BRITISH LIQUID CRYSTAL SOCIETY

LIQUID CRYSTAL NEWS

August 2000

Professor Frank M Leslie FRS
1935 – 2000

A deep sense of shock and grief spread through the liquid crystal community here in the UK, and also world wide, when it became known that Frank Leslie had died on June 15, 2000, at the age of 65, following complications after what should have been a routine hip replacement operation. I personally found it very hard to believe that this had happened, and I know that others – Roy Sambles, Harry Coles, John Goodby, Helen Gleeson and Cliff Jones – who like me travelled to Glasgow to attend the Memorial Service for Frank, held in the Barony Hall of the University of Strathclyde, also shared this feeling, even after the service. This was conducted with great sensitivity before a very large company of people, and Professor David Sloan, Head of the Department of Mathematics, spoke very touchingly about the scientific achievements and personality of this man whom we all knew and loved for the warmth of his personality.

Frank's death, coming so soon after the British Liquid Crystal Society Meeting in Strathclyde, was particularly poignant, for there he spoke with his usual wit and charm at the Conference Dinner which was in fact held to mark his retirement from full-time academic duties. Ellen Leslie was of course present and sadly much of the conversation afterwards related to the retirement "doon the Clyde" that they both looked forward to so much at Hunters Quay near Dunoon.

Those of us who attended the International Liquid Crystal Conference in Sendai will know too of the grief and disbelief felt by the international community over Frank's death, and I was particularly touched that the Japanese organisers, through Professor Yokoyama, had arranged a period when all delegates could attend a meeting not only to mourn Frank's death, but also to be thankful for his life. I was privileged to make the memorial address on that occasion and there were tears in many an eye, including mine, when a picture was shown of Frank at the Strathclyde BLCS Meeting, so shortly before he died.

A full, very sensitive obituary for Frank Leslie has been written by Professor Tim Sluckin of Southampton University and will appear shortly in an issue of the journal of Liquid Crystals. This details much of Frank's

professional career and achievements, but some aspects should be mentioned here. Born in Dundee in 1935 and educated there at the Harris Academy and then at Queen's College Dundee, a college of the University of St Andrews, Frank obtained a first in Mathematics in 1957. He then moved to Manchester University and completed his PhD there in 1961 for work on aspects of fluid flow. By then an Assistant Lecturer, Frank was awarded a one year Research Associateship at MIT where most significantly he first met Jerry Ericksen and learned of his work on anisotropic fluids.

Frank returned to England as Lecturer in Mathematics at Newcastle University where he remained until 1968, in which year he went to the Johns Hopkins University in Baltimore at Ericksen's invitation and, at Ericksen's suggestion, began his studies on the continuum mechanics of anisotropic fluids, building on Ericksen's earlier work. Two highly important publications stemmed from this work which overcame the earlier problems of Anzelius in generalising the theory of Sir Charles Frank to the dynamic regime and in effect gave us the standard continuum theory of liquid crystals. One of Frank's last publications, with Tomas Carlsson, in fact traces the historical evolution of this theory and was published just a year ago in 1999 in the September issue of Liquid Crystals, Vol **2 7**, 1267-1280. It is not always realised that Frank Leslie's work on the viscosity coefficients of nematics and the provision of the Leslie-Ericksen Elastic Theory of Liquid Crystals in

the late 1960s was of vital importance to the smooth development of the liquid crystal display industry. Because of the understanding of nematics that Frank Leslie provided, display device manufacture could be based on a confident and real understanding of the nematic materials being used.

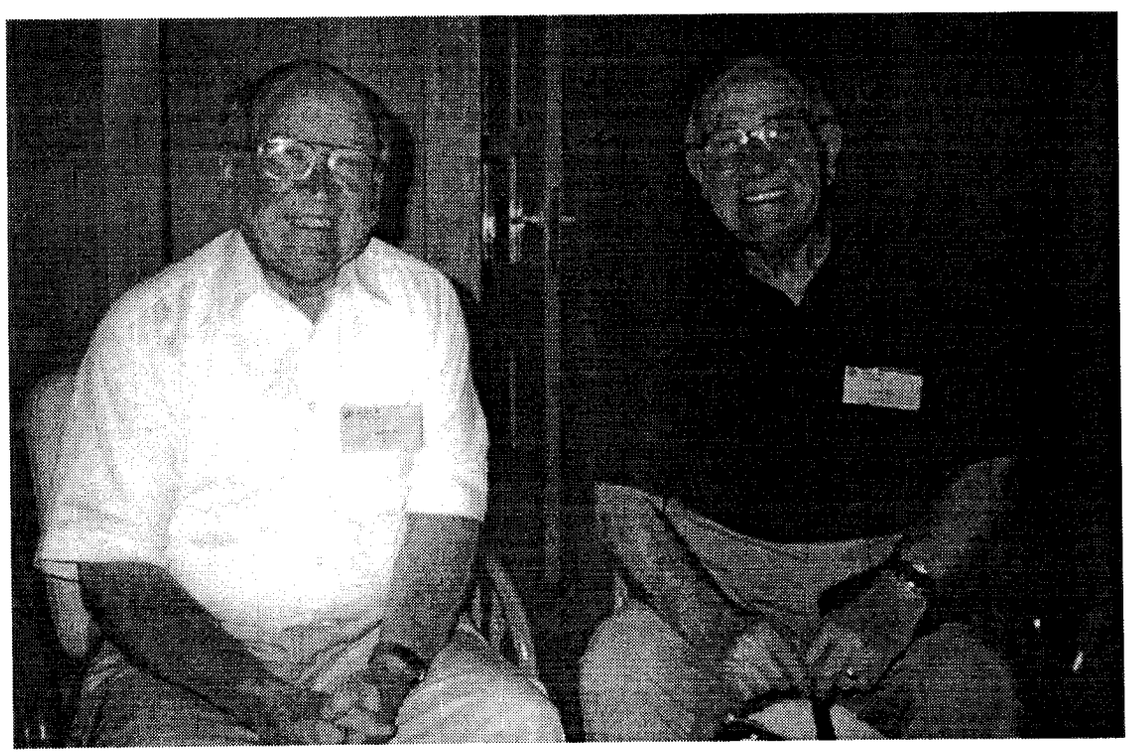
By the time such devices had become predominant, Frank was at the University of Strathclyde where his later research work turned to smectics for which the viscosity coefficients were greater in number and complexity. Again this work has impacted beneficially on the commercialisation of displays involving smectics, such as ferroelectric antiferroelectric displays.

