# IOP | Institute of Physics
## Engineering Physics Group

**NEWSLETTER** **July 2008**

QinetiQ's 5m Wind Tunnel at Farnborough, Hampshire *The subject of our visit on 28th February*

See http://eng.iop.org for further details about the Engineering Physics Group.

# A note from your chair

*John Battye*

Well, this time we have a bigger and more varied selection of articles; an account of an EPG organised visit, a look at life from one who ventured out into the industrial, pharmaceutical world ---- but who I think presents views and type of experiences that relate to those of many of us in different areas of industry ---- and an article giving a bit of detail about a specific area of technology in which one of our number works. Finally there is a survey to help your committee hear your views and experiences concerning training and career progression.

As I trust you know by now we are always looking for articles. I know that for many in industry the necessary commitment to the fortunes of their employer --- few of which see their interests as having any direct synergy with those of the IOP --- makes it difficult, to participate in the activities of the Institute. However, I hope with the diverse examples of the articles in this and previous Newsletters some of you are stimulated to make submissions for EPG Newsletters of the future. I understand at least one of those published in this edition was stimulated by some comments I made in an article I wrote last year. The Newsletters, and to a sizable extent the group, really do depend largely on the efforts you put in yourselves.

As you know I often bemoan the lot of engineers in the UK. In a recent radio broadcast I heard it reported that fees at private schools had gone up circa 40% in the last few years. It also pointed out that such as lawyers and accountants could afford to pay these fees without too much difficulty, but amongst those that could not, with out struggling, were engineers. I presume it is even worse for pure scientists. Since other, earlier reports have made it clear that whereas the private schools sector have generally maintained science teachers and a high level of science teaching the public sector has not. In fact many public sector schools apparently don't even have specialist maths and / or science teachers, and we all know the value of inspiration by a capable, teacher ….. and the reverse. Given also that a recent survey reported that 'A' level physics is the hardest of all subject in which to get good grades no wonder many universities are suffering under the burden of having to provide such as remedial maths lessons. Lessons that are eventually paid for by the poor debt burdened student of course. As if that wasn't enough, governments can hide the costs and present what spin they like but my information is that computer automated candidate pre-selection programs, used by many bigger employers, already downgrade their 'marking' for degrees from British universities compared to what was done in past years. The future certainly looks bleak for the physics and engineering professions in the UK.

I sent my kids to private schools, but that is largely because I left the UK for most of my working life and the company I worked for paid the bills. Having now been back in the UK for a number of years seeing, even more plainly, that if one can't

change the system, which probably means going into politics with this as a burning issue to be resolved (and what do you think ones chances of success if one did that) then one has to do the best one can for oneself and ones family on a wider stage. As you are, and your offspring are likely to be, of a scientific / engineering bent, the pursuit of such a philosophy not only benefits your family but the subject in general. The only difference is on a wider stage than that of the UK. I don't think I need to point out the moral of the story any further, do I?

But then it is now well over a decade since the government of the day declared the UK's aspiration was to move towards an economy dominated by service industries. To my simple mind that means; restaurantering, churning out nuts and bolts for a manufacturer making motor cars elsewhere (a manufacturer who also makes most of the profits), and banking. The current spate of TV programmes about cooking supports the first of these is well underway. The second is clearly long developed. The last, well, that can easily become a bit too nebulous can't it, difficult to see where reality lies? Mmmmm … that sounds familiar.

Those who wish to stay here surely have the duty to keep lobbying for a better all round appreciation of professional engineers and physicists in terms of both status and remuneration? In fact, of course, the two go together.

If any of you have any comments on what has been published in the last couple of years, or wish to submit an article for a future publication.

## Visit to QinetiQ's 5m Wind Tunnel

*Victoria Weise*

On Thursday 28th February 10 members of the Engineering Physics Group from Government, Academia and a variety of industries were shown around the QinetiQ 5m wind tunnel and its facilities by the Facility Manager, Andy Yarrow. The group were given a unique opportunity to view all aspects of the wind tunnel from the developments of physical models to walking the length of the tunnel itself.

