7

Future developments and outlook

7.1 General survey

In common with every other industry, textile coating and lamination is undergoing change and 'rationalisation' – unfortunately from the employees' point of view, all too frequently a euphemism for company mergers and job losses. On the positive side, a fresh approach is frequently stimulated which results in solutions to old problems and the bringing of new benefits and opportunities. Larger units, and being part of a larger group, can produce advantages of economies of scale and a wider economic and geographical reach. Some sectors of the textile industry, such as garments, are labour intensive, and the larger American and Western European companies have moved production to those areas of the world which have lower labour costs, such as Eastern Europe, North Africa and Asia. In many cases, they have retained the research, development and design functions in the home country. European designers of both garments and other items such as car upholstery are widely regarded as world leaders. A significant proportion of the UK polyurethane coating production has been lost to competition in the Far East, where many of the base fabrics of nylon and polyester are spun and woven. This process has, however, led to new overseas markets for British and European machinery producers and the chemical manufacturers who make the coating and lamination materials. The European machinery makers have an excellent reputation, but must stay ahead by investing in research and development. Some developing countries already have a good insight into and understanding of the overall global textile industry; they have plans for intensive development with a view eventually to becoming industry leaders.[1,2]

The coating and lamination industry is generally regarded as being closely associated with the technical textiles sector; this is generally true both because of the specialist technical requirements of the products, but also because of the technical nature of coating and lamination processes. However, there are still significant parts of the coating and lamination

industry which have a considerable fashion element, i.e. household textiles and especially sports protective clothing, some of which is now sold in chain stores with designer and seasonal associations. The boundaries between fashion sports clothing and high performance protective clothing for the keen sportsman appears to have become quite diffuse. A well-designed anorak containing the same fabric content as a plainer design can retail at perhaps three times the price. There is now more choice of clothes in different designs than at any other time, and 'mass customisation' is influencing each sector of the clothing market with a performance level and a price level for each article. Possibly there is scope for more levels of performance and design content in the sportswear protective clothing market, and this may be becoming true of any consumer item, e.g. curtains, upholstery, carpets, etc. The increase in the quality of life in the developed countries is raising standards all round with ever-increasing comfort and convenience. Many of the stiff, nylon coated, non-breathable anoraks and cagoules of the 1980s have been replaced by softer breathable coatings or laminates, and this trend for softer, lighter and more comfortable garments will continue, not just for the fashion sector but also for industrial garments. Mass customisation requirements are gradually spreading to all sectors of consumer industry, and the time will come when both consumers and industrial workers will require protective clothing in their own individual style and design. These garments will be tailored to fit their body size and shape exactly (via a 'body scan' taking perhaps 130 body measurements), will fulfil all the technical specifications required for protection and durability, and will be available within a day of ordering.

In the automotive industry, more responsibility for design and development is being passed on to the suppliers with whom the car makers have close relationships or partnerships. The immediate suppliers are known as Tier 1 suppliers, and indirect suppliers as Tier 2. Some of the largest Tier 1 suppliers are now so large and influential that they are termed 'Tier ½.' The automotive industry has become a truly global industry, where materials, including fabric, are out-sourced anywhere in the world. The car companies have become assemblers of components and modules produced by their suppliers. Modules are becoming more sophisticated, and the time will eventually come when a whole car interior will be supplied as a complete ready to install module. Competition is intense and suppliers are faced with annual 'cost downs', i.e. being required to lower their selling price to the OEMs. Delivery JIT is essential, and the time factor for new developments and time to market for new products is now, in many cases, considerably less than one year, while at one time the norm was considered to be at least three years. Of course time is critical in the fashion garment industry, and one of the distinguishing features of technical textiles is their reduced dependence on changing fashion. Having said this, however, we have seen

that there is now an element of up to date fashion requirement in virtually everything which the general public sees or comes into contact with.

7.2 Processing

To be profitable, it is now necessary to produce first quality material virtually all of the time – as industry in general aspires to the ideal of 'zero defects', i.e. giving the customer exactly what is agreed in the sales contracts every time and delivery on time every time. However, much intermediate and final inspection of fabric is still done manually by trained operatives, the best of whom still miss up to 20% of faults even at relatively slow speeds. Some customers actually specify the speed at which examination of their particular product must take place. Faults in pattern and fabric construction are still found at final inspection in laminated automotive fabric when the base fabric's value has been increased by a factor of maybe 500%. Research continues to inspect fabric on-line,[3] during production, and some advanced military technology is being adapted for this purpose. In an age where a car number plate can be read from a satellite in orbit, the technology fully to automate all aspects of coated and laminated fabric inspection is probably available. The problems are the initial cost of development and how to make it affordable for the small and average size fabric producer.

As much as possible, the 'human factor' is being removed from the production process and replaced by automatic instruments with computer control to ensure that the product is manufactured to a consistently high standard. The 'human factor' has become the least controllable and the least reliable in the manufacturing process. More automatic controls are required on processing machines to sense fabric tension variations and then automatically make the appropriate adjustments.[4] This will reduce variations in resin add-on in coating operations, variations fabric dimensional stability and pattern distortions, and also help to lessen the occurrence of creases. Resin add-on is already measured automatically on-line, for example by beta gauges. Again, the technology probably exists to ascertain the reason for the variation and to make automatic adjustments in, for example, blade angle or gap size, resin viscosity or whatever is necessary to bring the process back within specification. Material, however, must be produced in sufficient volume to justify the expense of such sophisticated instrumentation, and only very large operations will be able to afford it.

Waste reduction of chemicals and resins, especially those with a limited pot-life, is another area where better customer communications, production planning and organisation, perhaps computer assisted, could allow improvements and cost savings. Optimisation of resin coating add-on and the amount of adhesive necessary to pass specifications should lead the way to

more precise control of materials. If, say, the required peel bond can be achieved with a margin of safety with an adhesive add-on of 16 g/m^2 any thing over this is excessive cost. If the average add-on is even, say, 18 g/m^2, reducing it by just 2.0 g/m^2 would reduce the cost of adhesive by 11%. Precise automatic process control would be essential to enable this cost reduction.

Advances are being made gradually, and sometimes in quite ingenious ways. For example, advances in engineering are allowing the design and production of rollers which run truer without bowing and remaining completely parallel during the production process. This has been achieved on a thermobonding calender using electromagnetic forces.[5] Sensor Products have just introduced a novel roller pressure testing sensoring device in the form of a thin sheet, which changes colour depending on the pressure applied between two surfaces. These developments could have applications in pad mangles, calenders and nip rollers in coating and lamination machines, and improve the across-the-width uniformity of take-up and add-on of chemicals in padding operations. Uniform pressure across the width in nip rollers in lamination should help improve reproducibility and reduce variability of peel bond results.

Costs are being reduced by producing laminated material in the same production line as fabric. One manufacturer is film extruding polyolefin film on to freshly produced nonwoven material in a single manufacturing line. This of course eliminates a whole series of processes, packaging, loading, transportation, unloading, etc. The trend will also be for longer, wider production runs with less down time for changing machine settings and materials to produce different qualities, and for machine maintenance. More effective production planning should result from the communications revolution, perhaps eventually via the internet, and from combining related processes and by production under commission, possibly for external customers – even competitors! Future production costs will be reduced by more effective buying through better communications via the inernet, wider width processing, longer continuous running with much less down time, better process efficiency, less waste and making more first quality material by more precise automatic control of machine parameters. In addition, new management techniques, team working and the culture of continuous improvement will become more widespread.

7.3 New and novel materials

New materials, new yarns and yarn variants, speciality polymers, chemicals and films are introduced periodically to satisfy the ever-increasing requirements of a higher standard of living or to exploit some novel property, e.g. phase change material. Changing circumstances may also provide opportu-

nities for chemical specialities; for example upper atmosphere ozone depletion has led to the use of UV absorbing agents in clothing to reduce the risk of skin cancer. Since the late 1980s there has been a boom in anti-microbial yarns and chemicals as people become more conscious of health and hygiene. Yarns with exceptional strength, such as the ultra high modulus polyethylene Spectra, have been developed. Variants of polyester have appeared which are reputed to have many of its advantages together with better moisture management and softer handle and drape. WL Gore have developed a new yarn based on PTFE with 50% higher tensile strength than existing yarns. This can be used in structural and architectural applications, and when coated with PTFE, it becomes a coated material made from the same polymer, which is likely to facilitate recycling or ultimate disposal. There could be opportunities to develop coated products with these new yarns. An attempt has been made to produce a matrix for innovative product development in Tables 1.8 and 1.9.

