the bottom, over which are mounted gauze air distribution strips for even gas distribution. The fluidising medium is heated by externally mounted electric wall heaters. Heat transfer characteristics of the bed are very good, and speed of vulcanisation is limited only by degree of conductivity in the rubber.

The latest design incorporates modular, horizontal sections which may be joined together to give any bed length. Each section has independent fluidisation control, with a choice of temperature control systems to give either two temperature zones or a controlled temperature profile along the bed. Efficiency in the use of heat may be improved by using a multi-pass system wherby more than one extrusion is passed along the bed at one time.

To overcome the problem of porosity in cured extrusions, RAPRA developed a quicklime-in-oil dispersion (tradenamed Caloxol and available commercially) which serves to absorb moisture when compounded into the rubber.

SHIRLEY INSTITUTE

THE SHIRLEY FLUID BED SYSTEM

Shirley fluid beds provide highly efficient and compact process heaters with unique thermal properties and, following extensive research at the Shirley Institute, have been specifically designed as machines for the continuous processing of textiles.

A fluid bed consists of solid glass balls of 0.25mm diameter called ballotini, and is fluidized, that is, made to behave like a liquid by the injection of low-pressure air into the base of the bed container. The air flow is adjusted to a level at which the bed becomes agitated and takes on the consistency and appearance of a bubbling liquid. In this condition solid objects may be easily immersed and materials in elongated form such as threads or tapes may be passed through continuously. Heat is very quickly and evenly transferred from the heater surfaces to both sides

SHIRLEY INSTITUTE

THE SHIRLEY FLUID BED SYSTEM

Shirley fluid beds provide highly efficient and compact process heaters with unique thermal properties and, following extensive research at the Shirley Institute, have been specifically designed as machines for the continuous processing of textiles.

A fluid bed consists of solid glass balls of 0.25mm diameter called ballotini, and is fluidized, that is, made to behave like a liquid by the injection of low-pressure air into the base of the bed container. The air flow is adjusted to a level at which the bed becomes agitated and takes on the consistency and appearance of a bubbling liquid. In this condition solid objects may be easily immersed and materials in elongated form such as threads or tapes may be passed through continuously. Heat is very quickly and evenly transferred from the heater surfaces to both sides of the immersed yarn or fabric.

A standard unit fluid bed has been developed which is suitable for the processing of either yarns and threads or narrow fabrics up to 10cm in width, to improve their thermal stability,

SIRA

OPTICAL TRANSFER FUNCTION METHOD

In the early 1960's Sira developed equipment for measuring the imaging quality of lenses and optical systems by the optical transfer function method. This technique, in which a grating of variable frequency is imaged by the test lens and the image contrast is measured as a function of grating frequency, is now accepted universally as an objective measure of optical performance, and a range of equipment for use in the laboratory is available.

Over the last two years Sira has extended the application of this technique by the development of a lens testing system for television and film lenses. This new equipment enables the optical performance of lenses to be checked quickly and easily in the studio by television or film engineers. In addition to measuring the imaging quality of a lens, it assesses other parameters including glare, transmission, field illuminance, distortion and chromatic aberration. Five of these systems have already been sold to customers in the television and film industries.

TRADA

MARKETING OF LESS WELL KNOWN WOOD SPECIES

One of the most important forms of innovation in the timber industry is the utilisation of less well-known species. This involves the determination of the properties of the species and learning how to cope with any particular characteristic it may have.

A recent TRADA project has concerned the marketing of wood species from Papua New Guinea in the UK and other European countries: many Papua New Guinea species are little known in Europe. TRADA carried out a comparative study of these species and the better known market species. The results of this study were presented to the PNG Government and forest industry in a series of meetings in Papua New Guinea and arrangements were made for wood technologists from Papua New Guinea to present their species to the UK timber trade.

WATER RESEARCH CENTRE

MEDLUBE PIPE JOINT LUBRICANT

Extensive investigation showed that a high percentage of bacteriological failures in the initial disinfection of new water mains which are assembled with rubber ring push fit joints may be attributed to joint contamination exacerbated by the lubricants in use, which may form a physical barrier to the entry of chlorine into the joint space or may themselves absorb chlorine. Some lubricants of vegetable origin are also able to support the growth of coliform bacteria.

WATER RESEARCH CENTRE

MEDLUBE PIPE JOINT LUBRICANT

Extensive investigation showed that a high percentage of bacteriological failures in the initial disinfection of new water mains which are assembled with rubber ring push fit joints may be attributed to joint contamination exacerbated by the lubricants in use, which may form a physical barrier to the entry of chlorine into the joint space or may themselves absorb chlorine. Some lubricants of vegetable origin are also able to support the growth of coliform bacteria.

It was concluded that the simplest way to combat bacterial contamination within the joint would be to incorporate a suitable bactericide into a water soluble formulation so that lubrication and disinfection would be accomplished simultaneously. A product, Medlube, was developed and in field trials held in 1972, water engineers reported large savings in time and money from the reduction in cases where new and repaired mains fail the initial and subsequent bacteriological tests. Medlube is complementary to, but does not replace the need for adequate cleaning and disinfection.

Medlube is the subject of British Patent No. 1,336,142 and the trademark Medlube is registered in the UK, most European countries and the USA. The product is manufactured and distributed by Isaac Bentley Limited on a non exclusive licensing agreement with WRC. The product is now in widespread use by UK Water Authorities; some of the pipe manufacturers also provide Medlube as a service component for use with their pipe. The problem of adequate water mains hygiene is widely recognised, and the use of Medlube has extended to Europe, with a developing interest in countries such as Australia, Canada, New Zealand and USA.