However, it is for his work on nematics that Frank Leslie is best known and it is for this that honours and awards came his way – Visiting Professorships in four Universities, Fellowship of the Royal Society of Edinburgh (1980), Membership of the Johns Hopkins Society of Scholars (1980), Awardee of the British Society of Rheology (1982), Sykes Gold Medal of the University of St Andrews (1996), George Gray Medal of the British Liquid Crystal Society (1997), but the crowning distinction was surely the award of Fellowship of the Royal Society of London in 1995, and I am proud to have been his proposer for candidature there.

Whilst we remember his mathematical expertise and the achievements which have made his name so well-known, we also remember Frank as a warm and loveable person, quite unaffected indeed by the awards and recognition that came his way. He loved his native Scotland dearly and was indeed an ardent Scottish Nationalist; it is very cruel that he has been denied his retirement in the grandeur of Argyll.

Frank was a loving husband and father, and indeed, just recently a grandfather, and a loyal friend to many of us in the Society of which he was such an effective Chairman from 1987 to 1991. We are all deeply saddened by what has happened and I am sure that all members of the Society join me in extending our deepest sympathy of his wife, Ellen, and our assurance that should she ever need our help, this will be readily given.

George Gray



2000 BLCS Young Scientist Prize Lecture

Biaxiality in the smectic C phase near to a chevron interface

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Considerable effort has been expended in recent years on the development of continuum theories for smectic C (S_C) and chiral smectic C ferroelectric liquid crystals (S_C^* or FLC). This research has been partly motivated by scientific interest, but also because of the considerable potential for exploitation of ferroelectric liquid crystals in display devices. Commercial interest has largely centred on understanding the structures formed and the switching within surface–stabilized homogeneously aligned cells. One of the most characteristic structures found within these cells is the 'chevron'. This was first observed in surface–stabilized ferroelectric liquid crystal (SSFLC) cells using x–ray diffraction [1,2] and confirmed optically using a guided mode technique [3]. The chevron structure has subsequently been found in thicker cells [4] and in the smectic A (S_A) phase [5]. In the original x–ray experiments the presence of two peaks in the diffraction trace corresponded to equal and opposite layer tilts, $\pm\delta$, with a sharp transition between them, see Fig. 1(a). Rieker *et al* [2] demonstrated the independence of the layer tilt, δ, on the treatment of the cell surfaces, and its dependence on the cone angle θ. Such experimental studies have estimated the chevron 'tip' thickness to be $\approx 10^{-8}$ m [2].

Clark *et al* [7] put forward the original theoretical model of the chevron, which explained it in terms of a *kink* or discontinuous change in the smectic layering (Fig. 1). In Figure 1(a) we see that the layer normal, **a**, lies in the xz plane and the layer orientation may be described simply by the layer tilt angle δ. In one half of the cell the layer tilts in one direction (i.e. $\delta>0$) whilst in the other half of the cell the layer tilts in the opposite direction (i.e. $\delta<0$). As indicated in Fig. 1, in the smectic C phase the nematic–like director, **n**, is

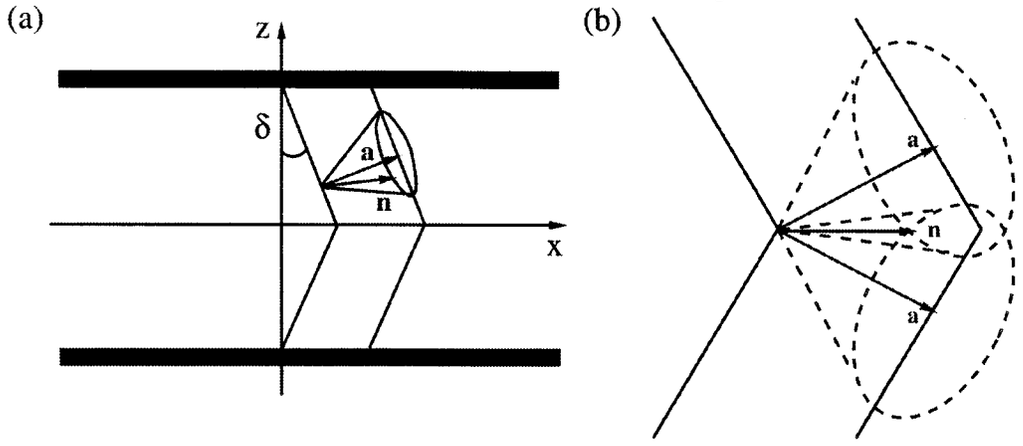

Figure 1:
(a) A pictorial representation of a chevron in a surface stabilized FLC cell.
(b) The matching condition at the chevron interface which ensures continuity of the director structure.

tilted with respect to the layer normal and may rotate around the *smectic cone* (the director within the layer can therefore be described in terms of the cone angle θ and the azimuthal angle around the smectic cone, ϕ, see Fig. 2). It is this freedom that allows the director to maintain a continuous configuration across the chevron interface. This is illustrated in Fig. 1(b). The director must lie on the smectic cone in the top half of the cell and the bottom half of the cell. Therefore, at the interface the director is restricted to lie at the

intersection of the two smectic cones associated with the upper and lower tilted layers. There are two points of intersection at which the director may lie and it is between these two positions that the director switches in ferroelectric liquid crystal devices. Although this model has a discontinuity in the layer tilt δ, the **n**–director structure is continuous at the chevron interface.

The chevron structure is believed to form due to the mismatch between a prescribed S_A layer thickness at the cell surfaces and the layer thickness within the bulk of the cell which is determined by the smectic cone angle θ. So as the cone angle increases in the bulk of the cell the layer thickness decreases whilst at the surface the layers remain of the same thickness as S_A state. This layer thickness mismatch will be satisfied by tilting the layers away from the cell surface normal, thus increasing the effective layer thickness in the x direction.

An alternative, but equivalent, way of looking at chevron formation is to consider the density of the material. As the cone angle increases the layer thickness decreases and were the layer to remain of the same *length* the density of the material would change. However, the liquid crystal may be taken as effectively incompressible and therefore the density cannot change. The density can remain constant if the layer increases in length to compensate for the decrease in thickness. In a fixed finite cell this increase in layer length causes a buckling of the layer, i.e. the chevron forms.

Since the simple model described by Clark *et al* was proposed, a number of other models of the chevron interface have been put forward [8–13]. Generally, a feature that these models have in common is that the discontinuity in δ is avoided by allowing one or more of the parameters of the system such as the layer tilt, δ, the cone angle, θ, the azimuthal angle around the smectic cone, ϕ or the layer thickness, to vary smoothly within the cell.

One of the drawbacks of these models is that they do not include the inherent molecular biaxiality of the smectic C phase (see Fig. 2). This macroscopic biaxiality of the smectic C phase is related to a hindered rotation about the molecular long axis which for chiral, polar molecules will induce a spontaneous polarization.