New 'foam-in-place' and 'one-shot' manufacturing techniques in the automotive industry have produced new applications for foams or films which are laminated to fabric. In the former technique a car head rest, for example, is made by sewing the head rest cover into a 'bag' into which liquid chemicals are poured. These chemicals react to form the polyurethane foam inside the headrest cover. The foam, which is usually a high density, low porosity type, prevents the liquid components seeping through the fabric before the reaction is complete. In the latter case the fabric, laminated to a film, is put into a mould and hot liquid polymer is injected on to it to form a rigid component such as a door casing. The film prevents the hot polymer seeping through to the face of the fabric. These techniques combine several steps into a single process. Variants of this technique could be used in the manufacture of other articles and components in other industries. However, it is notable that, even in these high tech operations, the trimming of edges is still done by hand. Engineers still strive to eliminate manual handling by the use of robots.

Anti-wicking yarns have been developed for tarpaulins and covering materials. There is much activity in re-examining the use of natural fibres for use in composite structures and for the automotive industry. Resins made from natural products are being developed; possible coating resins may be also be produced from naturally occurring renewable sources. Some of the major chemical companies are focusing on biotechnology for polymer production.[6] It has been suggested that eventually we will be able to tailor make a polymer of a fibre which with have virtually any property required. Biosynthesis of molecules is believed to be more versatile and more precise than chemical methods. In addition, the manufacturing processes could require less capital and also be environmentally cleaner with less pollution, and the products themselves perhaps more biodegrad-

able. However, LCA should be applied to both existing and any alternative technology or product.

The weak points in any garment are the seams. This is especially so for those garments intended for protection against water or maybe some other more harmful liquid. Seam design is a subject for garment technologists, but at the end of the day, when the garment is sewn, holes are made. Seams are generally taped in up market garments, but as wearers know, some seams are better than others. Welded seams are better, but not all materials are suitable, and welding, if not done carefully, can result in creasing and puckering. The Welding Institute believes they have a solution for this problem in a new laser-based process which could replace sewing in garment production, including water-resistant garments.

Surface science research continues to lead to a better understanding of the factors which determine good adhesion, and newer techniques are being developed to pretreat surfaces including those of fibres.[7] Plasma treatment has already led to significantly improved adhesion in polyurethane fabric coating, and could also produce benefits in other areas of coating and lamination. These techniques may possibly lead, not only to new products, as the result of being able to join materials which could not previously be joined together satisfactorily, but also to coating processes taking place at reduced temperatures and faster speeds. In the case of lamination, reduced levels of adhesive may be possible, and these steps would produce significant economic as well as environmental benefits.

Small independent companies may not have the resources for research, but there may be opportunities to join a consortium for collaborative research, possibly with government or even EU funding. The textile departments of universities, and especially BTTG, are usually well informed on these matters. The UK government is currently funding the TechniTex Faraday Partnership to promote improved interaction between the UK science, engineering and technology base and the technical textile industry. A prime objective is to turn the scientific and technological knowledge available in UK universities and research organisations into commercial success. The involvement of small companies is emphasised in the network, which is being built up to produce a proactive interface between industry and academia. The intention is that this will lead to academic excellence, industrial innovation and best practice in technical textiles. The exercise is being co-ordinated by BTTG and involves Heriot-Watt, UMIST and Leeds University.

7.4 Environmental aspects

As discussed in Chapter 6, the environment is likely to have a higher profile from now onwards. This is going to affect both chemical manufacturers and

coating and lamination factories, as potentially toxic chemicals are brought under more control and emissions to atmosphere are restricted more stringently. Technology already exists to control virtually all manner of emissions; applying it to commercial operations is a matter of cost. New EC legislation has further tightened up regulations which in the 1980s and 1990s were themselves regarded as exacting, and this trend is likely to continue. The use of solvents is likely to continue to fall and perhaps disappear completely. The use of even water-based products may become unacceptable at some stage because of their relatively high energy demand in the evaporation of water – 539 calories/g. Both solvent and water-based adhesives are likely to be replaced more and more by 100% solids or hot melt materials, which require less energy for processing and hence produce less overall emissions. The appearance of reactive, moisture curing polyurethane adhesives has allowed high peel bonds to be achieved at low levels of adhesive add-on and gives softer handle in laminated garments. These adhesives have formed a new benchmark for fabric adhesives. Ways of saving energy are being explored on a number of fronts. Rohm and Haas and other resin manufacturers have researched low temperature crosslinking acrylic resins since before the 1980s, but recently a consortium including Oil States Industries (Aberdeen), Freudenburg (Wallsend), BP and Robinson Brothers (West Bromwich) have initiated a project to develop ultra fast cure accelerators for rubber.[8] The objective is to enable rubber to be cured at much lower temperatures than normal, thus saving energy. The UK government is contributing to the cost of the research through its Energy Efficient Best Practice Programme.

Environmental protection can be combined with significant economic benefit, as has been shown by certain companies, e.g. Heathcoats. The government is encouraging combined energy saving schemes, and factories where these are already in place report significant savings in cost and energy. Allowances in the new 'Climate Change Levy' on fuel (the so called carbon tax) should result in more energy efficient processes. Increased landfill tax will make landfill the last option with more effort put into recycling and composting. In the long term, these measures may well have harmful effects on the coating and lamination industry, since it basically joins two or more materials together which, at present, are generally dissimilar chemically. The disposal of coated fabrics does not appear to be a serious issue at the time of writing, but it does need serious consideration, especially if the coating contains heavy metal stabilisers, other additives and FR chemicals. Incineration, if not conducted efficiently, could lead to harmful emissions, especially dioxins, which could arise from chlorine containing materials. The residual ash from incineration, which may contain potentially harmful materials such as heavy metals in a now more concentrated form, needs to be disposed of, and some type of landfill seems the only option,

even with all the possible risks. The debate continues as to whether incineration with energy recovery, now referred to as EfW, is the way forward. Most environmentalists agree, however, that recycling must increase, and there may well come a time when coated and laminated materials will come under scrutiny.

More LCAs are now being conducted, and indeed this is a feature of the ISO 14000 group of standards. Natural products are not necessarily the most environmentally friendly materials. Cotton is being recognised as quite environmentally unfriendly when the pesticides required for the growth of the cotton plant and the considerable wet processing required to produce a cotton garment are taken into consideration. In addition, the energy and detergent necessary to launder cotton goods compared to synthetic fibres should not be forgotten. We may see more use of bast fibres and of hemp, regarded by some environmentalists as the most environmentally friendly fibre. Is there any information on the coating adhesion of fabric coating polymers on specialist natural fibres such as pineapple fibre or hemp? Biodegradable polymers or polymers derived from renewable resources continue to be developed – can any of these be used in fabric coating, either as a resin or filler?

Disposable garments, such as surgeons' gowns and other items used in the medical sector, are presenting a disposal problem, and the search is on for materials with the necessary performance standards which are also washable, sterilisable and reusable. Laminated fabrics are being considered as possibilities; the results of 'cradle to grave' analyses will be interesting. The expected growth in incontinence devices and garments is likely to lead to disposal problems, and there may be an opportunity for comfortable, washable, reusable items which could be produced from coated fabrics. There may be parallels with and lessons to be learnt from other areas, presenting further possibilities for coated and laminated fabrics. Before the appearance of disposable nappies and diapers, there was a market for coated baby pants which could be machine washed and reused many times. Products of this type may well reappear and the disposable culture may well recede.

The joining of two or more dissimilar materials may eventually be discouraged as not being environmentally friendly. At the present time, consideration is being given to reduced VAT on products bearing eco-labels, and this may well put certain coated and laminated materials at a disadvantage.[9] The Oeko-tex label is being used more and more, and it is gaining wider recognition not only in Europe but also in Japan and the USA. Probably the long term future lies in producing laminates from materials of a similar chemical type, an example being the replacement of polyurethane foam laminated to polyester fabric for car seat fabric by polyester nonwoven material. By doing this, a laminate with similar, but by no means

identical properties is obtained from a laminate comprising two chemically similar materials which can be conveniently recycled. Research is being conducted to produce water-based polyester resins, which could be coated on to polyester fabric to give barrier properties. One material used quite widely in laminated fabrics is PTFE, which at present cannot be easily recycled. However, the actual volume must be quite small in comparison to, say, PVC, which has been the subject of recycling projects for a number of years. Possibly some laminated goods could be produced with a 'measured' amount of adhesion, so the two chemically dissimilar materials could be separated at the end of the articles' life to facilitate recycling. This concept has already been mentioned in the Crea Tech process, see Section 6.5.7. Government funding is available through WRAP, a non-profit-making company, which has been set up to increase recycling and to develop stable and efficient markets for recycled materials.