WIRA

STENTER MONITOR

Developed during the past three years this equipment uses wet and dry bulb hygrometry to monitor the moisture content of fabric passing through the stenter. Improved quality and speed of production and substantial energy savings accrue following the ability of the operator to maintain the required level of moisture content at all times. A continuous control feed-back loop is currently being incorporated into the system.

Substantial promotion of this equipment in the UK has resulted in some 35 successful installations. Sale or return facilities backed by government funds are helping to accelerate the exploitation. World wide sales are anticipated following the licensing of Messrs. E. Gordon Whiteley Ltd to sell the equipment built in to new machines.

The technique is widely applicable to other processes.

installations. Sale or return facilities backed by government funds are helping to accelerate the exploitation. World wide sales are anticipated following the licensing of Messrs. E. Gordon Whiteley Ltd to sell the equipment built in to new machines.

The technique is widely applicable to other processes.

LIST OF NAMES, ADDRESSES AND DETAILS OF RESEARCH ASSOCIATIONS/ORGANISATIONS IN THE UK AND CANADA

CTION OF THE RA	PARTICUL THE RA CAPABILI	PARTICULAR R & D CAPABILITIES	PARTICULAR TECHNICAL SERVICES	SIZE AND SENIOR STAFF
provides a comprehensive range nual and computerised scientific echno-economic information es, library facilities, publications, ltancy, training, conferences and ngs, and undertakes research and opment, all designed to promote ffective management and use of nation resources in industry, nerce, government departments and ies, education, research, and the ssions. Aslib has an international rate membership, covering the nd 75 other countries, in these ories.	Information comprehensive range Assessment computerised scientific Systems stnomic information of partic facilities, publications, informaining, conferences and Investigatindertakes research and of differ designed to promote nagement and use of ources in industry, nment departments and ion, research, and the ib has an international ership, covering the er countries, in these	Information systems evaluation. Assessment of educational techniques. Systems studies of the performance of particular elements of information transfer. Investigation of the information needs of different types of organization.	Information and library services in all subject areas. Consultancy and advice on design, planning and managing information systems. Publications, including guides to data bases and databanks. Demonstrations of on-line operations at exhibitions and conferences. Training courses and technical conferences. As a EUSIREF Centre Aslib also offers guidance to European users of on-line networks.	Approx. 60 employees T/O £0.6m. Deputy Director: L.J. Anthony Head of Research and Development: J. Martyn Director of Consultancy: P.H. Vickers Marketing Manager: K.L. Wakelam
activities cover all the normal ons of a trade association ling sponsored research, education, ical services, publicity and trade otion, liaison with the Government rganisations connected with the uction industry throughout the on behalf of its members from ay and calcium silicate brick try.	cover all the normal rade association ored research, education, s, publicity and trade on with the Government s connected with the dustry throughout the of its members from cium silicate brick			

*RITISH CARBONISATION RA Vingerworth Chesterfield Derbyshire 42 6JS Tel: 0246 76821 Director: J.P. Graham	The British Carbonisatior Association conducts co-*ATION RA* research on behalf of the coal-tar industries and al research and information organisations outside its Its particular expertise li6821 production and evaluatioP. Graham metallurgical coke, the p utilisation and evaluation the characterisation of c materials, the treatment of liquid effluents, and t of air pollution.	The British Carbonisation Research Association conducts co-operative research on behalf of the coking and coal-tar industries and also provides research and information services to organisations outside its membership. Its particular expertise lies in the production and evaluation of metallurgical coke, the processing, utilisation and evaluation of tar products, the characterisation of carbonaceous materials, the treatment and analysis of liquid effluents, and the assessment of air pollution.			
*RITISH CERAMIC A Queen's Road Penkhull Stoke-on-Trent ST4 7LQ Tel: 0782 45431 Director: A. Dinsdale, OBE	The British Ceramic Res*ERAMIC* Association provides rese information, consultancyad services relating to all as production and service b*ent* ceramic materials– potte sanitaryware, tiles, electri5431 refractories; technical cer engineering and electricalale, OBE clay- and calcium silicate building products (bricks and their behaviour in st	The British Ceramic Research Association provides research, information, consultancy and testing services relating to all aspects of the production and service behaviour of ceramic materials– pottery (tableware, sanitaryware, tiles, electrical porcelain); refractories; technical ceramics for engineering and electrical applications; clay- and calcium silicate-based building products (bricks, sewer pipes) and their behaviour in structures.			
*RITISH GLASS NDUSTRY RESEARCH SSOCIATION Northumberland Road Sheffield S10 2UA Tel: 0742 686201 Telex: 54208 CHAMCO G for (BGIRA) Director: C.Thorpe	BGIRA carries out co-op*LASS* on behalf of its members mainly those companies *f* British Glass Industry. T*ION* also provides informatior*land Road* consultancy services relat aspects of glass manufact provides sponsored resea86201 facilities at differential ra)8 members and non-membe for (BGIRA) .Thorpe	BGIRA carries out co-operative research on behalf of its members, who are mainly those companies making up the British Glass Industry. The Association also provides information and consultancy services relating to all aspects of glass manufacture and provides sponsored research or testing facilities at differential rates for members and non-members.	Silicate analysis. Glass forming. Glass melting/furnace technology. Physical properties of glass, especially strength. Refractory/glass problems.	Chemical analysis of glass and batch materials. Physical property measurement on glasses. Small scale glass melting. Inhomogeneity determinations. Provision of Standard Strain Discs. Temperature measurements (furnaces and moulds). Air pollution measurements (in-factory and stack emission). Assessment of corrosion-resistance of refractories. Measurement of lighting/noise levels. Statistical analysis of production data.	65 staff T/O 1976–77 £334 860 Information Officer: P.J. Doyle Secretary: R.W. Chilton Technical Secretary: S.E. Bedford