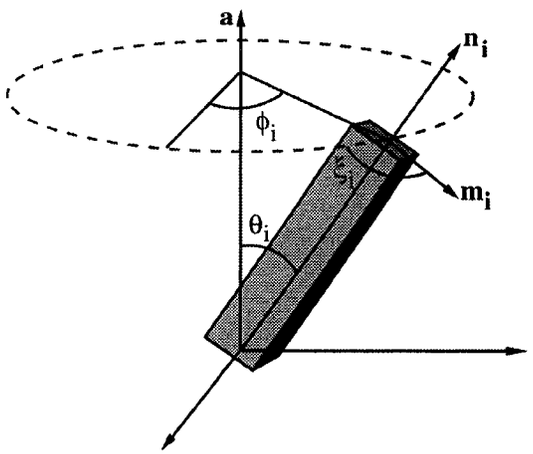

Figure 2: Configuration of the biaxial liquid crystal molecule. The vector **a** is parallel to the smectic layer normal. The major molecular axis, $\mathbf{n}_i$, is described by the cone angle, θ_i, and the azimuthal angle, ϕ_i. A secondary molecular axis, $\mathbf{m}_i$, is described by the angle, ξ_i.

Figure 2 shows a biaxial molecule, in a simplistic representation, as a rectangular cuboid with no equal side lengths. The macroscopic variable **a** is defined as the vector normal to the smectic layer whilst the variables $\mathbf{n}_i$, $\mathbf{m}_i$, θ_i, ϕ_i, and ξ_i are defined for *each* molecule. In this paper we will assume that the order parameters associated with the molecular distribution of θ_i and ϕ_i are constant and thus the macroscopic director $\mathbf{n}=\langle\mathbf{n}_i\rangle$ can be defined by the macroscopic variables **a**, $\theta=\langle\theta_i\rangle$ and $\phi=\langle\phi_i\rangle$. Where $\langle\ \rangle$ denotes the thermal average of the variable. The vector $\mathbf{m}_i$ is in the direction of the permanent molecular dipole of the molecule whilst ξ_i is the angle of rotation of the molecule about the long axis. We will assume that the average value $\mathbf{m}=\langle\mathbf{m}_i\rangle$ remains constant and perpendicular to **a** and **n** (i.e. tangential to the smectic cone) whilst the order parameter defined by $S = \langle\cos(2\ \phi_i\ )\rangle$ is allowed to vary [14]. This definition implies that when all molecules are perfectly aligned with **m** (i.e. $\mathbf{m}_i=\mathbf{m}$ or $\xi_i=0$ for all molecules) then S=1, and when the molecules are randomly oriented around the molecular long axis (i.e. $\mathbf{m}_i$ or ξ_i are random) then S=0. When

the molecules are all perpendicular to **m** (i.e. $\mathbf{m}_i.\mathbf{m}=0$ or $\xi_i=\pi/2$ for all molecules) then S=–1. This description allows us to consider the macroscopic biaxiality of the liquid crystal as a material property which may vary through the cell. In a uniaxial state such as the smectic A phase the molecules freely rotate around the molecular long axis and therefore S=0. However, in a smectic C state in which the molecules are hindered from rotating around the long axis there will be some amount of ordering of the **m** director and there will exist a non–zero biaxiality, i.e. S≠0. The importance of this biaxiality will now become evident when we consider the chevron interface.

Figure 3 illustrates the importance of including the biaxial order parameter in our description of the chevron. We are now looking end on to the layers depicted in Fig. 1. If the biaxial order parameter is non–zero the statistical distribution of the **m** director will be elongated along the tangent to the smectic cone as shown in Fig. 3. In an FLC material this would result in the spontaneous polarization lying tangential to the smectic cone. Figure 3(a) shows that on either side of the chevron interface there exists a mismatch of the molecular distributions and a corresponding mismatch of the polarization vectors. It is obvious that such a discontinuity is rectified by insisting that the biaxial order parameter is zero at the chevron interface so that the system is uniaxial there [Fig. 3(b)]. As we will see later, since the biaxial order parameter is coupled to the smectic cone angle θ, the condition that S=0 at the chevron implies that θ will also change in this region.

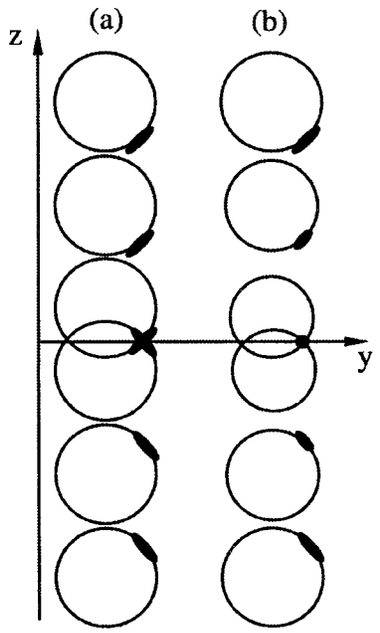

Figure 3: (a) With a fixed value of the biaxial order parameter, S, there exists a discontinuity of molecular distributions at the chevron interface.
(b) If the biaxial order parameter is allowed to vary, S may be continuous at the chevron interface.

Although biaxial order is known to exist in SSFLC cells through the existence of a spontaneous polarization none of the presently published models of chevron structures include it. With the above description of macroscopic biaxiality we will extend the original model of Clark *et al* to include continuity of biaxial ordering at the chevron interface.

A full description of the theoretical model, analytic solutions and numerical results may be found in the more detailed paper [17]. In this short paper we will briefly describe the model and outline the important numerical results. We start with a simple description of the bulk of the liquid crystal sample. Using a Landau expansion in terms of the cone angle θ and the biaxial order parameter S the free energy density is written as

$$f_{bulk}=f_0+\frac{A}{2}\theta^2+\frac{B}{4}\theta^4-\frac{Q}{2}S\,\theta^2+\frac{3}{4}C\,S^2.$$

The first three terms are simply the standard Landau expansion terms for the free energy density close to the smectic A to smectic C phase transition, the cone angle θ being the relevant order parameter. The parameter A is dependent on temperature and is such that when A>0 the energy terms are minimized by θ=0, i.e. the smectic A phase, whilst when A<0 the energy terms are minimized by a non–zero value of θ, i.e. the smectic C phase. The fourth term represents the interaction between the cone angle and the biaxiality. Here we assume that increasing the cone angle causes an increase in the biaxiality. The last term stabilizes a finite biaxiality state in the smectic C phase and ensures that the stable state in the smectic A phase is the S=0 uniaxial state. This bulk free energy density, when minimized with respect to θ and S, leads to the equilibrium values

$$\theta_e=\sqrt{\frac{3AC}{Q^2-3BC}},\quad S_e=\frac{Q}{3C}\theta_e^2.$$

In a bulk sample of the liquid crystal material the cone angle and biaxial order parameter are given by the above formulae. The smectic C state therefore exists when $AC/(Q^2-3BC)>0$. It is possible to prove that for a stable solution to exist then we must have B>0, C>0 and $Q^2-3BC<0$. Which means that, as expected, A must be negative, i.e. the temperature must be below the smectic A–smectic C transition temperature.