Wind tunnels are essential tools for the understanding of aerodynamics, an extension of the science of fluids which pushes at the boundaries of knowledge relating to mathematical theory and physics. They provide the key to unlocking the potential for greater altitude, speeds and handling characteristics of aircraft, including wing profiles, wing components and composition, plane stability criteria, strength standards and flutter theory. The rapid changes advanced by the twentieth century's iconic industry, aviation, witnessed matching developments in the design of wind tunnels, key factors in their performance being the size of the model, the speed of air flow and the atmospheric pressure.

Farnborough is one of the key sites in Europe relating to the development of aviation, particularly powered flight. The history of the QinetiQ site can be traced back to the Balloon Equipment store which was moved there in 1905, with the factory being established in 1906. The first wind tunnel, R52, was built on the site in 1916, marking a critical period in Farnborough's development, when it was renamed the Royal Aircraft Establishment (RAE). Five of the RAE's original wind tunnels are now based in the middle of the Farnborough Business Park, in three listed buildings. An independent charity, Farnborough Air Sciences (FAST), is working with the developers to re-open the wind tunnels for commercial, small scale use.

Part of the RAE site is still in use by QinetiQ; the 5m Pressurised Low Speed Wind Tunnel. It was constructed during the 1970's to provide a low speed wind tunnel where the effects of compressibility and scale can be investigated separately; to facilitate the design of aircraft with improved low-speed performance; reduce the level of developmental flying, and reduce the risk of expensive modifications being required at the flight test stage. It is fully self supporting commercially, having transitioned from supporting research programmes to almost full time 'production' testing for commercial customers.

The facility is a closed circuit, pressurised tunnel, which can be operated at total pressures ranging from atmospheric pressure (~101.3 kPa, 14.7 psi) up to 300 kPa (43.5 psi). The maximum speed in the test section ranges from M = 0.32 at atmospheric pressure, to M = 0.27 when the tunnel is operated at a total pressure of 300 kPa. The facility is designed to optimise high lift systems for improved takeoff and landing performance.

The tunnel was designed for high productivity during testing. The test section can be isolated and evacuated to atmospheric pressure, whilst the rest of the tunnel circuit remains pressurised. This greatly reduces the time required to access the model for changes to its configuration. In addition, the model is mounted on one of four interchangeable carts, which forms the floor of the working section. When a cart is not in use in the test section, it is parked in one of the rigging bays adjacent to the tunnel. Thus it is possible for a model to be rigged, whilst another model is tested in the tunnel. The use of the interchangeable cart system offers a wide range of model support options, including strut mounting or sting mounting of whole-models, and floor mounting of half-models. The wind tunnel test section walls are fitted with many surface pressure tappings that facilitate the use of the two-variable wall pressure signature method for the correction of highly-separated flows which are commonly experienced during high lift testing.

## You Couldn't Make it Up

*Robin Payne*

The journalist wondered what she'd done to deserve this assignment. 'Go find a physicist in an engineering role in the pharmaceutical industry', her boss had said. 'And if you can, find out how the heck they got there'.

A few weeks later she'd arranged to meet Robin, forty odd years old, working for a global Pharma company and based in the UK. "So", she asked, "you're a physics graduate; how did you get into this industry?" Whoops she thought, a little incredulity slipped out there.

"Good question," came the reply, with half a smile. "It shouldn't be so hard to believe, physicists are able to find out how things work, which makes them pretty useful really. I did a theoretical physics course at Durham University; enjoyed the life and the subject, and decided to go for a PhD if someone would take me on."

The journalist started to relax. Physicists are no different to the bulk of the population then: get them talking about themselves and there's no stopping them. "How did you go about that then?" She switched on the tape recorder.