CTION OF THE RA	PARTICUF THE RA CAPABILI	PARTICULAR R & D CAPABILITIES	PARTICULAR TECHNICAL SERVICES	SIZE AND SENIOR STAFF
A Fluid Engineering provides ffective and rapid information, ltation, design and development es for the mechanical, chemical ivil engineering industries. All ts of fluid engineering, including ehaviour of mixtures (solid/liquid/ are included within BHRA's tise.	Physical mngineering provides hydroelastnd rapid information, designed aesign and development modelling mechanical, chemical Instrumentering industries. All or designec engineering, including experimenf mixtures (solid/liquid/ use. Fully ed within BHRA's and metalv undertake constructin tests.	Physical models, both dynamic and hydroelastic correctly scaled, can be designed and built. Mathematical modelling using digital mini-computers. Instrumentation packages assembled or designed and built for experimental work or for client's use. Fully equipped woodworking and metalworking shops can undertake client's work as well as constructing models for laboratory tests.	Contract design and development, testing to prove design. Techno-economic studies. Technical advice and consultation. Field investigations and surveys. Comprehensive information and library services including information analysis and retrieval using on-line magnetic tape data base. Specialist courses and conferences within fluid engineering.	Approx. 180 staff, 70 qualified engineers and scientists. T/O £1.5m. Hydraulic Engineering: G.A.J. Young (Asst. Director) High Pressure Engineering: M.J. Fisher (Asst.Dir) Pumping and Pipeline Technology: P.J. Baker Sealing Technology: B.S. Nau Information Services: H.S. Stephens (Asst. Director)
Leatherhead Food RA operates ationally providing research, opment and technical services on pects of the food manufacturing ssociated industries. It provides co-operative and contract research ies for both large and small anies. It is able to provide food ation information for most ries in the world.	Wide rangid Food RA operates scientific eproviding research, Spectromed technical services on etc throughe food manufacturing scale prodndustries. It provides ve and contract research th large and small able to provide food mation for most world.	Wide ranging from sophisticated scientific equipment e.g. GC/Mass Spectrometry, electron microscopy etc through to a full range of pilot scale production facilities.	Complete analytical facilities for handling members' samples. Comprehensive library and information facilities, provision of small scale equipment, training.	Approx. 200 staff. T/O £1.3m Deputy Director Science: Dr E.H. Steiner Deputy Director Administration: F.M. Read Project Co-ordinator: N.R. Jones Project Co-ordinator: W.E. Whitman
offer information, opinion and to its members on the safety in f all types of naturally occurring ynthetic chemicals. undertake the safety evaluation of icals of economic and technical tance. develop better methods which lead to improved safety evaluations o undertake basic research which give a greater understanding of effects.	Short and ormation, opinion and animal embers on the safety in Metabolic of naturally occurring Microbiolonemicals. techniqe the safety evaluation of Analytical onomic and technical etter methods which mproved safety evaluations e basic research which eater understanding of	Short and long term multi species animal studies. Metabolic and autoradiographic studies. Microbiological and immunological techniques. Analytical methodology development.	Chemical, biochemical and radiological analyses. Pharmacological bioassays. Radioimmunassays. In vitro carcinogenicity screening tests Information services.	Approx. 130 staff T/O £0.87m Head of Pathology: Dr P. Grasso Head of Biological Chemistry: Dr S.D. Gangolli Head of Toxicology: Dr K.R. Butterworth Head of Sponsored Projects: Dr I.F. Gaunt Head of Editorial Department: Miss A.M. Seely R.A. Secretary: M.D. Clarke

'HE BRITISH VTERNAL OMBUSTION NGINE RESEARCH VSTITUTE LTD 11-112 Buckingham Ave. lough, SL1 4PH el: 75-27371 lirector: A.G. Jaquiss	BICERI, being a compan*SH* guarantee and having no provides a confidential re*ON* development service to n*ESEARCH* of the internal combustic *LTD* sizes from small road vehckingham Ave. to large marine diesel en 4PH service is also available t71 of ancillary equipment, G. Jaquiss etc.	BICERI, being a company limited by guarantee and having no shareholders, provides a confidential research and development service to manufacturers of the internal combustion engine in sizes from small road vehicle engines to large marine diesel engines. The service is also available to manufacturers of ancillary equipment, oil companies etc.	Engines-diesel, petrol & gas from motor cycle to industrial and marine. Prototypes: design consultancy, manufacture and development. Research and development: combustion, fuel injection, performance optimisation, economy, noise, vibration, exhaust emissions. Bearings, gears, transmissions, component design, fatigue testing. Development and durability testing and lubricating oil testing (120 hr per week). On-site testing, computer programme for torsional vibrations and whirl. Associated services: testing of flowmeters, heat exchangers, antifreeze etc.	Library service and weekly technical abstracts.	Approx. 50 staff T/O £300K p.a. Director & Chief Engineer: C.H. Thornycroft Director & Chief Scientist: E.J. Nestorides Director and Commercial Manager: A.G. Jaquiss
RITISH EATHER IANUFACTURERS' ESEARCH SSOCIATION lilton Park troude Road gham, Surrey, W20 9UQ el: Egham (078) 3086/7 lanaging Director: R.L. Sykes	The application of scienc technology to the conver and skins to leather in o*TURERS'* maximise the value added production processes. *'ON* Information and consulta relevant to process and p ad development are availabl rey, the majority of BLMRA' collaborative research. (078) irector: es	The application of science and technology to the conversion of hides and skins to leather in order to maximise the value added by the production processes. Information and consultancy services relevant to process and product development are available although the majority of BLMRA's work is in collaborative research.	Co-ordinated use of chemical, microscopical and physical techniques to investigate the performance of fibrous materials. Deterioration of materials under conditions of storage and use. Evaluation of colorants (dyes & pigments) and surface coatings. Treatment of industrial wastes and effluents.	Optical and electron microscopy, environmental testing, classical and automated chemical and biochemical analysis, mechanical and fastness testing of material. Advisory service on pollution control and avoidance.	Approx. 45 staff T/O £0.4m Technical Services: A.W. Landmann Library & Information: E. Longstaff