To model the layer structure within a cell we must also include gradient terms in θ and S in order to model any variations of these variables through the cell. Since we are interested in the behaviour around the chevron interface we may justifiably assume that the azimuthal angle is constant either side of the interface. The free energy density of the layer now becomes

$$F=\frac{2\alpha}{\lambda}\left(\frac{d\Theta}{dZ}\right)^2+\frac{1}{\lambda}\left(\Theta^2-(1-\lambda)\right)^2+\left(\frac{d\sigma}{dZ}\right)^2+\sigma\left(\sigma-2\Theta^2\right),$$

where we have defined new scaled variables $\Theta=\theta/\theta_e$ and $\sigma=S/S_e$. The new parameters λ and α are defined as

$$\lambda=\sqrt{\frac{Q^2}{3BC}},\quad \alpha=\sqrt{\frac{3CK'}{2B\kappa\vartheta_e^{\,2}}},$$

where κ and K' are effective elastic constants. The z coordinate has been nondimensionalised using

$$Z=z/\sqrt{\frac{2\kappa}{3C}}=z/\zeta.$$

To complete the mathematical description of the system we must set boundary conditions. We will concentrate on the region close to the chevron interface and because the cell is symmetric we need only consider half of the cell. So we set boundary conditions at the interface (z=0) to be S=0 and dθ/dz=0 or in our new scaled variables σ=0 and dΘ/dZ=0. The first of these ensures the system is uniaxial at the interface, as previously discussed and illustrated in Fig. 3(b), whilst the second condition is a 'natural' boundary condition ensuring that there is no internal resultant torque on the director in the bulk of the cell. The conditions away from the chevron interface are that the two variables θ and S attain their equilibrium values. So as $z\to\infty$, $\theta\to\theta_e$ and $S\to S_e$ or in the new scaled variables $\Theta\to 1$ and $\sigma\to 1$. By minimizing the free energy we obtain two equations in Θ and σ. In our full paper [17] we solve these equations analytically and numerically although here we will simply present illustrative numerical results.

The full equations are solved numerically using the continuation package AUTO97 [15,16] and the results, for different values of the parameter λ, are shown in Fig. 4.

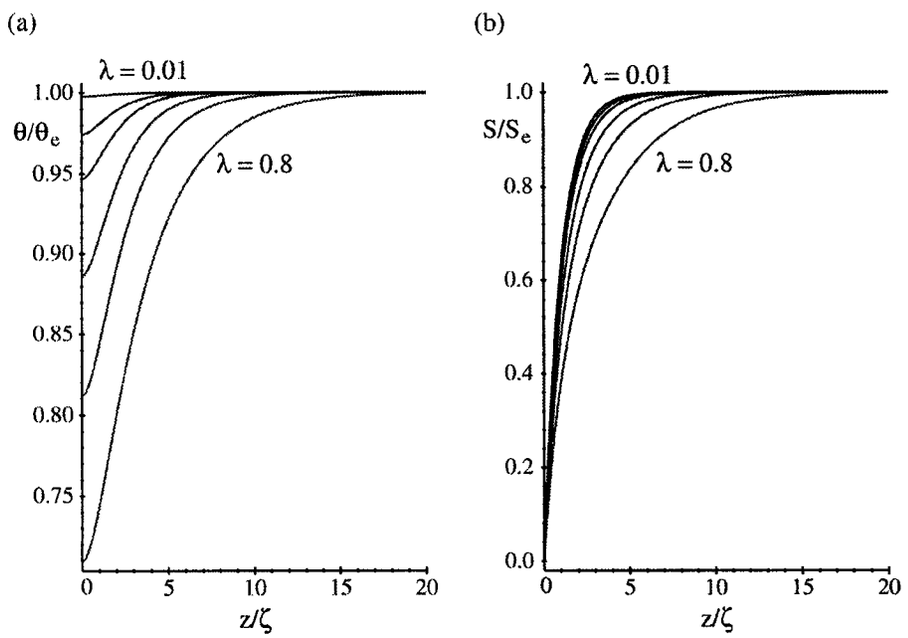

Figure 4: The variation of (a) the tilt angle, θ, and (b) the biaxial order, S, near to the chevron interface (which is located at z=0) for various values of the parameter λ.

As expected, the biaxial order parameter S varies smoothly from it's equilibrium value in the bulk of the cell ($z \rightarrow \infty$) to zero at the interface (z=0), see Fig. 4(b), whilst the cone angle θ is slightly reduced from its equilibrium value at the interface, Fig. 4(a). This reduction is caused by the intrinsic coupling between the order parameter and the cone angle. Since S=0 and θ=0 in the smectic A phase, any forced reduction in S (i.e. the presence of the interface) will induce a reduction in θ in order to minimize the thermodynamic free energy of the system. From Fig. 4(a) it can be seen that there may be a significant reduction in the cone angle at the chevron interface. Using appropriate experimental techniques, i.e. guided mode studies, it may be possible to detect such behaviour.

Apart from the purely scientific interest in finding the correct structure of the chevron interface, the continuity of biaxial ordering at the chevron interface has an important technological consequence for chiral smectic C materials. In the bulk of a S_C^* liquid crystal there exists a spontaneous polarization due to a permanent molecular dipole. However, the rotational symmetry of the state S=0 implies that there is zero polarization at the chevron interface. This result may be extremely important when considering ferroelectric devices, which switch through the coupling between the spontaneous polarization and an applied electric field. The question is, how does this reduction in polarization, at the very point where switching occurs, affect the switching characteristics of the cell?

The authors wish to thank Dr. M. J. Towler for useful discussions and the EPSRC and Sharp Laboratories of Europe (SLE) Ltd for financial support. NJM would also like to thank the British Liquid Crystal Society for the Young Scientist Award 2000.

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Professor Lev Blinov
2000 GW Gray Medal Winner

Congratulations to Lev Blinov who was awarded this year's GW Gray medal by the British Liquid Crystal Society in honour of his contribution to liquid crystal research. The medal was presented at the 2000 BLCS annual meeting in Strathclyde. A more detailed description of Lev's life and work will be appear in the next issue of Liquid Crystal News.