Another possibility is to extend the use of mechanical means of temporarily fastening two materials together, such as hook and loop fasteners which are much stronger than most people appreciate. As with the automotive industry, the time may well come when, before anything is actually made, the method of disposal or recycling possibilities will be considered. The public is now much more educated in environmental affairs, and some environmentally unfriendly processes or materials may have to be discontinued or replaced, not only due to government legislation or to pressure group action, but also because of pressure from major customers who themselves wish to appear as 'green' as possible.

7.5 New opportunities

Many problems remain unsolved in certain areas – for example American firemens' turnout uniforms weigh 50–70 pounds which is far from ideal – and answers are still sought for problems in ecologically friendly comfortable medical protective clothing. Airbags, probably the largest growth area in technical textiles, require coating, usually on both sides, with an expensive resin, and opportunities for further innovations probably exist in fabric, polymer and film development. New materials still appear, such as phase change material and memory shape materials, for which applications are still being developed. From papers delivered in the Aventex Symposium in Frankfurt, it seems that clothing sales in the developed world have gradually declined since the 1970s. The growth areas are now travel, computers, cellular phones, leisure activities and medical and health products. If cosmetics and body care can be combined with some textile article, it could produce new areas and outlets for technical textiles. People are more aware of health factors, such as dust mites and possible toxic materials in everyday items such as carpets. Perhaps coated or laminated products could be

devised to control, prevent, screen or help remove these agents. The coating and laminating technologist should keep up to date with the world around him or her, because opportunities for new applications may arise at any time. Examples are the fuel tank linings made from coated Kevlar for Concorde and the use of PVC coated linen in place of sandbags for flood control. The fear of terrorist activity is boosting sales of gas masks and NBC type clothing, not only for the military but also for the general public.

Coating presents opportunities for the exploitation of new materials, which may be either made into a coating resin or a film for lamination, or added as a filler to a resin. There is scope for synergies with the film and packaging industries, which are larger than the textile coating industry and have larger development budgets. Whatever can be done with a film can be done with a textile via a coating process or by laminating the pre-prepared film on to a fabric. More lateral thinking is necessary to exploit inventions or novel properties in other industries and technologies, or even those occurring in nature, and apply them to textile coating and laminating. Some world changing inventions have been made using relatively simple established technology in a novel manner. An example is 'post it' note paper which exploits the novel properties offered by microencapsulation spheres and pressure sensitive adhesives (see Tables 1.8 and 1.9). Researchers need to be constantly alert to new possibilities and requirements which may be entirely unconnected with a job in hand. The search is on for new angles or something that will make a particular product stand out from the rest, e.g. the kettle which changes colour when it has boiled. The new science of nanocomposites is producing materials with quite extraordinary properties – could they be exploited in some way if combined with the flexibility and covering power of a coated or laminated fabric? An example of an ingenious application requiring considerable technical input is the mobile phone cover made from coated waterproof fabric, which incorporates electronic components and is also actually the keyboard for the mobile phone.

We have entered the exotic age of 'smart fabrics' and 'intelligent clothes', and with a tremendous variety of base fabrics and resins and novel substances to put into coatings as additives, there has never been a better time to innovate.[10–13] With NanoSphere (Schoeller) technology[14] plus a little more innovation, the 'Man in the White Suit', which never needs washing and lasts for ever, may well become a reality! Chameleon effects (i.e. changing colour or pattern according to the environment) could be exploited in novel fashion clothing as well as being of practical and strategic value for the military. The automotive industry and others are developing a culture of continuous improvement and innovation which, if sustained, will certainly take us into new areas and product development – in addition to allowing annual 'cost downs'! A single garment suitable for all weathers, hot or cold, dry or wet, and which never needs cleaning may well be possible in the

fullness of time! Failure to solve a particular problem in the past should not deter another fresh attempt, because times change; new materials and technology appear all the time, and these may make a solution possible. As in any science the horizons are limited only by the imagination of the research and development scientist, but they must have the support of management and equally imaginative sales and marketing departments. There are going to be technical problems to solve, but to the true scientist and technologist these are merely challenges to be overcome to open the door to worthwhile benefits or at least to further development opportunities.

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8

Sources of further information

8.1 General comments and suggestions

The coating and lamination sectors of the technical textiles industry are constantly changing and advancing, although not as fast as some other areas. However, new information, materials and applications continue to be produced and to present new opportunities. Keeping up to date is time consuming but need not be difficult, provided staff know where to look, i.e. which relevant journals to read and which conferences and exhibitions to attend. This section lists some sources of information likely to be useful to all involved with coating and lamination. Attending conferences and exhibitions is an excellent way of keeping up to date and making personal contacts. The coating and lamination technologist must be aware of current world affairs to be able to use his or her imagination and ingenuity to exploit new materials to solve a particular problem, or to offer an improvement on an existing product. Recent examples are the development of fabrics using the latest ultra high modulus polyethylene fibre to contain terrorist bombs on aircraft, the use of a flexible Kevlar composite to reinforce the fuel tanks of Concord against puncture, and the use of coated fabrics to protect property during the recent floods in England. Regular reading of general science magazines, such as *New Scientist* and *Scientific American*, and quality newspapers can stimulate innovative development work to improve existing products or to develop new ones.

Sportswear and equipment consume significant quantities of coated fabric, and regular reading of magazines devoted to pursuits such as walking, sailing and golf is recommended. The quarterly trade publication *World Active Sportswear* is written with significant scientific content and is essential reading for researchers and sales staff. The journal also issues an annual directory and buyers' guide. Regular conferences, for example the *Survival* conferences convened by Leeds University, and exhibitions devoted to sportswear and equipment provide an excellent forum for interchange of news and views. There are also specialist journals on industrial

protective clothing, medical textiles, civil engineering, the building industry, the furniture industries and fire research and prevention. These journals could stimulate novel ideas and new applications. The paper, film and foil converting industries, whose production volumes are much greater than the coating and laminated textiles sector, could also provide inspiration, especially on production and handling aspects. These industries face some of the same problems, such as static build up, creasing and rollers not running true, cutting and general conversion and environmental challenges, etc.

The prime publication for coated fabrics was undoubtedly the *Journal of Coated Fabrics*, which was published for 28 years by Technomic Publishing of the USA. This journal first appeared in July 1971 with the objectives of disseminating information on the coating and lamination industries and associated areas and providing a forum for discussion amongst those working in them. During these 28 years of publication, high quality articles covering virtually every aspect of fabric coating and lamination appeared in the journal, and the back issues are a tremendous mine of information. Unfortunately the October 1999 edition, Vol 29 No 2, was the last issue to be published, but material on coating and lamination will continue in Technomic's *New Journal of Industrial Textiles*. The publisher will continue to sponsor the annual International Conference on Textile Coating and Lamination, which it has done since the first took place on 6–7 November 1991. A coated fabrics symposium is also organised regularly in the USA by the Association of American Textile Chemists and Colorists (AATCC), and BTTG (Shirley Institute) have hosted conferences in England. In September 1999, Unitex and Centexbel organised the 1st European Symposium on Textile Coating and Laminating. These regular forums signify the importance and potential of the coating and lamination of textiles.

Publications of the Textile Institute and World Textile Publications Ltd are invaluable in keeping up to date with both the academic and the more industrial aspects of textiles in general. World Textile Publications also publish a range of commercial directories on chemicals, textile companies and textile markets, e.g. Eastern Europe and China. For general wet processing, the *Journal of The Society of Dyers and Colourists* and its annual *Review of Progress in Coloration* are excellent sources of information with extensive references. The monthly *International Dyer* features topical news and views and well presented articles of a more practical nature. World Textile Publications also produce invaluable directories such as *Index to Textile Auxiliaries*, and directories of textile agents and dyers and finishers in the UK and abroad.