CTION OF THE RA	PARTICUI THE RA CAPABILI	PARTICULAR R & D CAPABILITIES	PARTICULAR TECHNICAL SERVICES	SIZE AND SENIOR STAFF
A carries out research and opment in the fields of ship design, uction and operation for its ber companies, comprising UK uilders, ship operators and a ber of ancillary firms. It is inised as the main research arm e government-owned British builders. It also provides ultancy and technical services on a act basis to the marine and ed industries throughout the d.	Computer-ut research and product the fields of ship design, Ship hydrc operation for its and strunies, comprising UK Noise & viip operators and a (includillary firms. It is vibratioe main research arm Ships' engient-owned British automa also provides Technolog technical services on a methodo the marine and Interactivees throughout the Simulation Anti-corro: technol Design & c measuri	Computer-aided design and production systems for ships. Ship hydrodynamics, performance and structural strength. Noise & vibration reduction (including propeller-excited vibration). Ships' engineering system (including automation). Technology of shipyard production methods. Interactive graphics. Simulation techniques. Anti-corrosion & anti-fouling technology. Design & development of specialised measuring instruments.	Information services. Design support. Shipboard engineering and automation. Noise and vibration. Corrosion and fouling. Ship trials. Service performance. Shipyard methods. Measurement & instrumentation. Computing.	Approx. 300 staff T/O £2.4m Administrative Director & Secretary: J.C. Asher Asst. Director Administration: R.F. Darling Manager Shipbuilding Technology: D. Goodrich Asst. Manager Ship Technology (Naval Architecture): Dr G. Ward Asst. Manager Ship Technology (Engineering): J. Morrison Manager Computing Technology: I.M. Tolmie Manager Technical Services: M.N. Parker Project Manager Ship Structural Design System: Dr M.J. Todd Head of Technical Information Division: R.C. Kahler
tA provides information, advisory problem solving services to its bers in the heating, ventilating, onditioning, plumbing and ling electrics industry. On a yment basis it also carries out oment testing, system testing and missioning, instrument hire and nical investigations.	Heat transs information, advisory On-site da lving services to its perform heating, ventilating, Market Re, plumbing and cs industry. On a is it also carries out ing, system testing and instrument hire and tigations.	Heat transfer, air movement, acoustics. On-site data collection and performance monitoring. Market Research.	Testing and Certification of equipment. On-site regulation of systems. Full scale model testing of building modules. Instrument hire. Market research. Information services. Seminars on building services.	Approx. 65 staff T/O £450,000 Member Services: A.G. Foster Technical: L.J. Stewart Contracts: G.J. Baker Information Officer: A.R. Eaves

'ONSTRUCTION NDUSTRY 'ESEARCH AND NFORMATION SSOCIATION Storey's Gate ondon, SW1 3AU 'el: 01 839 6881)irector: Dr. L.S. Blake	CIRIA is an industrial co TION research association set u British construction indu AND the support of the UK g TION identify, finance and ma ON and the collection and d ate of information required W1 3AU construction industry. 1 6881 Blake	CIRIA is an industrial co-operative research association set up by the British construction industry, with the support of the UK government, to identify, finance and manage research and the collection and dissemination of information required by the construction industry.	Research management and the provision and presentation in the following broad fields: structural design, building and civil engineering construction, earthworks and foundations, hydraulic and public health engineering, underground construction, off-shore structures, diving, etc.		40 permanent staff + 140 under contract. T/O £¾m Director of Research: P. Pullar-Strecker Director of Administration: J.B. Behr
'OTTON SILK ND MAN-MADE IBRES RA hirley Institute)idsbury lanchester, 120 8RX 'el: 061 445 8141 'elex: 668417)irector of Research: L.A. Wiseman, O.B.E.	All aspects of research o LK and processing characteri MADE short-staple man-made fi continuous-filament yarn itute improvement of textile e the design and operation facilities, and the assess markets for textile prod 5 8141 417 Research: eman,	All aspects of research on the properties and processing characteristics of cotton, short-staple man-made fibres and continuous-filament yarns, the improvement of textile end-products, the design and operation of production facilities, and the assessment of the markets for textile products.	Polymer and fibre structure and properties. Textile machinery—development, optimization, productivity. Design and development of textile products. Garment industry efficiency. Forecasting. Flammability, static electricity and colour measurement of textiles. Design and development of high-performance fibre reinforced plastics. Medical textiles development. Filtration materials characterisation. Enzymes, microbiology and biodeterioration. Effluent treatment and water conservation.	Testing especially in relation to processing or product faults. Forensic testing of textiles. Textile information. Productivity surveys. Energy audits and optimisation of energy usage. Control of dust and noise. Safety surveys. Patents, litigation and technical witness.	230 staff T/O £1.2m Head of Projects and Membership Dept.: Dr D.M. Jones Senior Research Marketing Manager: J.E. Ford
'UTLERY AND LLIED TRADES 'ESEARCH SSOCIATION lenry Street heffield 3 7EQ 'el: 0742 79736)irector of Research: E.A. Oldfield	CATRA carries out resea AND development to reduce t RADES production and to impro of cutlery (which includ ON professional cutlery, kitc t folding knives and scisso tools. 79736 Research: lfield	CATRA carries out research and development to reduce the cost of production and to improve the quality of cutlery (which includes table cutlery, professional cutlery, kitchen knives, folding knives and scissors) and edge tools.	Abrasive machining, polishing, drop forging of small components, press feeding and guarding, heat treatment and application of martensitic stainless steels and tool steels. High efficiency gas furnaces for small drop forgings, cold forming. Development of special purpose machines for making cutlery etc.	Measurement of surface finish, sharpness and durability of edges. Assessment of corrosion resistance and strength of cutlery and similar products. Failure investigations.	Approx 14 staff T/O £80,000 Senior Research Officer & Metallurgist: J.W.Mee Information & Liaison Officer: R.H. Bingham Senior Abrasives Officer: S.J. Whitham Senior Engineer: R.C. Hamby