BLCS Young Scientist Prize

This award is for researchers under the age of 30 who have made a significant contribution to Liquid Crystal Science. It would normally be expected that such a person would have published several research papers in this area and that they would have made presentations at both National and International conferences. Generally, but not necessarily always, the recipient will be continuing research work in the area of liquid crystals. Ideally, the recipient will have shown some evidence of independent research by the time of their award, but BLCS is aware that the age limit means that this will not always be the case.

Once the closing date is passed each year, the BLCS Chair will assemble a small group of appropriately qualified people to consider the nominations and to make recommendations for the award. This small group will be chosen such that they are not directly connected to any of the nominees.

The prize-winner is asked to give an oral presentation of the work on which the award is based at the Annual BLCS conference and then to write an overview of the work for the BLCS Newsletter. The prize takes the form of a framed certificate and a cheque for £200.

Most recipients will have undertaken a PhD in liquid crystals and will have continued as a Post Doctoral Researcher. The list of previous award winners illustrates well the qualities expected of the recipient:

- 1990 Duncan Bruce (Experimental Chemist, now Professor in Chemistry at Exeter)
- 1991 Steve Elston (Experimental Physicist, now lecturer in Engineering at Oxford)
- 1992 Mark Wilson (Computational Chemist, now lecturer in Chemistry at Durham)
- 1993 Corrie Imrie (Physical Chemist, now Reader in Chemistry at Aberdeen)
- 1994 Cliff Jones (Experimental Physicist, now SPSO at DERA Malvern)
- 1995 Andrew Emerson (Computational Chemist, now Research Scientist, CNR)
- 1996 Guy Bryan-Brown (Experimental Physics, now DERA Fellow at DERA Malvern)
- 1997 Diane Ulrich (Experimental Physics, now researcher at Sharp Laboratories)
- 1998 Richard Miller (Experimental Physicist, now Senior Scientist at DERA Malvern)
- 1999 Martin Bates (Computational Chemist, now EPSRC Advanced Fellow, Southampton)
- 2000 Nigel Mottram (Theoretical Physics, now lecturer in Applied Mathematics at Strathclyde)

Cliff Jones does it again!

2000 Charles Vernon Boys Medal and Prize from the Institute of Physics

Cliff Jones of the Defence Evaluation and Research Agency (DERA) wins the Charles Vernon Boys medal and prize for his outstanding contributions to the development of liquid crystal displays. At the age of 35 he has already published over 100 papers and patents, covering areas as diverse as novel materials, electronics and panel fabrication. In particular he has been aiming to produce large flat-panel television displays and low-power flexible displays for portable equipment.

Cliff Jones is a world-leading expert in the science of ferroelectric liquid crystals. His deep understanding of these materials led him to the realisation of the important role played by the dielectric biaxiality in the switching mechanism of display devices. The biaxiality is due to the low symmetry of the ferroelectric phase and means that the material properties are different along three principal directions. Jones implemented careful methods for measuring the biaxial dielectric constants, refractive indices and elastic properties. In order to establish a complete picture of the electro-optical behaviour of the ferroelectric liquid crystal display, he pushed through a wide series of studies, including chemical synthesis, X-ray diffraction, dielectric spectroscopy, optical characterisation and theoretical modelling.

Over the past few years Jones has turned his attention to bistable nematic displays based on surface relief grating structures to align the liquid crystal. This work has attracted world-wide interest, since it offers the prospect of low power, plastic displays that retain their image in the absence of an electrical field, even when subject to severe mechanical shock. He is also working on re-configurable holograms and spatial light modulators.

Jones chairs DERA's liquid crystal consortium, which involves most of the UK universities working in the field. For the past four years he has led the technical programme of a major collaborative project between DERA and the Sharp Corporation of Japan, and his research on fast-switching ferroelectric liquid crystals has enabled Sharp to develop a prototype 17 inch flat-screen television. In 1997, Jones was the youngest person ever to be awarded DERA fellowship."

Adapted from the IOP magazine 'Physics World'

"Liquid Crystals in the next millennium. Where do we go from here?"

Report on a meeting at The Institute of Physics, 9th February 2000.

About 35 people attended this discussion meeting with representatives from industry, MOD and academia. Speakers, having been asked to be forward looking, possibly controversial, covered a range of topics almost entirely focused upon display aspects of the use of liquid crystals.

Adrian Geisow (Hewlett-Packard) began the afternoon by drawing attention to the continuing problem of light throughput and light 'usage' in general for most LC displays. Emphasising that the future demands a broad range of technologies and not just a single approach, when asked by fellow industrialists if there were any questions to be addressed by academia the immediate answer was that there was a 'real need for some radical thinking'. Diana Ulrich (Sharp) pointed out that coloured images on paper are still not matched by LCDs - a problem for the future.

This very much device oriented presentation was followed by a talk on one of the key issues in future LC technology, that of new source materials with novel and desirable properties. John Goodby (Hull University) pointed out how difficult it is to find funding to support the synthesis of LCs. Moreover, no longer is it sufficient for chemists to make new candidate materials but often they are expected to fully characterise them as well. In the past much characterisation work has been conducted by other institutions such as DERA (Malvern) but this is no longer the case, presenting a major block to rapid progress in the development of new LC materials. Without question there is much material development to be done in areas such as AFLCs and other novel LCs but the lack of a UK based research material supplier in this area will present the community with a major problem in the future.

Harry Walton (Sharp) gave a rather more upbeat picture of the future, drawing attention to the enormous wealth of applications for LCDs and listing a vast range of problems which need resolving. He wisely pointed out the need to look beyond just the LC in an LCD, all the components need exploring, including polarisers, colour filters, diffusers etc. There is, he said, a need for new innovative science and technology and perhaps an even more pressing need for good materials characterisation (returning us to the issue raised by John Goodby). Surprisingly only a few nematic materials have their viscosities properly determined. In view of the rapidly expanding display market there is a need to explore in much greater depth structure/property relationships. In the future we should reconsider, he said, adding function to LCs, for example coloured LCs, or scatter effect LCs, multistability etc. He left us with the very positive message that the LCD market is still growing and that there is a wealth of research and developmental science to be undertaken.