Fabric coating and lamination are closely linked to plastics, and journals of the plastics industry regularly feature news and information. *Plastics and Rubber Weekly* reports the latest news and developments and regularly features technical items and specialist articles. *British Plastics and Rubber*, *European Plastics News* and the American publication *Modern Plastics*

International all regularly feature news items and technical papers of relevance to the textile coating and lamination industry. News on the related area of fabric composites also appears frequently. The Institute of Materials, now incorporating the Plastics and Rubber Institute, is a professional body, which keeps its members informed of the latest developments through publications and conferences.

In addition to the conferences and symposia listed below, many additional ones are organised regularly by the Textile Institute, the SDC and the Institute of Materials. Local and regional branches of these bodies meet regularly. Universities and research organisations such as BTTG (British Technology Textile Group), SATRA (Shoe and Allied Trades Research Association), and RAPRA Technology also organise conferences and run short courses. The University of North London offer workshops on rubber compounding and processing, which have the support of the Institute of Materials. The Center for Professional Advancement regularly runs courses on technical subjects, including polymer compounding, plastics additives and coating processes in the USA and Europe.

The IFAI, whose activities are at present mainly in the USA, has a growing number of members in Europe and Japan, and eventually regular meetings of the local branches will be held. The IFAI have specialist divisions, the relevant ones being Marine Fabricators Association, Awning Division, Truck Cover and Tarpaulins Association, Safety and Protective Products Division and the Transportation Division. Composites symposia are organised by universities and by various professional bodies including the Institution of Mechanical Engineers. Nottingham University has a 'Composites Club'.

Mention must be made of the wealth of information contained in the ASTM Volumes on test methods, Vols 7.0 and 7.1 for textiles and Vol 9.02 for rubber products, including rubber coated fabrics. There are of course British Standards that are equally useful. Some researchers consider the patent literature to be the most extensive single source of information, both historical and up-to-date. Last but by no means least is the vast 'ocean' of information freely (specialist information may have to be paid for) available on the internet, which is being added to every day. The revolution in communications, information and ease of international travel is fostering 'global synergy' in research, development and innovation.

8.2 Conferences and exhibitions

8.2.1 General textile

1. *Fibre to Finished Fabrics*, organised annually by the Textile Institute usually in December in Manchester.
2. *International Man Made Fibres Congress*, held annually at Dornbirn,

Austria. In recent years automotive textiles have been featured every two years. Organised by Osterreichisches Chemiefaser-Institut Tagungsburo Dornbirn, Rathausplatz 1, A-6850 Dornbirn, or Kolingasse 1, A-1090 Vienna, Austria. The conference is sponsored and arranged in association with the CIRFS, Avenue E Van Nieuwenhuyse 4, B-1160 Brussels and the City of Dornbirn.

3. *Techtextil*, held annually in Frankfurt, Germany where about 100 papers on all aspects of technical textiles are presented. Organised by Messe Frankfurt GmbH, Postfach 15 02 10, D-60062, Frankfurt am Main, Germany. Techtextil Conferences are now also held in other regions of the world, e.g. Asia and South America.
4. *Textiles in Automobiles* (sometimes run in conjunction with the *Plastics in Automobile Engineering Conference*). Held on average every two to three years. Organised by Verein Deutscher Ingenieure (VDI), Graf-Recke-Strasse 84, D-40239 Dusseldorf, Germany.
5. *World Textile Congress*, Huddersfield, England held annually featuring different aspects. Organited by Department of Textiles, University of Huddersfield, Queensgate, Huddersfield HD1 3DH. The 2001 Conference is being hosted by Bolton Institute.

8.2.2 Other relevant conferences

1. *Camping and Outdoor Leisure Association* (COLA) Exhibition, usually held in October at Harrogate.
2. *Intabond*, conference on hot melt adhesive technology, organised every two to three years by Dermil Research Ltd, 24 Buckingham Square, Wickford Business Park, Wickford, Essex SS11 8YQ.
3. *Interplas* and *Kunstoff* are international chemical exhibitions, organised every two to three years in Birmingham (NEC) and Dusseldorf (Dusseldorfer Messegesellschaft mbH-NOWEA, D-4000 Dusseldorf, Germany).
4. *Rubber Bonding* and other conferences are organised periodically by RAPRA Technology Ltd (see Section 8.4.3), in conjunction with partners such as *European Rubber Journal*.
5. *Survival*, occasional conference for sportswear and protective clothing, organised in recent years by the Department of Textiles of the University of Leeds.
6. *Textile Coating and Lamination International Conferences*, organised annually by Technomic Publications Inc., 851 New Holland Avenue, Box 3535, Lancaster PA 17604, USA.
7. *Urethanes Technology*, organised by Crains Communications Ltd, New Garden House, 78 Hatton Garden, London ECIN 8JQ – in both Europe and Asia.

8.2.3 Materials and machinery

1. Conferences and exhibitions setup by the organisers of *Techtextil*, the Messe Frankfurt, GmbH, Postfach 15 02 10, D-60062 Frankfurt am Main, Germany, are held in Europe, but recently additional events have been held in other parts of the world including Asia and South America. They include: Interstoff – yarns for fashion and performance, *InterYarn* and *Heimatex* (household and hospitality textiles).
2. *Expofil* – European yarn exhibition, held twice annually, Rue de Neuilly, BP 121, F92113 Clichy Cedex, Paris, France.
3. *Index* – conference for non-woven fabrics, organised in Europe, usually in Geneva by EDANA – see Section 8.4.1.
4. *ITMA*, the International Textile Machinery Exhibition, is held usually every three years; the location rotates between Milan, Paris and Hanover. It is by far the largest exhibition of its type. Organised by the CEMATEX-Comite Europeen des Constructeurs de Materiel Textiles, General Secretary, Bredewater 20, Postbus 1 90, NL-2700 AD Zoetermeer, Netherlands.

8.2.4 Automotive conferences

This selection of regular conferences feature automotive development and automotive interiors in general and are not specific to textiles. In the USA, the IFAI periodically organises conferences on automotive interior trim.

1. *Automotive and Transportation Interiors Expo*, organised in the USA by the magazine of the same name.
2. *Autoplas* conferences on use of plastics in the automobile (and also recycling), organised by Schotland Business Research Inc., 16 Duncan Lane, Skillman, New Jersey 08558–2313 USA.
3. *Autotech Conference*, held annually at the NEC, Birmingham organised by Centre Exhibitions jointly with the Institute of Mechanical Engineers, Automobile Division. NEC House, Birmingham B40 1NT.
4. *Comfort in the Automotive Industry*, organised approximately every two years by the Italian Associazione Technica Dell'Automobile (ATA) and Bologna University and held at Bologna. ATA, Strada Torino, 32/A, 10043 Orbassano (TO), Italy.
5. *Inter Auto*, organised by *Inside Automotives International* in conjunction with the Turret group. Events in Europe have been held at the RAI Centre, Amsterdam. *Inside Automotives International*, ANCAR Publications Inc., 21700 Northwestern Highway, Suite 565, Southfield MI 48075 USA.

6. *ISATA* (International Symposium on Automotive Technology and Automation), an annual event organised by Dusseldorfer Messegesellschaft mbH-NOWEA, Postfach 101006, D40001, Dusseldorf, Germany.

8.3 Journals

Many of the journals publish an annual resource file, where to buy guide, yearbook and review of progress.

8.3.1 Textile journals

1. *African Textiles* (for African and Arab markets), Alain Charles Publishing Ltd, 27 Wilfred Street, London SW1E 6FR.
2. *ATI* (America's Textiles Industries), Billian Publishing Inc., 2100 Powers Ferry Road, Atlanta GA 30339 USA.
3. *Canadian Textile Journal*, Textile Technology Centre, 3000 Boulle, St-Hyacinthe, Quebec, Canada J2S 1H9.
4. *International Fiber Journal*, International Media Group Inc., 1515 Mockingbird Lane, Suite 210, Charlotte NC 28209 USA.
5. *International Nonwovens Journal*, INDA, TAPPI and ANIC – see Section 8.4.1 for addresses.
6. *International Textile Bulletin*, *Textile Leader*, International Textile Services, Univer Hans, Kessler strasse 9, CH-8952, Schlieren, Zurich, Switzerland.
7. *JTN Monthly* (Japanese Textile News), Osaka Senken Ltd, 3-4-9, Bingomachi, Chuo-ku, Osaka 541-0051, Japan.
8. *Kettenwirk-Praxis* (German, with English translations), Karl Mayer Textilmaschinenfabrik GmbH, Postbox 1120, D-63166, Obertshausen, Germany.
9. *Knitting International*, World Textile Publications – see *Textile Horizons* below.
10. *Nonwoven Industry*, Redman Publications Inc., 70 Hilltop Road, 3rd Floor, Ramsey NJ 07446, USA.
11. *Nonwovens Report International*, World Textile Publications Ltd, see *Textile Horizons* below.
12. *Textile Asia*, Business Press Ltd, California Tower 11th Floor, 30–32 D'Aguilar Street, Hong Kong.
13. *Textile Horizons*, The Textile Institute and World Textile Publications Ltd, Perkin House, 1 Longlands Street, Bradford, West Yorkshire BD1 2TP.
14. *Textile Month*, World Textile Publications – see *Textile Horizons* above.