CTION OF THE RA	PARTICUI THE RA CAPABILI	PARTICULAR R & D CAPABILITIES	PARTICULAR TECHNICAL SERVICES	SIZE AND SENIOR STAFF
A conducts wide-ranging erative research on the forming of metal and provides advisory, nation, consultancy and arbitration es. The main subjects of interest roduction processes, forge ces, energy conservation, die life, anical handling and environmental ems, particularly noise. The iation is becoming increasingly ed in the legal aspects of ers' activities.	s wide-ranging earch on the forming of provides advisory, nsultancy and arbitration ain subjects of interest processes, forge conservation, die life, dling and environmental ularly noise. The ecoming increasingly legal aspects of ties.			
British Launderers' Research iation and the Dyers' and Cleaners' rch Organisation Ltd were tly amalgamated to form the Care Research Association.	nderers' Research the Dyers' and Cleaners' isation Ltd were mated to form the earch Association.			
offers research, test, technical, ting and management advice icilities, for UK and international ure manufacturers and their ers of materials, components and nery.	Chair frame earch, test, technical, Furniture c management advice Evaluation r UK and international synthetiacturers and their Forecasting erials, components and perform adhesive Upholstery Flammabili combina Component set-up te Statistical r Ergonomics Timber and compon	Chair frame design analyses. Furniture durability standards. Evaluation techniques for modern synthetic fabrics. Forecasting panel material performance—chipboards, finishes, adhesives and hardware. Upholstery foam performance. Flammability—foam/fabric combinations. Component dimensioning/machine set-up techniques. Statistical marketing analyses. Ergonomics of furniture. Timber and plastics as furniture components.	Furniture evaluation and testing. Testing furniture materials and components. Supply of test machinery. Market research and sales forecasting. Technical information services. Design and supply of special instruments for component dimensioning and tolerancing. Quality control systems. Costing and accountancy. Factory layout and machine selection. Special training courses.	Approx. 90 staff T/O £750,000 Assistant Director, Finance & Administration: J.V. Gatchfield Assistant Director, Communications: A.D. Spillard Head of Research: M. Charity Head of Technical Services Department: J.E. Moses Head of Marketing Department: P.J. Raper

'ATRA Gregory Boulevard lottingham IG7 6LD el: Nottingham 623311 elex: /o Nottingham hamber of Commerce omind G 37605)irector of Research: W.A. Dutton OBE, FTI	Hatra provides research, (and technical services in the production and dyeir of knitted fabric and gar Member services in the f consultancies, publicatior sponsored work are an in of the organisation's acti All knitting companies in Kingdom are Members ar Membership is available t firms.	Hatra provides research, development and technical services in all aspects of the production and dyeing of every type of knitted fabric and garment. Member services in the form of testing, consultancies, publications, liaison and sponsored work are an important part of the organisation's activities. All knitting companies in the United Kingdom are Members and Associate Membership is available to non-knitting firms.	Electronic and mechanical knitting control mechanisms. Computer aided systems in lay marking, cutting and garment production. Colour difference formulae and batch dyeing controls. Knitting fabric engineering. Advance stain identification techniques.	Knitting and making-up quality control systems and installations. Video tape productions for technology transfer operations. Liaison services including courses, seminars in-factory demonstrations. Information services.	Approx. 70 staff T/O £400,000 Head of Research Div.: Dr E.A. Kellett Head of Member Service: T.S. Nutting Head of Marketing: R.L.S. Duffey Secretary: J.K. O'Neill
AMBEG *VDUSTRIAL RA* he Research Institute isburn, BT27 4RJ lorthern Ireland el: 023 82 2255 elex: 747425)irector: H.A.C. Todd OBE	LIRA undertakes researcl development and provide and information services It has specialist expertise staple fibres (flax, jute a fibres) polyolefin extrusi processing, non-flam mat test methods, clothing cc textiles for civil engineer catalytic methods of poll control, metrology and e	LIRA undertakes research and development and provides technical and information services for industry. It has specialist expertise in long staple fibres (flax, jute and man-made fibres) polyolefin extrusion and processing, non-flam materials and test methods, clothing comfort, carpets, textiles for civil engineering applications, catalytic methods of pollution control, metrology and engineering.			
MACHINE TOOL *VDUSTRY* *'ESEARCH* *SSOCIATION* lulley Road Macclesfield Cheshire K10 2NE el: 0625 25421)irector of Research: A.E. De Barr	MTIRA provides research development, testing and technical services in all a design, manufacture and machine tools and simila Technical and economic i services are provided and be sponsored by individu groups.	MTIRA provides research, design, development, testing and other technical services in all aspects of the design, manufacture and use of machine tools and similar machines. Technical and economic information services are provided and work may be sponsored by individual clients or groups.	Design of structures and foundations. Design of bearings, spindles, slides and slideways, gears and gearboxes. Design, development and manufacture of control systems. Noise reduction, guarding for machinery. Machine tool performance. Reliability and maintenance.	Vibration and performance analysis. Manufacture of models. Noise measurement. Machine calibration and alignment. Information services. Seminars and conferences. Technological forecasts and surveys. Machine design.	Approx. 70 staff T/O £0.5m Technical Director: Dr G. Sweeney Commercial Director: J.A. Stokes