Steve Elston (Oxford University) added another perspective to the discussion by drawing our attention to the pivotal role that good, convenient, modelling theory had played in the development of nematic LCDs. He pointed out that notwithstanding excellent theoretical descriptions developed at Strathclyde and elsewhere the detailed optical response of FLCs were simply not predictable. Further, reinforcing Harry Walton's comment about nematics, he pointed out that very few elastic constants were known for these materials so even if a theory which could handle the chevron, the surface regions and Ps were available in convenient form there was still no real chance of predicting the response of a FLC or AFLC cell in any detail. He also correctly drew our attention to the fact that both spatial and temporal variations of order parameter may need to be introduced in order to model nematic cells as pixel sizes are reduced and edge effects become ever more important. It is clear that there really is still much to be done in developing continuum theories as well as in numerical modelling. In addition optical modelling codes beyond those based on the Berreman approach, which treats the LC as invariant in the plane, have to be implemented for modelling the optics of pixelated devices.

The final talk of the afternoon by Cliff Jones (DERA) covered a range of display issues. He again reinforced the problem of lack of basic measurements, such as the flexoelectric coefficients which may be vital for the next generation of bistable nematic devices. He also drew our attention to AFLCs and once more brought up the frustrating issues of material supply, material synthesis and characterisation. There are, he said, also a wide range of problems at the fundamental physics level, for example an explanation for V and U shaped switching of AFLCs . He also asked the question 'Should BLCS not establish stronger links with the Irish and UK chapter of SID?', the point being that the UK LC science presence at SID conferences has been very limited over the past ten years and if we are serious about the future of LCD technology in the UK then we need to address this. This final talk also pointed out a pivotal issue to nearly the whole UK LCD community that of the changing role of DERA. While in the past it has acted as a hub to many interactions this may no longer be possible as they move towards privatisation and hence competition with previous collaborators such as Sharp and Hewlett-Packard.

In summary then an unusually open and frank afternoon where many of the unspoken issues of UK LCD research were aired and, to a degree, openly discussed.

The major points to emerge were:

a. Many technical problems still to be overcome.
b. Much fundamental science to be resolved.
c. Further improvements required in numerical modelling, continuum theory development and dynamic modelling.
d. Synthesis of new materials is going to be a problem with only one or two groups in the UK working in this area.
e. Funding for good characterisation of LC materials is likely to continue to be very limited, this needs addressing.
f. There is an extremely large and still expanding low-power-consumption-display market.

Finally, Tim Spiller (Hewlett-Packard) suggested that if the UK LC community really wished to progress rapidly then perhaps we should consider setting up a distributed IRC in LCs involving all the key players. As the chair of the meeting pointed out this sounds fine but it would mean some individual investing a large amount of time and effort into establishing such a research grouping, obtaining funding, and then making it work. Considering the rather disparate nature of the community this would really be a major challenge for the new millennium.

Roy Sambles
(Meeting sponsored by The British Liquid Crystal Society and The Quantum Electronics and Photonics Group of the Institute of Physics)

BLCS Annual General Meeting, University of Strathclyde

17th April, 2000, Minutes

1. Statement from the Chair
Geoffrey Luckhurst reported on the progress made for the organisation of the International Liquid Crystal Conference in Edinburgh in 2002 and expressed the view that all was on course for a successful meeting and that he hoped there would be a strong UK turn out. In order to maximise UK participation in the meeting, he proposed that there be no BLCS Annual Conference in that year.
He then reported on the state of arrangements for the Anglo-Japanese Seminar on Liquid Crystals which would be held in Oxford in 2001. He expressed the view that this meeting would effectively subsume the Annual BLCS Conference for that year.

2. Treasurer's Report
Mike Hird presented the Annual Accounts which are appended to these minutes. The accounts showed the Society's funds to be in a healthy state.

3. Secretary's Report
Duncan Bruce reported that the Society's website would be acquiring a new address of the form 'blcs.org.uk' or similar and that it would be moving to a third part server.
He further reported that in response to the calls for nominations for the three Committee posts available, there had been only two nominations and that subsequently one of the nominees had withdrawn.

He then took the opportunity to thank Geoffrey Luckhurst on the Society's behalf for all the hard work he had done for the Society during his six years as Chair. He drew attention to the Anglo-Japanese Seminar on Liquid Crystals which had raised the profile of UK liquid crystal science in Japan and of Japanese liquid crystal science in the UK, the successful outcome of negotiations with SID to put the SID/Sturgeon Prize on a firmer footing, his pivotal rôle in bringing the International Liquid Crystal Conference to the UK in 2002 and his work with George Gray in establishing the G.W. Gray Medal.

4. Election of Chair
There was one nomination, Roy Sambles, proposed by Frank Leslie and seconded by Peter Raynes. Roy Sambles was duly elected.

5. Election of Vice-Chair
There was one nomination, John Goodby, proposed by Duncan Bruce and seconded by Peter Raynes. John Goodby was duly elected.

6. Result of Ballot for election of Three Ordinary Members of Committee
There was one nomination, Cliff Jones, proposed by Damien McDonnell and seconded by Duncan Bruce. In the absence of other nominations, the Committee had nominated Sally Day to serve for a further three years to further develop links with SID (Sally has just been elected Vice Chair of SID). Cliff Jones and Sally Day were duly elected. The third post will remain vacant.

7. Newsletter
Corrie Imrie reported that a Newsletter would be produced soon. He also announced that he was standing down as Newsletter editor. He was thanked for all his hard work in producing the newsletter over some six years. [***Secretary's Note***: Bill Crossland has agreed to become the next Newsletter editor].

8. Logo Competition
Geoffrey Luckhurst showed the two entries and the meeting voted for one of them which was submitted from the University of Exeter. A copy is attached to the minutes.

9. Any Other Business
Geoffrey Luckhurst gave notice that it was the Committee's intention to propose some changes to the BLCS Constitution at the next AGM. The changes would mean that normally, the person elected to serve as the Society's Vice Chair would then automatically assume the post of Chair after three years. This would ensure continuity in the Society's business. Other 'tidying-up' changes would also be brought.

A Japanese Adventure

(or how to miss two major football matches in less than a week!)

The occasion was the first Anglo-Japanese Symposium on Liquid Crystals which was to be held in the historic Japanese city of Nara, not far from Osaka, itself some three hours south of Tokyo by bullet train. And the timing - oh! the timing. I was to fly out on Saturday the 22nd May (F.A.Cup Final) and return at the end of the week, just in time for my daughter's birthday. In the middle of the week was the European Cup Final! The journey started early, leaving Exeter at 4.30 am to catch a very early connecting flight to Amsterdam from Bristol. The early start was rather fortuitous as it allowed a five-hour stop-over in Amsterdam, somewhere I had never visited, and so I took advantage and enjoyed a cruise round the canals before hurrying back to Schipol Airport to meet Neville Boden and Peter Raynes with whom I would make the long flight direct to Osaka Kansai Airport, Osaka's new international airport which stretches out into the sea. On boarding the plane, the three of us set about trying to find out whether there was any way that the Cup Final could be relayed into the plane, whether via a video link or with commentary through the headsets. We were to be disappointed and in the end, Peter telephoned home from the on-plane phone to find out that Manchester Utd had won. With the prospect of the treble looming, all partisan feelings disappeared as we wanted to see a British team complete this unique football achievement.