15. *Textiles World*, Maclean Hunter Publishing Co., 29N Wacker Drive, Chicago IL 60606 USA.

8.3.2 Technical textiles

1. *AATCC Review*, AATCC, see Section 8.4.1.
2. *Chemical Fibers International*, issued six times a year with annual Year Book, IBP International Business Publishers Gmbh, Mainzer Landstrasse 251, D-60326 Frankfurt am Main, Germany.
3. *Clothing and Textiles Research Journal*, International Textiles and Apparel Association Inc., PO Box 1360, Monument CO 80132–1360 USA.
4. *High Performance Textiles*, monthly newsletter from International Newsletters – see *Technical Textiles International* below.
5. *Industrial Products Review*, published by IFAI USA, see Section 8.4.1.
6. *Industrial Textiles*, published by Impact! on behalf of MUTA, see Section 8.4.1.
7. *International Textile Bulletin*, *Yarn and Fabric Forming*, International Textile Services, see Section 8.3.1.
8. *Journal of the Textile Machinery Society of Japan*, Osaka Science and Technology Center Building (Utsubo Park), 8-4 Utsubo-hommachi 1-chome, Nishi-ku, Osaka 550, Japan.
9. *New Journal of Industrial Fabrics*, Technomic Publishing Company Inc., 851 New Holland Avenue, Box 3535, Lancaster PA 17604 USA, and in Europe Missionsstrasse 44, CH-4055 Basel, Switzerland.
10. *Melliand Textilberichte* (also *Melliand English*), 60264, Frankfurt am Main, Germany.
11. *Technical Textiles International* (with annual Where to Buy Guide), International Newsletters, PO Box 133, Witney, Oxford OX8 6ZH.
12. *Technische Textilien* (German with English Translations), PO Box 10 0606, D-6000 Frankfurt am Main, Germany.
13. *Textile Research Journal*, TRJ Princeton, 601 Prospect Avenue PO Box 625, Princeton NJ 08542 USA.
14. *Textiles Usage Textiles* (TUT) (French with English summaries), Euredia SA – editorial collaboration with the French Textile Institute, 16 Rue Ballu F-75311, Paris Cedex 09 France.

8.3.3 Dyeing and finishing

1. *American Dyestuff*, *Reporter*, Promenade A, Suite 2, Harmon Cove Towers, Secaucus NJ 07094 USA.
2. *International Dyer*, World Textile Publications Ltd, – see *Textile Horizons* in Section 8.3.1.

3. *International Textile Bulletin, Dyeing*, *Finishing*, *Printing*, International Textile Services, see Section 8.3.1.
4. *Journal of the Society of Dyers and Colourists* (with annual Review of Progress in Colouration and annual Resource File), SOC, see Section 8.4.1. for address.
5. *Textile Chemist and Colorist*, AATCC, see Section 8.4.1.

8.3.4 Plastics and chemicals

1. *British Plastics and Rubber*, MCM Publishing Ltd, 37 Nelson Road, Caterham, Surrey CR3 5PP.
2. *European Adhesives and Sealants* (with annual Year Book), FMJ International Publications, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS.
3. *European Plastics News*, Emap Maclaren, Maclaren House, 19 Scarbrook Road, Croydon, Surrey CR9 1QH.
4. *Modern Plastics International* (with annual Buyers Guide), McGraw Hill, Modern Plastics International, PO Box 605, Hightstown NJ 08520 USA.
5. *Plastics and Rubber Weekly*, EMAP Business Communications, Ruislip, Middlesex HA4 9LT. The Journal of the Malaysian Rubber Research and Development Board, Tun Abdul Razak Centre, Brickendonbury, Hertford, SG13 8NL.
6. *Rubber World Magazine*, PO Box 5451, Akron OH 44334-0451 USA.
7. *Urethanes Technology*, Crain Communications Ltd, see *Urethanes Technology* in Section 8.2.2.

8.3.5 Composites

1. *Advanced Composites Bulletin*, monthly International Newsletters – see *Technical Textiles International* (Section 8.3.2).
2. *Composite Science and Technology*, Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB.
3. *Material Science*, Institute of Materials, see Section 8.4.3.
4. *Plastics, Rubber and Composites*, Institute of Materials, see Section 8.4.3.

8.3.6 The environment

1. *The ENDS Report*, Environmental Data Services Ltd, Finsbury Business Centre, 40 Bowling Green Lane, London EC1R 0NE.
2. *Energy and Environmental Management*, DEFRA, Ashdown House, 123 Victoria Street, London SW1E 6DE.

3. *Environment*, Heldref Publications, 1319 Eighteenth Street NW, Washington DC 20078-6117, USA.
4. *Environmental Manager*, Monitor Press, Suffolk House, Church Field Road, Sudbury, Suffolk CO10 2YA.
5. *Environment Business Magazine* (annual Directory), Information for Industry Ltd, 4 Valentine Place, London SE1 8YX.
6. *Environment Monthly*, Informa Publishers Ltd, 69–67 Paul Street, London EC2A 4LQ.
7. *Environment Times*, Beckhouse Media, 22 Warwick Street, Adlington, Lancashire PR7 4JQ.
8. *European Environment*, John Wiley and Sons, Baffins Lane, Chichester, West Sussex PO19 1UD.
9. *EUWID Recycling and Waste Management*, PO Box 1332, D-76586 Gernsbach, Germany.
10. *Material Recycling Week*, EMAP Maclaren Ltd, 19 Scarbrook Road, Croydon CR9 1QH.

Other environmental contacts include:

11. The Environment Agency, Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol BS32 4UD. The Department of the Environment publish a large amount of free literature on environmental matters, energy conservation and other issues. Free advice is offered as well as information on technical matters, environmental legislation, conferences and seminars. They have a telephone helpline 0800 585794 (in the UK) and have a web site http://www.etsu.com/etbpp/
12. The EU also produce information on the environment – the general contact is Office for Official Publications of the European Communities, L-2985 Luxembourg.
13. The National Centre for Business and Ecology, Peel Building, University of Salford, Manchester M5 4WT.
14. The National Society for Clean Air and Environment Protection (NSCA), 136 North Street Brighton BN1 1RG. NSCA issue their *Pollution Handbook* every two or three years and also publish a series of well written and well presented information leaflets for the general public.
15. Warren Springs Laboratory (UK DTI Environment), Hertfordshire. Helpline 0800 585794.

Web sites:

16. Department of the Environment, *www.detr.gov.uk/*
17. The Environmental Agency, *www.environment-agency.gov.uk/*
18. US Environmental Protection Agency, *www.epa.gov/*

8.3.7 Automotive journals

1. *Automotive & Transportation Interiors* (with annual Where to Buy Guide), 6255 Barfield Road, Suite 200, Atlanta GA 30328-4300 USA.
2. *Automotive Engineering* (a publication associated with SAE of the USA), PO Box 5004, Pittsfield MA 01203-9990 USA.
3. *Automotive Industries AI*, 201 King of Prussia Road, Radnor PA, or 3011 W. Grand Boulevard, Ste. 2600 Detroit MI 48202 USA.
4. *Automotive Interiors International*, Turret-RAI plc., Armstrong House, 38 Market Square, Uxbridge, Middlesex UB8 1TG.
5. *Automotive News Europe*, Crain Communications Ltd, see *Urethanes Technology* in Section 8.2.2.
6. *Automotive World Publications*, Financial Times, Maple House, 149 Tottenham Court Road, London W1P 9LL.
7. *Inside Automotives International* (with annual Where to Buy Guide), ANCAR Publications Inc., 21700 Northwestern Highway, Suite 565, Southfield MI 48075 USA.