TION OF THE RA	PARTICUL. THE RA CAPABILIT	PARTICULAR R & D CAPABILITIES	PARTICULAR TECHNICAL SERVICES	SIZE AND SENIOR STAFF
ational Computing Centre develops ques and provides aids for the ffective use of computers. NCC n-profit distributing organisation by government and industry. entre: perates with, and co-ordinates work of members and other anisations concerned with puters and their use. vides information, advice and ning. lies software packages. notes standards and codes of tice.	Computing mputing Centre develops Database rovides aids for the Methods se of computers. NCC Microproces stributing organisation Package Dev ment and industry. Privacy & S Software De th, and co-ordinates Standardisat embers and other Training De concerned with d their use. mation, advice and are packages. dards and codes of	Computing with Communs Database Methods Microprocessors Package Development Privacy & Security Software Development Standardisation & Legislation Training Development	Advice Information Publications Software Standards Training Courses Training Material Seminars	180 staff T/O £2m Group Director of External Relations: E.D. Scriven Group Director of Development: R. Boot Deputy Director: E.J. Howe

INT RESEARCH SOCIATION ldegrave Road ldington ldx. '11 8LD : 01 977 4427 ex: 928720 naging Director: G. de W. Anderson	PRA is a research organisa*ARCH* about 150 Members world*N* including manufacturers ofoad its raw materials and majoı paint. Its research and tech are dedicated to expanding technical capability and ea1427 capacity of Members and c0 is also an intelligence centrector: to assess market demands, Anderson requirements and the signi advances made elsewhere.	PRA is a research organisation having about 150 Members world-wide including manufacturers of paint and its raw materials and major users of paint. Its research and technical services are dedicated to expanding the technical capability and earning capacity of Members and clients. It is also an intelligence centre equipped to assess market demands, legal requirements and the significance of advances made elsewhere.	Paints: All types of solvent, aqueous and powder coatings. Chemistry: Resins, pigments, and paint additives. Microbiology: Evaluation of industrial biocides. Technology: Paint application and performance studies. Pollution control: Gaseous and water effluents from paint manufacture. Instruments: For measurement and control.	Consultancy, Training Courses, Analysis and Testing.	Approx. 85 staff T/O £0.5m Research Director: J.H. Arendt Chemistry Division: G.L. Holbrow Technology Division: T.R. Bullett Information Dept.: D. Dasgupta
PER AND ARD, PRINTING ID PACKAGING DUSTRIES RA ndalls Road ıtherhead 'rey, KT22 7RU : 037 23 76161 ex: 929810 'ector: N.K. Bridge	Pira has expertise in most industries. Although it is a*NTING* research organisation with *IGING* UK and overseas firms, mo *RA* half its work is consulting d work f or non-members anc members as well as UK me 7RU 76161 0 je	Pira has expertise in most aspects of the industries. Although it is a co-operative research organisation with some 1000 UK and overseas firms, more than half its work is consulting and testing work f or non-members and overseas members as well as UK members.	Pulping, paper & board making. Waste paper treatment, environmental problems, particularly effluent. Printing by all conventional and some of the newer processes. Electronic composition, colour printing, book binding. Packaging design and evaluation of all kinds, eg plastics, glass, metal, paper and board. Package systems. Migration of toxic materials from packaging.	Papermaking—pulping, pulp evaluation, engineering advisory, moisture and grammage variations, microbiological, noise, colour control, paper testing, roll contour, effluent advisory. Printing—printing trials on full scale machinery, electronic composition, quality control, bookbinding and finishing. Packaging—barrier performance evaluation, package cushioning material evaluation, carton service, package testing (small and large) Computerised technical and market information in all three areas. Also techno-economic studies.	165 staff T/O £1.1m Director of Paper & Board: D. Attwood Director of Printing: G.F. Buckler Director of Packaging: F.A. Paine Director of Information and Training: B.W. Blunden