We landed in Osaka the next morning and went our separate ways. I was spending Sunday and Monday with a Yo Shimizu in Osaka and was to take part in a small symposium at his institute the next day. I crossed town by bus and met him at the City airport (2.30 am UK time) from where we went to his home for a short while and then, after lunch, headed off deep into the countryside close to nearby Kyoto. After a couple of hours of driving (some of which I spent 'readjusting' to the time difference), we reached the most beautiful place - a small Japanese village, nestling against the bottom of some green, wooded hills, and named 'Straw Hut Village'. It was here that I saw a remarkable connection with home in that most of the houses had thatched roofs! In fact, we were even able to watch Japanese thatchers at work, restoring the roof of one of the houses. This was a remarkable find in what must be the world's most technologically advanced nation - another of those remarkable contradictions, which is Japan.

The next day, Monday, it was off to the Osaka National Research Institute where I was able to catch up with one or two old friends and to discuss their research with them. The symposium was in the afternoon (other speakers used Japanese, although many of the slides were in English) and afterwards, I had to get back to central Osaka to a new hotel for that evening. My guide was one of the other speakers, but we managed to get lost in Osaka station, which is very much bigger than the centre of Exeter, and we arrived at the hotel at the time we were supposed to leave for dinner!

On Tuesday morning, I left Osaka with Hideo Takezoe from Tokyo to take the short train ride to Nara. We arrived at the hotel and found that many of the conference delegates had arrived already. The rest of the morning was to be taken up with an excursion to some of the old temples in Nara with a special lunch at the end. The temples were stunning and it was an interesting experience trying to take in their beauty and significance while being the focus of attention for hundreds of Japanese schoolchildren, all of whom were anxious to say, "Hello". Lunch was indeed special, if only for the discovery that many of us were simply either not supple enough or of the wrong shape (or both) to sit cross-legged for the time it took to eat the meal, even if it was washed down with liberal quantities of good Japanese beer. I have the photos to prove it! Pre-symposium preparations took up the rest of the day but already, we had begun the search for a TV that would show the big match the next night.

The first day of the symposium was a great success, with super talks spanning a good deal of the subject. Debate was also lively and so, by the end of the day's sessions, everyone was in a very good mood. The search for the TV had continued, on and off, throughout the day and it had been discovered that there was a Japanese cable station that would be carrying the game, although it was not available in the hotel. The time difference with the UK was eight hours and so if we were to be successful, we would need to find somewhere that would let us watch the game in the early hours of Thursday morning in Japan. To cut a long story short, the search was in vain and so sorrows were drowned that evening in the hotel bar.

However, the result came through in a most unexpected way. At some unearthly hour of the morning, I was aware of banging on room walls and telephones ringing. Someone (Harry Coles, I think) had had a call from the UK with the result that Bayern Munich had been beaten in the last seconds of the game and he could not resist letting everyone know about it! The rest of the symposium was a great success and there is a wonderful story to tell about the taking of the official photo, but that must wait for another day. The 'return' symposium will be held in the UK in 2001 and I am sure that it will be equally memorable. However, this time I hope that the dates will be chosen more carefully.

Duncan W Bruce

2000 British Liquid Crystal Society Accounts

Registered Charity (328163)

The balance sheet for 2000 contains more items than usual because the details of the 1998 conference at Leeds were too late to include last year and the later conference this year allows the details of the 1999 Winter Workshop to be included.

The General Fund at the start of the financial year showed a healthy £9484.51 plus a further £6755.27 in the Sturgeon Fund, giving a total of £16239.78.

Income from subscriptions was a substantial £1697, but around £500 was collected from the previous year, but was too late to include in those accounts.

The 1998 Leeds Conference showed a remarkable surplus and the 1999 Durham Conference a healthy surplus, which provided a combined conference income over two years of over £4000.

The Winter Workshop has generated a surplus of over £900 over the last two years.

Interest earned on the Society's funds is relatively poor, but still contributed over £500 for the last full calendar year. Interest was apportioned to the General Fund (58.4%) and the Sturgeon Fund (41.6%) based on the relative proportions of the total fund at the start of the financial year. The Society is a Registered Charity and so all interest is paid without the deduction of tax.

Expenses incurred for the forthcoming International Liquid Crystal Society Conference in Edinburgh in 2002 (£452.87) will eventually be refunded.

The cost of the Sturgeon Lecturer for 1998 (Leeds Conference) was substantially higher than for 1999 at the Durham Conference. Such costs are far higher than the interest being generated from the Sturgeon Fund, and the capital level is obviously falling.

Overall the income generated by the Society this year is substantial, but does cover the proceeds from two Conferences, two Winter Workshops, and more subscriptions than normal. The balance of the General Fund is now 60% higher than last year, although the Sturgeon Fund has fallen by 10%.

Balance Sheet at 31st March 2000

Description of Income (£ Sterling)		
Cash at Bank		
General Fund	9484.51	
Sturgeon Fund	6755.27	
Total Cash at Bank		16239.78
Subscriptions		
General	1237.00	
From Leeds Conference	240.00	
From Durham Conference	220.00	
Total Subscriptions		1697.00
Leeds Conference 1998		3281.91
Durham Conference 1999		830.00
Hull Winter Workshop 1998		508.86
Hull Winter Workshop 1999		407.10
Interest (30/12/98 to 29/12/99)		
General Fund	292.39	
Sturgeon Fund	208.27	
Total Interest		500.66
Total Income		**23465.31**

Description of Expenditure (£ Sterling)		
BLCS Secretarial Expenses		161.11
BLCS Young Scientist Award		
and Certificate 1999	216.55	
GW Gray Medal and		
Engraving 1999		254.29
ILCC 2002		452.87
IOP One-day Meeting		187.54
Sturgeon Lecturer 1998		625.96
Sturgeon Lecturer 1999		314.18
Postage		6.00
Cash at Bank		
General Fund	15223.41	
Sturgeon Fund	6023.40	
Total Cash at Bank		21246.81
Total Expenditure		**23465.31**

Mike Hird
BLCS Treasurer

BLCS Committee, 2000/01

Officers

Chair	Prof. Roy Sambles (Exeter)	(2003)
Vice-Chair	Prof. John Goodby (Hull)	(2003)
Treasurer	Dr Mike Hird (Hull University)	(2002)
Secretary	Prof. Duncan Bruce (Exeter)	(2001)*

*Denotes second continuous term.