8.3.8 More specialist technical journals

1. *Converting Today*, Angel Business Communications Ltd, Kingsland House, 361 City Road, London EC1V 1PQ.
2. *Film, Foil and Paper Converter*, PO Box 12978, Overland Park KS 66282–2978 USA.
3. *Filtration and Separation*, Elsevier Advanced Technology, PO Box 150, Kidlington, Oxford OX5 1AS.
4. '*Fire*' (and Fire group of journals), DMG World Media (UK) Ltd, Queensway House, 2 Queensway, Redhill Surrey RH1 1QS.
5. *Geotechnical Fabrics Report*, official publication of the Geosynthetic Materials Division of IFAI USA, see Section 8.4.1.
6. *Journal of Coatings Technology*, 492 Norristown Road, Blue Bell PA 19422–2350 USA.
7. *Journal of the International Geosynthetics Society*, The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB.
8. *Journal of Science and Medicine in Sport*, MS Ester Guerzoni, Sports Medicine Australia, PO Box 897, Belconnen ACT 2616, Australia.
9. *World Sports Activewear* (international magazine for sports textiles and apparel), PO Box 6, 36 Crosby Road North, Liverpool L22 0QN.

8.3.9 General interest scientific journals

1. *Focus*, G + J of the UK, Portland House, Stag Place, London SW1E 5AU.

2. *Nature*, Porters South, 4 Crinan Street, London N1 9XW.
3. *New Scientist*, Reed Business Information Ltd, 151 Wardour Street, London WIV 4BN.
4. *Science*, American Association for the Advancement of Science, 1200 New York Avenue NW, Washington DC 20005, USA.
5. *Scientific American*, 415 Madison Avenue, New York, NY 10017-1111 USA.

8.3.10 Popular sports magazines

1. *On the Hill*, Maze Media (2000) Ltd, 89 East Hill, Colchester, Essex CO1 2QN.
2. *Outdoor Pursuits Magazine*, Tudorseed Limited, Unit 3, Ripon House, 35 Station Lane, Hornchurch, Essex RM12 6JL.
3. *Practical Boat Owner*, Westover House, West Quay Road, Poole, Dorset BH15 1JG.
4. *Practical Caravan*, Haymarket Magazines Ltd, 60 Waldegrave Road, Teddington, Middlesex TW11 8LG.
5. *The Rambler* (official magazine of the Ramblers' Association), 1–5 Wandsworth Road, London SW8 2XX.
6. *Yachting World*, Kings Reach Tower, Stamford Street, London SE1 9LS.

8.4 Technical and professional organisations and institutions

8.4.1 Textile organisations

1. AATCC (American Association of Textile Chemists and Colorists), PO Box 12215, Research Triangle Park NC 27709-2215, USA.
2. American Flock Association, c/o NTA Bolgen, 230 Congress Street, Boston MA 02110 USA.
3. American Textile Manufacturers Institute, 1130 Connecticut Avenue, NW-Suite 1200, Washington DC 20036-3954, USA.
4. ANIC (Asia Nonwoven Fabrics International Conference), Soto Kanda 6 Chome, Building 3Fl, 2–9 Chiyoda-ku, Tokyo 101, Japan.
5. Association of Nonwovens Fabric Industry, PO Box 1288, Cary NC 27512, USA.
6. British Textile Machinery Association, 20 Ralli Courts, West Riverside, Manchester M3 5FL.
7. BTTG (British Textile Technology Group), Shirley House, Wilmslow Road, Didsbury, Manchester M20 2RB.
8. Canadian Textile Institute, 66 Slater Street, Ste 1720, Ottawa, ON K1P 5H1, Canada.

9. CENTEBEL, National Textile Research Centre, Belgium Technologiepark, B-9052, Zwjinaarde, Belgium.
10. CIRFS (Comité International de la Rayon et des Fibres Synthetiques), Avenue E Van Nieuwenhuyse 4, B-1160 Brussels.
11. DCTA (Defence Clothing and Textiles Agency) (formerly SCRDE – Stores, Clothing, Research and Development Establishment – of the MOD), Flagstaff Road, Colchester, Essex CO2 7SS.
12. DWI (Deutsches Wollforschungsinstitut), Veltmanplatz 8, D-52062 Aachen, Germany (German Wool Institute – Organisers of the annual *Aachen Textile Conference*).
13. EDANA (the European Disposables and Nonwoven Association), 157 avenue Eugene Plasky, Bte 4-1030 Brussels, Belgium.
14. Ghent University, Dept of Textiles, Techologiepark 9, 9052 Gent Zwijnaarde, Belgium.
15. Hohenstein Institutes, Schloss Hohenstein, D-74357 Boennigheim, Germany.
16. IFAI (International Industrial Fabrics Association). Several divisions including a Transportation Division and European and Japanese Branches. IFAI USA, 1801 County Road B W, Roseville MN 55113-4061 USA. European Office: IFAI Europe, Marcel Thirylaan 204, B-1200 Brussels, Belgium. Japanese Office: IFAI Japan, 3-8-9 Nishidai, Itami, Hyogo 664, Japan.
17. INDA (Industrial Nonwovens and Disposable Association), 1700 Broadway 25th Floor New York, NY 10019 USA.
18. Institut Textile de France, Avenue Guy de Collongue-B.P. 60-69123 Ecully Cedex, France.
19. MUTA (Made-Up-Textiles Association) Ltd, 42 Heath St Tamworth, Staffordshire B79 7J.
20. The Nonwovens Network, BTTG WIRA House, West Park Ring Road, Leeds LS16 6QL.
21. North Carolina State University, Dept of Textiles, Box 8301, Raleigh NC 27695-8301, USA.
22. Osterreichisches Chemiefaser, Kolingasse 1, A-1090 Vienna, Austria.
23. Sachsisches Textil Forschungs Institut, Annaberger Strasse 240, D-09125, Chemnitz, Germany.
24. SATRA (The Shoe and Allied Trades Research Association), SATRA House, Rockingham Road, Kettering, Northants NN16 9JH.
25. SDC (Society of Dyers and Colourists) (publishes monthly journal and annual resource file), PO Box 244, Perkin House, 82 Gratton Road, Bradford, West Yorkshire BD1 2JB.
26. Swedish Institute for Fibre & Polymer Research (IFP), Box 104, SE-431 22 Molndal, Sweden.

27. Swiss Federal Laboratories For Materials Testing and Research, Lerchenfeldstrasse 5, CH-9014, St Gallen, Switzerland.
28. TAPPI (Technical Association of the Pulp and Paper Industry), PO Box 105113, Atlanta GA 30348, USA.
29. The Textile Institute, St James's Buildings, Fourth Floor, Oxford Street, Manchester M1 6EJ.
30. The Textile Technical Institute (AKZO Nobel), Kasinostrasse 19–21, D-42103 Wuppertal, Germany.
31. TNO, Institute of Industrial Technology (Netherlands), Centre for Textile Research, NL-2600 JA Delft, Netherlands.
32. UNITEX (Union of High Members of Belgium Textiles), Rivierstraat, 19/102, B-9080 Beervelde, Belgium.
33. Verband de Flockindustrie eV (Association of the Flock Industry), Tannenberger Strasse 66/62 D-72760 Reuttingen, Germany.
34. WIRA (Wool Industries Research Association) Technology (BTTG), West Park Ring Road, Leeds LS16 6QL.
35. Woolmark Company, Valley Drive, Ilkley, West Yorkshire LS29 8PB.
36. Wools of New Zealand, Design and Development, Little Lane, Ilkley, West Yorkshire LS29 8UG.

8.4.2 Some UK universities/institutions with textile departments

1. Bolton Institute, Deane Road, Bolton BL3 5AB.
2. Heriot-Watt University, Scottish Borders Campus (formerly Scottish College of Textiles), Netherdale, Galashiels, Selkirkshire TD1 3HF.
3. Huddersfield University, Queensgate, Huddersfield HD1 3DH
4. Leeds University, Leeds LS2 9JT.
5. Manchester Metropolitan University, John Dalton Building, Chester Street, Manchester M1 5GD. Hollins Facility (Garment Design & Development).
6. Nottingham Trent University, Burton Street, Nottingham NG1 4BU.
7. Royal College of Art (Postgraduate Art & Design/Textile Design), Kensington Gore, London SW7 2EU.
8. UMIST, PO Box 88, Manchester M60 1QD.