TION OF THE RA	PARTICUL THE RA CAPABILIT	PARTICULAR R & D CAPABILITIES	PARTICULAR TECHNICAL SERVICES	SIZE AND SENIOR STAFF
stablished in 1944, PGRO's ble objects are the provision of d research, advisory, educational ther technical and scientific s in relation to the production, tion and harvesting of vegetables ocessing, in particular peas and It is supported primarily by ary levy and subscription, but so involved in contractual ch and consultancy work. It me 4,500 Members and ate Members; the majority are ised, but there are Associate ers in 18 countries overseas. incorporation, in 1956, the isation has produced 446 ations.	in 1944, PGRO's are the provision of advisory, educational cal and scientific on to the production, arvesting of vegetables n particular peas and orted primarily by nd subscription, but d in contractual sultancy work. It Members and ers; the majority are here are Associate countries overseas. ion, in 1956, the produced 446			
oduction Engineering Research ation assists manufacturing sations with contract research, cal and management consultancy, ion and training and unications. PERA operates ationally and offers technical iation and advisory services, and abstracting services and the of a general research programme mber organisations in 24 ies disseminated through ations and regular liaison visits.	Computer a Engineering Research Plasma assis ts manufacturing Noise contr h contract research, Plant and m nagement consultancy, Application aining and industria PERA operates Computer a nd offers technical Plastics and advisory services, Machining c acting services and the Recycling s ral research programme nisations in 24 inated through regular liaison visits.	Computer aided drawing. Plasma assisted machining. Noise control service. Plant and machinery monitoring. Application of electronics to industrial control. Computer aided group technology. Plastics and composites applications. Machining data club. Recycling scrap material.	Technical Consultancy. Contract Research. Education and Training Courses. Management and Consultancy. Industrial Maintenance. Marine Documentation. Translation Services. Project Management. Manufacturing and Productivity Improvement. Technology Transfer.	350 staff T/O £2 6m Director: Research Division: R. Tilsley Director: Industrial Services Division: D.D. Morgan Director: Regional Services Division: J.A. Phillips Secretary: D.W.J. Foster
ernational technical centre for lymer industry. RAPRA offers a ehensive, multi-disciplinary of services, including product and s development, information and cal projects, and advanced training fessional staff, undertaken through edium of Membership or as ential contracts.	R & D in c technical centre for to products stry. RAPRA offers a quality assu multi-disciplinary environmen including product and nent, information and s, and advanced training taff, undertaken through Membership or as tracts.	R & D in conversion of materials to products, product performance, quality assurance, standards and environmental studies.	Testing and analysis, processing studies, fire testing, productivity and operation research, productivity surveys, microscopy, management studies, general laboratory work. Technical enquiry services. Information and library services, publications, market surveys, translations.	Approx. 220 staff, including some 80 professional and qualified staff. Director of Technical Development: M.M. Hall, BSc, PhD, MInstP Director of Administration and Secretary: A.B. Davey, MA, APRI.

)E AND *.IED TRADES* a House kingham Road :ering thants. 16 9JH 0536 516318 x: 34323 ctor: .G. Butlin	To advance footwear techn increase the profitability an*DES* competitiveness of its mem through carrying out collect in research and developmenload and management services an services to individual memb in these areas. Membership high labour cost countries. 318	To advance footwear technology and increase the profitability and competitiveness of its member-firms through carrying out collective projects in research and development, technical and management services and providing services to individual member-firms in these areas. Membership limited to high labour cost countries.	Research and development in areas of: shoe upper materials adhesives and solings complete footwear (for special purposes) recruitment, selection and training methods shoemaking processes and machines production planning and control productivity. Design of test equipment (for shoes and shoe materials and components).	Fashion trends and technology of new fashions. Performance forecasting for all footwear components and materials. Design and assessment of lasts for population coverage, suitability for shoe materials and construction, fitting potential and correct size markings. Assessment of lasts for fitting potential and correct size marking. Last design. Analysis of malfunctions in production. Testing of footwear for fitness of purpose. Performance forecasting to minimise returns. Testing safety footwear for official acceptance—national or international. Advising exporters on foreign specifications. Analysis of wear complaints. Production Services. Efficiency testing of factory processes. Assessment of work layout, operation and organisation. Definition, interpretation and implementation of quality standards. Production planning and factory layout. Work Force Efficiency. Recruitment and selection. Aptitude tests. Job specification. Training. Method and work study. Health and safety precautions. Management services. Feasibility studies for the installation of business efficiency methods. Computer bureau. Staff structuring. Translation services. Control systems.	Approx. 175 staff T/O over £1m Deputy Director and Secretary: J. Butcher Assistant Director (materials and products): E.F. Hall Assistant Director (processes): D.J. Pilkington

TION OF THE RA	PARTICULA THE RA CAPABILIT	PARTICULA R R & D CAPABILITIES	PARTICULAR TECHNICAL SERVICES	SIZE AND SENIOR STAFF
stitute operates internationally, ng research, development and al services in all aspects of sign, manufacture and ition of scientific and industrial nents and control equipment. stitute provides consultancy and -economic information services, e conduct of single or multi- sponsored work.	Electronic s rates internationally, digital. h, development and Optical and in all aspects of and systems facture and Precision m entific and industrial Electro-chen control equipment. Laser scann vides consultancy and On-stream c information services, Optical wor of single or multi- work.	Electronic systems analogue and digital. Optical and electro-optical devices and systems. Precision mechanical systems. Electro-chemical analysis. Laser scanners. On-stream composition analysis. Optical workshop technology.	Instrument evaluation, testing and calibration. Prototype and small batch instrument production. Market research and business evaluation. Information services. Mounting of seminars and symposia.	Approx. 160 staff T/O £1.3m Manager—Industrial Optics: Dr L.R. Baker Manager, Industrial Instrumentation: T.P. Flanagan Manager—Engineering: S.E. Cole Manager—Marketing: D.J. Berry
A is the only co-operative h organisation in the world d solely to improving all aspects ng technology. ssociation undertakes a mme of research for its rs and in addition provides lting and contract research .	Spring desig ly co-operative Material sele tion in the world Design and o improving all aspects special ecogy. Material dev undertakes a Performanc search for its addition provides contract research	Spring design. Material selection. Design and construction of special equipment. Material development. Performance evaluation.	Fatigue testing of springs and spring materials. Relaxation testing. Corrosion performance evaluation. Computer aided design.	Approx. 25 staff
TA provides research and pment, testing, consultancy, tion and commercial and al information services to el castings industry and to pliers and customers. It ins strong professional ise in metallurgy of steel s in production technology, assurance, and health and and it active in training. It taff of over 100, and a ntial development foundry makes it a unique sation of its kind.	s research and ting, consultancy, ommercial and ation services to industry and to customers. It professional llurgy of steel ction technology, , and health and ive in training. It er 100, and a opment foundry unique ts kind.			