Ordinary Members of the Committee

Dr David Coates (Thorn CRL)	(2001)
Dr Sally Day (University College)	(2003)*
Dr Steve Elston (Oxford)	(2002)
Dr Corrie Imrie (Aberdeen)	(2001)*
Dr Cliff Jones (DERA)	(2003)
Professor Maureen Neal (Coventry)	(2001)
Dr Martin Tillin (Sharp)	(2001)
Professor Bill Crossland (Cambridge)	(2002)

Report on the 18th International Liquid Crystal Conference, Sendai, Japan

(A student's-eye view)

The 18th International Liquid Crystal Conference was held in Sendai, Japan from the 24th–28th July, and was attended by over 800 delegates from around the world. The Sendai International Center proved to be an excellent venue, providing a comfortable and relaxed environment. The lectures were run in four parallel sessions and covered a broad spectrum of liquid crystal science and technology; molecular design and synthesis, microscopic and macroscopic properties, applications, displays and instrumentation. Keynote speakers included T. Lubensky, D. Demus, H. Kawakami, M. Hijikigawa, W. Helfrich, S. Chandrasekhar and K. Prafcke. Poster and social sessions had an informal atmosphere allowing for lively discussion and a chance for some of the younger researchers to present their work.

On Tuesday afternoon the Glen H Brown Awards were presented, followed by oral presentations by the prize-winners, promising a bright future for liquid crystal research. Prizes for the best poster from each day were awarded at the closing ceremony, having been voted for by conference participants. Several British winners were included in the prize-winners.

A memorial address was given by George Gray in memory of Professor Frank Leslie who died suddenly in June. This was extremely well attended, clearly reflecting the esteem in which Professor Leslie is held by the international liquid crystal community

Wednesday afternoon heralded a welcome break from the busy rounds of lectures and poster sessions, with a bus and boat trip to Matsushima, culminating in the conference banquet. Our enthusiasm was not dampened by what would appear to have been the end of a tropical typhoon and we cheerfully queued onto our buses, remembering to write our bus, row and seat numbers onto our ticket to avoid any of us getting lost. There is an old saying that Matsushima is beautiful even in the rain, and I would have to agree with that. The production of rain dolls made by children when praying for better weather did not, unfortunately, seem to have any effect on the downpour. The delicious banquet was followed by a truly awe inspiring display of Japanese drumming, and this was followed by a less awe inspiring attempt at drumming by some of the 'big guns' in liquid crystals. Another high point was the singing of the International Liquid Crystal Song in various languages. Thankfully karaoke fever didn't last too long, although we had an enjoyable sing-along on the bus back to Sendai.

An exhibition by relevant businesses was held in the nearby sports centre and was of interest to everyone, not only those involved in the many different technologies on display. In particular it was interesting to see the next generation of large flat screen TVs.

The closing ceremony on Friday provided us with another example of our hosts warm hospitality. The presentation for the next international conference to be staged in Edinburgh in 2002 promised to deliver another high standard conference on a par with that experienced in Sendai.

Peter Henderson,
Department of Chemistry, University of Aberdeen.

The new editorial team

Tim Wilkinson and
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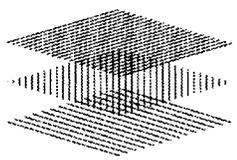
Next Issue articles: April 2001



BRITISH
LIQUID
CRYSTAL
SOCIETY

Logo designed by
Sue Barradell, Exeter

Procedures for the Ben Sturgeon Award

Eligibility for the Award

1. Young Scientists or Engineers (under 40).
2. Must have made significant contributions to the displays field over the past 10 years.
3. Ideally the work they are nominated for should be in the liquid crystal display field (this includes all aspects of technology used in LCDs).
4. Under exceptional circumstances nominees from other display areas will be considered. In that case the international value of the work must be clearly demonstrated.

The Nominations

1. Letter of nomination clearly setting out the value of the nominees' work.
2. Additional letters of support are helpful but not essential.
3. CV for the nominee.
4. Publications (papers and patents) list.
5. Copies of key papers.
6. Nominations should be sent to the Chair of SID (UK).

The Role of SID (UK)

1. The SID (UK) Committee will appoint two of its members to the Ben Sturgeon Award sub-committee to review nominations for the Ben Sturgeon Award and make recommendations to the SID Committee.
2. The SID (UK) committee will publicise the award through the SID Newsletter, the SID (UK) Homepage, through EPSRC, DTI and through individual networking.
3. The Ben Sturgeon Award Sub-Committee is responsible for selecting the winner (s). The decision of the Sub-Committee will except in exceptional circumstances (e.g. where the Sub-Committee is unable to come to a majority decision) be approved by the SID (UK) Committee which is responsible for making the award. In any such exceptional case the SID (UK) Committee will make the final selection of the winner based on the information presented by the sub-committee, through a majority vote. In this case the vote will exclude the two SID (UK) nominees to the Ben Sturgeon Award sub-committee.
4. SID (UK) will present the award at their annual autumn conference (usually in association with EID) unless the recipient cannot attend that meeting. In that case SID will make the award at the next SID (UK) Technical meeting.

The Role of BLCS

1. The BLCS committee will appoint two members of the BLCS to the Ben Sturgeon Award sub-committee to review nominations and make recommendations to the SID (UK) Committee. This will allow the BLCS Committee to select the best-qualified people taking into account the candidates nominated. In practice the Sub-Committee members would be appointed from BLCS Committee members provided they have appropriate expertise.
2. BLCS will publicise the award through their Newsletter and the BLCS Homepage, through individual networking and other appropriate routes.

The Role and Constitution of the Ben Sturgeon Award Sub-committee

1. The sub-committee is constituted of two members from the SID (UK) committee and two members from the BLCS committee, selected by the BLCS.
2. One of the two SID (UK) Committee members will be appointed by the SID (UK) Committee as co-ordinator.
3. The SID sub-committee members are responsible for writing the call for nominations in consultation with BLCS.
4. The members of the sub-committee should individually review all nominations and then either meet or through other means come up with recommendations for the award. The recommendations should include a ranking of all the nominations and a justification.
5. In the exceptional case that the sub-committee cannot agree, individual recommendations (with justifications) should be made to the SID (UK) Committee. The Sub-Committee can also recommend two awards being made.

Timetable

Nominate SID Sub-committee members	February
Write call for nominations	March
Issue call for nominations	March/April
Deadline for submission of nominations	June
Appoint BLCS Sub-Committee members	July
Review of nominations	July/August
Sub-committee recommendations	End August
Selection of award winner	Early September
Inform winner	Early/Mid Sept
Publicise Award ceremony (EID)	September
SID order plaque	Mid September
Award ceremony EID	November