8.4.3 Plastics, rubber and composites

1. APME (Association of Plastics Manufacturers in Europe), Avenue E. Van Nieuwenhuyse 4, Box 3, B-1160 Brussels, Belgium.
2. BPF (British Plastics Federation), 6 Bath Place, Rivington Street, London EC2A 3JE.

3. British Rubber Manufacturers' Association Ltd, 90 Tottenham Court Road, London W1P 0BR.
4. The Center for Professional Advancement, Box 1052, 144 Tices Lane, East Brunswick, NJ 08816-1052, USA.
5. Institute of Materials, 1 Carlton House Terrace, London SW1Y 5DB.
6. The Malaysian Rubber Producers' Research Association, Tun Abdul Razak Laboratory, Brickendonbury, Hertford SG13 8NL.
7. Nottingham University Composites Club, School of Mechanical Materials, Manufacturing Engineering and Management, University of Nottingham, University Park, Nottingham NG7 2RD.
8. RAPRA Technology Ltd (Rubber Industries Research Association), Shawbury, Shrewsbury, Shropshire SY4 4NR.
9. SAMPE (Society of Advanced Materials and Process Engineers), International Business Office, 1161 Parkview Drive, Covina, California 91724-3748 USA.
10. SATRA Footwear Technology Centre, see Section 8.4.1.
11. The School of Polymer Technology, University of North London, Holloway Road, London N7 8DB (run courses in rubber technology and compounding).
12. The Society of Plastics Engineers, 14 Fairfield Drive, PO Box 403, Brookfield CT 06804-0403, USA.
13. VDI-Gesellschaft Kunstofftechnik (VDI-K), Graf-Recke-Strass 84, 40239 Dusseldorf, Germany (Institute of German Engineers – Technical Plastics).

8.4.4 Joining technology/other research organisations

1. FIRA (Furniture Industries Research Association), Maxwell Road, Stevenage, Herts SG1 2EW.
2. Laboratory of the Government Chemist, Queens Road, Teddington, Middlesex TW11 0LY.
3. Loughborough University, Institute of Surface Science and Technology, Ashby Road, Loughborough, Leics LE11 3TU.
4. National Physics Laboratory, Teddington, Middlesex TW11 0LW.
5. Oxford Brookes University, Joining Technology Research Centre, Oxford OX3 0BP.
6. SAE (Society of Automobile Engineers), 400 Commonwealth Drive, Warrendale, PA 15096-001, USA.
7. TWI (The Welding Institute), Abington Hall, Abington, Cambridge CB1 6AL. N.B. 'Welding' encompasses all joining techniques – including adhesives.

8. Warrington Fire Research Centre Ltd, Holmesfield Road, Warrington WA1 2DS.

8.4.5 Testing and standards

1. AATCC (American Association of Textile Chemists and Colorists), see Section 8.4.1.
2. ANSI (American Standards Institute), 11 West 42nd Street, 13 Floor, New York, NY 10036-8002, USA.
3. Association Francaise de Normalisation, F-92049 Paris, La Defense Cedex, France.
4. ASTM (American Society for Testing and Materials), 1916 Race Street, Philadelphia, PA 19103-1187, USA.
5. BSI (British Standards Institution), 389 Chiswick High Road, London W4 4AL.
6. CEN (The European Committee For Standardisation), Central Secretariat, Rue de Stassart 36, B-1050 Brussels, Belgium.
7. Detroit Testing Laboratory Inc, 7111 E Eleven Mile, Warren, MI 48092, USA.
8. DIN (Deutsches Institut fur Normung), Burggrafenstrasse 6, D-10787 Berlin, Germany.
9. Ente Nazionale Italiano di Unificazione, Via Battistotti Sassi 11/b 1-20133 Milano, Italy.
10. International Organisation for Standardisation, Central Secretariat, 1 Rue de la Varenbe Case Postale 56, CH-1211, Geneva 20, Switzerland.
11. Japanese Industrial Standards Committee, Department of Standards, Industrial Science and Technology Agency, Ministry of International Trade and Industry, 1-3-1, Kasumigaseki, Chiyoda-ku Tokyo 100.
12. Korean National Institute of Technology and Quality, 1599 Kwanyang-dong, Dongan-ku, Anyang City Kyonggi-Do 430-060, Republic of Korea.
13. Secretary of the International Oeko-Tex Association, Oko-Tex Association, Postfact 585, CH-8027, Zurich.
14. Swiss Federal Laboratories for Materials Testing and Research, Lerchenfeldstrasse 5, CH-9014, St Gallen, Switzerland.
15. United States Testing Inc., 1415 Park Ave., Hoboken, NJ 07030, USA.

8.4.6 Recycling organisations

1. Bureau of International Recycling, 24 Avenue Franklin Roosevelt, 1050 Brussels, Belgium. Web site *www.bir.org*
2. Textile Recycling Association, PO Box 124, Huntingdon, Cambridgeshire PE18 7DP (Forum on Recycled Textiles).

8.5 Market information on technical textiles industry

1. David Rigby Associates (DRA), Peter House, St Peter's Square, Manchester M1 5AQ. *www.davidrigbyassociates.com*
2. Datamonitor Plc., 106 Baker Street, London W1M 1LA. *www.marketprofiles@datamonitor.com*
3. The Economist Intelligence Unit, PO Box 200, Harold Hill, Romford, Essex RM3 8UX.
4. Euromonitor, 60-61 Britton Street, London EC1M 5NA.
5. Freedonia Group Inc, 767 Beta Drive, Cleveland OH 44143-2326, USA.
6. IFAI (Industrial Fabrics Association International), 1801 County Road, BW Roseville MN 55113-4061, USA (Members).
7. Intercontuft (Automotive Fabrics), 3080 Tervuren, Moorelboslaan 15, Belguim.
8. Textile Outlook International, 10 Beach Lane, Wilmslow, Manchester M1 5AQ.

8.6 General further reading

8.6.1 Coating and laminating of textiles

There are very few textbooks devoted to this subject, apart from the following. Much of the available literature is in the form of articles and papers, manufacturers' technical information leaflets and manuals and proceedings of the *International Coating and Laminating Conferences* organised by Technomic (11 consecutive years 1990–2001), AATCC in the USA, BTTG (Shirley Institute) in the UK and Unitex/Centebel in Europe.

1. Holker JR. *Bonded Fabrics*, Merrow Monograph MM/TT/14 Merrow, Watford 1975.
2. Lennox Kerr P (Editor), *Flexible Textile Composites*, Textile Trades Press/WRC Smith, Manchester/Atlanta 1973.
3. Van Parys M, *Coating*, Eurotex (EEC Comet Program), Guimaraes 1994.
4. Wypych J, *Polymer Modified Textiles*, New York, John Wiley 1988.

8.6.2 Textile reference

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8.7 Glossary of unfamiliar terms and abbreviations

These are for information only in the context of technical textiles and coating and lamination. Many of the terms will be familiar to those in the plastics, rubber and adhesive industries but unheard of by the average textile technologist. They are not official definitions, and the list is not intended to be exhaustive. A *Textile Terms and Definitions* publication is available from the Textile Institute, and in addition there are the various ASTM Terminology documents: D 123 relating to textiles, D 3990–93 (1998) relating to fabric defects, D 4391–93a relating to burning behaviour of textiles, D 907 relating to adhesives, D 883–98 relating to plastics, D1566–99a

abbreviated terms relating to plastics, D 1566a relating to rubber, D 1517–98 relating to leather and F 1494–94 relating to protective clothing.