ADA cking Lane ghenden Valley h Wycombe :ks, HP14 4ND : 0240 24 3091 ector: J.G. Sunley, MSc, FIStructE, FIWSc.	TRADA is an independent and development organisati jointly financed by firms a individuals, the timber trad professions and industry, a aided by the Department o Environment. TRADA emp architects, engineers and te working in the interests of users and specifiers. TRAD is disseminated by means o publications, advisory servi lectures, technical training publicity. TRADA's advice services are open to everyo	TRADA is an independent research and development organisation, jointly financed by firms and individuals, the timber trade, the professions and industry, and grant aided by the Department of the Environment. TRADA employs architects, engineers and technicians working in the interests of timber users and specifiers. TRADA's work is disseminated by means of publications, advisory services, lectures, technical training and publicity. TRADA's advice and services are open to everyone.	Any R & D requirements relevant to design and the use of wood in the construction and other industries and the industrial and marketing problems of the timber industry world-wide. TRADA has made important contributions in housing and building, timber engineering, industrial applications, fire research, timber drying, stress grading and testing of structures, components and finishes.	Information, advisory and consultancy services relevant to TRADA's function; mechanical and fire testing services; quality assurance arrangements for the timber industry; mounting of seminars and symposia; provision of educational and training facilities.	Approx. 130 staff T/O £1.5m Head of Building Devt. Dept.: J. Ollis Head of Engineering Dept.: H.J. Burgess Head of Industrial Dept.: J.B. Deveson Head of Technology Dept.: Dr G.S. Hall Head of Mechanical Services: J.D. Harvey Head of Training Dept.: P.G. Walker Head of Central Advisory Services: P. Houghton.
RA adingley Lane eds, 6 1BW : 0532 759071 ex: 557189 ector and Chief ecutive: Dr B.E. King	Wira provides research, tec development, testing, consu arbitration and informatio to industry. It has particul expertise in the wool texti in clothing production and in carpet performance and moisture control, water co effluent treatment, chemic prevention and engineering	Wira provides research, technical development, testing, consultancy, arbitration and information services to industry. It has particular expertise in the wool textile industry, in clothing production and performance, in carpet performance and in the moisture control, water conservation, effluent treatment, chemical, noise prevention and engineering fields.	Raw fibre and yarn processing, woven and non-woven production. Dyeing and finishing plant and expertise. Machinery assessment. Clothing, carpet and other end product research. Marketing and market research. Engineering, prototype and production facilities. Electronic and instrumentation development.	Test house for fibres, yarns, fabrics and consumer and industrial textile end products. Consultancy in all aspects of textile, clothing and carpet production. Training facilities. Computer pattern grading service. Quality control and productivity advice. Engineering, drawing office and workshop.	170 staff Deputy to Director and Chief Executive and Research & Services Director: M.W. Townsend Finance Director and Secretary: G.M. Oddy

ION OF THE RA	PARTICULA HE RA CAPABILITI	PARTICULAR R & D CAPABILITIES	PARTICULAR TECHNICAL SERVICES	SIZE AND SENIOR STAFF
tre undertakes research on f Members worldwide ; Water Authorities and es in England and Wales er Undertakings in Scotland thern Ireland. The Centre ates a full information nical advisory service and es contract work for and non-Members. The a Collaborating Institution orld Health Organisation.	Reservoir stuc akes research on River flow, re worldwide ecology. ithorities and Groundwater and and Wales kings in Scotland Evaluation and nd. The Centre of existing an information wastewater tre ory service and sludge treatme work for Water mains a Members. The renovation, w rating Institution waste and lea h Organisation. Health effects Coast and est Application of research and e over the whol	Reservoir studies. River flow, regulation quality, ecology. Groundwater studies, geophysics. Evaluation and development of existing and new water and wastewater treatment processes: sludge treatment and disposal. Water mains and sewers, materials, renovation, water quality effects, waste and leakage. Health effects of water quality. Coast and estuary pollution. Application of Operational research and economics studies over the whole water cycle.	Technical liaison, information (including computerised retrieval) technical enquiries, libraries, biodegradability index, conferences, seminars and regional meetings, radiotracer and geophysical services.	Approx. 535 staff (all grades) Budget 77/78 Research and Support services £6 million.
ides research and ent services for the textile ing industries of the UK s constituent RA members:— atra, Lace RA, LIRA, stitute and Wira.	ch and s for the textile ies of the UK ent RA members:— RA, LIRA, l Wira.			