AATCC – Association of American Textile Chemists and Colorists
ABS – acrylonitrile-butadiene-styrene plastic. Not to be confused with automatic braking system
ALREM – Association of Load Restraint Equipment Manufacturers
APME – Association of Plastics Manufacturers in Europe
ASTM – American Society for Testing and Materials
ATH – aluminium trihydrate (FR agent)
BATNEEC – best available techniques not entailing excessive cost (for prevention of release of harmful substances to the environment)
BCF – bulked continuous filament
Benchmarking – a procedure which compares competitive products to one's own and then seeks to establish the 'best practice'
BOD – biological oxygen demand
BPF – British Plastics Federation
BRITE EURAM – Basic Research for Industrial Technologies in Europe, European Research in Advanced materials. (EU sponsored research)
BSI – British Standards Institution, hence BS = British Standard
BS AU – British Standard Automobile Series
BTTG – British Textile Technology Group
CAD – computer assisted design
CAM – computer assisted manufacturing
CEFIC – European Chemical Industry Council (Federation)
CEN – Comite European de Normalisation
CFC – chlorofluorocarbons, chemicals once used in refrigeration, foam making, etc. Identified as damaging to the environment and now being phased out worldwide
CHIP – Chemical hazard information and packaging regulations
CIELAB – Commission International du Eclairage (LAB refers to colour differences calculated)
CIRFS – Comite International de la Rayonne et des Fibres Synthetiques (Brussels)
COD – chemical oxygen demand, the amount of oxygen needed to purify effluent
COSHH – Control of Substances Hazardous to Health
CR – chloroprene (e.g. Neoprene, DuPont)
CRAG – Composite Research Advisory Group (UK Ministry of Defence)
Crosslinking – *see* curing
CRE – constant rate of extension
CRL – constant rate of load
CSM – chlorosulphonated polyethylene (e.g. Hypalon – DuPont)

CTR – constant rate of traverse
Curing – crosslinking of a compound or resin
DBDO – decabromodiphenyl oxide (FR agent)
DCTA – Defence Clothing and Textile Agency (UK)
DEFRA – Department of the Environment, Food and Rural Affairs (UK)
DIN – Deutsches Institut fur Normung (German Standards Institute)
Dioxins – a generic term applied to groups of chemicals including polychlorinated dibenzo-*p*-dioxins (PCDDs) and chlorinated dibenzofurans. They are sometimes created as by-products in certain combustion processes and some are extremely toxic
DMF – dimethylformamide
EDANA – European Disposables and Nonwovens Association
EfW – energy from waste
ELV – end-of-life vehicle. Vehicle that has come to the end of its useful life – sometimes referred to as EOL – end-of-life vehicle
EMAS – European Eco-Management and Audit Scheme
EMS – Environmental Management System
Energy recovery – the useful energy produced by using waste material as fuel
EOL – *see* ELV
EPDM – ethylene propylene diene monomer rubber
EPM – ethylene propylene monomer rubber
EVA(c) – ethylene vinyl acetate
FAAS – flame atomic absorption spectroscopy
FAKRA – Fachnormenausschuss Krafflahzeuge – German body for automotive standards – probably best known in textiles' industry for accelerated light stability test, DIN 75202
FES – flame emission spectrophotometry
FISITA – International Federation of Automotive Engineering Societies
FKM – fluoro-elastomer (Viton, DuPont)
FMEA – failure mode and effects analysis – a systematic procedure to assess the potential failure of a component or process and its effects and, to establish ways to prevent re-occurrence
FPM – hexafluoropropylene vinylidene fluoride (Viton – DuPont)
FR – flame retardant properties
FRP – fibre reinforced plastic
FTIR – Fourier transform IR (analysis)
GC – gas chromatography, an analytical method
GLC – gas liquid chromatography, an analytical method
GRP – glass reinforced plastic
GRU – glass reinforced urethane
GRV – gross vehicle weight
HDPE – high density polyethylene

HMPE – high modulus polyethylene
HT – high tenacity – a term applied to yarns of above average tensile strength, i.e. generally in excess of 7 g/dtex
IFAI – Industrial Fabrics Association International
IMMFC – International Man-Made Fibres Congress (Dornbirn, Austria)
IMO – International Maritime Association
INDA – Industrial Nonwoven and Disposables Association (USA)
IPC – integrated pollution control
IPPC – integrated pollution prevention and control
IR – infra red
ISO – International Standards Organisation
ISOPA – European Isocyanate Producers' Association (Polyurethane Industry) – an organisation within the European Chemical Industry Federation (CEFIC)
ITMA – International Textile Machinery Association (Exhibition every four years in Europe)
JAR – Joint Aviation Regulations
JIT – just in time
LCA – life cycle analysis – a method of assessing a product or process for impact on the environment which takes into consideration every factor, from the raw materials, through production, distribution, use and final disposal. Also referred to as 'cradle to grave' analysis
LCP – liquid crystal polymer – used in instrument panel displays
LDPE – low density polyethylene
LLDPE – linear low density polyethylene
LOI – limiting oxgen index, FR test used mainly by researchers
LS – low shrinkage
MEK – methyl ethyl ketone
MF – melamine formaldehyde
MFI – melt flow index – viscosity measurement for molten polymers and adhesives
MOD – Ministry of Defence
MPW – mixed plastics waste
MUTA – Made up Textiles Association
MVP – moisture vapour permeability (of perspiration)
MVTR – moisture vapour transfer (of perspiration)
NAMAS – National Measurement Accreditation Service – by the NPL (UK)
NBC – nuclear, biological and chemical protection
NBR – acrylonitrile butadiene rubber
NBS – National Bureau of Standards (US)
NFPA – National Fire Protection Agency (USA)

NPL – National Physics Laboratory (UK)
NR – natural rubber
NSCA – National Society for Clean Air and Environmental Protection (UK)
NVH – noise, vibration and harshness
OEL – occupational exposure limit (of chemicals)
OEM – original equipment manufacturer of automobiles, i.e. Ford, BMW, etc
PA – polyamide, known also as nylon – designated with numbers which relate to the starting materials from which they are made, e.g. nylon 6, nylon 66, nylon 46, etc
PAN – polyacrylonitrile, usually refers to acrylic fibre, e.g. Courtelle
PBDE – polybrominated diphenyl ethers
PBI – polybenzimidazole, a material with very high FR properties
PBTP – polybutylene terephtalate, a polymer related to PET, with more stretch in yarn form and a lower melting point
PCB – polychlorinated biphenyls
PCDD – see dioxins
PE – polyethylene
PET – polyethylene terepthalate, known commonly as polyester
PO – polyolefin, a general chemical term used to describe plastics made from polyethylenes and polypropylenes
PP – polypropylene
PPE – personal protective equipment
PRAVDA – Project Altfahrzeugverwertung Deutscher Automobilhersteller (German automobile manufacturers used vehicle recycling project)
Prepreg – an assembly of fibres impregnated with resin which will be formed into a composite by curing
PSAB – pressure sensitive adhesive backed
PSB – polystyrene – butadiene rubber
PTFE – polytetrafluoroethylene
PU – polyurethane, interior trim can be made from polyurethane polyester foam or from polyurethane polyether foam. In the trade they are referred to as 'polyester foam' or 'polyether foam', and even simply as 'ether' and 'ester'. Not to be confused with polyester
PUR, (PU) – polyurethane
PURRC – Polyurethane Recycle and Recovery Council (of the Society of the Plastics Industry – USA)
PVA(c) – polyvinyl acetate
PVA(l) – polyvinyl alcohol
PVC – polyvinylchloride

PVDC – polyvinylidene chloride
PVDF – polyvinylidine fluoride
QS 9000 – quality system based on IS0 9000 specially designed for the auto industry
Rad XL PP – radiation crosslinked polypropylene (foam)
RAPRA – Rubber and Plastics Industry Research Association (UK)
RF – radio frequency
SAE – Society of Automotive Engineers (USA)
SAMPE – Society of Advanced Materials and Process Engineers (composites)
SBR – styrene butadiene rubber
SCRDE – Stores, Clothing, Research and Development Establishment
SDC – Society of Dyers and Colourists (UK)
SEPA – Scottish Environmental Protection Agency
SERA – Socialist Environmental and Resources Association
SI – Systeme International des Unites
SME – small medium enterprise
SPC – statistical process control
SUV – sports utility vehicle
Tack – the property of an adhesive to form a measurable bond, immediately it is brought into contact with a surface under low pressure. Sometimes referred to as 'grab' or 'green tack'
Taguchi Methods – statistical techniques for prototyping and optimising product and process design
TDI – toluene di-isocyanate
TI – Textile Institute
TLV – threshold limit value
TPE – thermoplastic elastomer
TPO – thermoplastic polyolefin
TPU – thermoplastic polyurethane
TQM – total quality management
UF – urea-formaldehyde
UL – Underwriter's Laboratory (e.g. for FR testing)
UNCED – United Nations Conference on the Environment
UV – ultra violet
VDI – Verein Deutscher Ingenieure – Association of German Engineers
Viscosity – the perceived resistance of liquids to flow ('thickness')
VOC – volatile organic compound
Vulcanisation – a crosslinking process which improves the properties of rubber materials
WIRA – Wool Industries Research Association