"Well I responded to half a dozen adverts from different universities and was invited for interview at three. I was quite surprised to find that the most practical research topic sounded the most interesting, perhaps because of the open and enthusiastic way the senior lecturer described it. Anyway, I accepted the offer of a PhD studentship studying radiation damage in amorphous metals, to find out whether these materials could be used in the first wall of a fusion reactor. I was based in a Materials Science department in an engineering faculty, with close relations with the adjacent Physics group."

"Sounds interesting," she said. 'Got him now, she thought.

"Yes, it was. Rapid solidification processes to produce the amorphous metals, particle beam lines to irradiate samples either at Surrey or at Harwell, and a range of electron microscopy techniques to study the effects. Combine that with some diffusion and defect nucleation theory; and a decent sports hall and a student bar, what could be better?"

"Did you complete your PhD?"

"Yes, a little over the three years, but yes. And then I spotted a post-doc role in the same department, studying diffusion in polymers. It was nearly a real job, and after a few minor papers at conference and on the back of my supervisor's previous work, we generated some interest from some industrial scientists. I'd met my wife by this time and we were thinking about our own house, so finances

were becoming a factor. A vacancy came up in a blue chip chemicals firm and I was offered a job developing carbon fibre composites for aerospace and automotive applications. I think this was my first experience of working in a truly multi-disciplinary team: chemists, material scientists, engineers building and maintaining plant; an analytical group with mechanical testing, microscopy and surface science techniques all within easy access. At one point we had samples on the outside of the space shuttle and the inside of a 'formula one' car. Then there was a major reality check."

"Something dramatic happened?"

"There was a downturn in the bulk chemicals market which meant funding for diversifying development work dried up, rapidly. A lot of jobs disappeared and a small number of us went to work at universities supported by corporate funding. I spent a very enjoyable eighteen months studying crystallinity in polymers at Cambridge's Cavendish laboratory. It was a productive time on the publications front: probably because of the number of bright folk to work with, but perhaps also because of the focus and team working I'd gained in the industrial environment."

"So now you were back in academia?"

"Yes, but if there is one constant as they say, it is change. Still employed by the company, I was asked to take a secondment to the Pharmaceutical division, to work on the development of a product based on a controlled release polymer, so that's what I did. On the new project I was introduced to factorial experimental design and more rigour in process control. The approaches rang statistical bells from my physics background and addressing a broad range of data worked really well. I've been reminded of the need to base decisions on data whenever possible on numerous occasions since. And when that project finished, I was offered a more permanent role as an analyst in a physical sciences group supporting pharmaceutical development and manufacturing. This was quite fortunate as the company split up and the pharmaceutical division became a company in its own right. And the increases in share price suggested this had 'delivered increased shareholder value'. You could put that in inverted commas if you like, because I don't think I'll ever really understand the ways of the market from my background."

"It seems to me that there have been a lot of different jobs in your career. Could it be that physicists have difficulty sticking with a job?"

"Glad you included all physicists in that statement and not just me. There could be some truth in that, but quite often my moves have been necessary, even if I've not taken huge risks in the roles I've gone for. Perhaps the next move was one of the most risky. After about three years I decided to apply for a completely

different role in a Knowledge Management group that was part of Product Strategy. This involved project managing the introduction of IT to support the collection and analysis of information about the market place. There were a lot of 'Knowledge Management consultants' buzzing around industry at that time, and a fair bit of folklore generated about the term. Fundamentally, this involved finding ways to encouraging people to gather and share information in structured processes, which could then be facilitated by databases with somewhat bespoke user interfaces. There was no doubt I learnt a lot about the way people interact and the diverse ways in which people prefer to communicate and learn. Any project management role requires first levels of leadership too I believe.

That was all going well until a corporate merger took place. It shook up product strategy. I had to find another role and joined the central IS group as a Service Manager, responsible for the reliability of a number of IT solutions across what had become a truly global organisation. This responsibility came with no line management, so the ability to influence others became critical: and suddenly the phrase customer focus really started to mean something. I helped introduce the IT Infrastructure Library to the service management and delivery organisations. This approach contains lots of good practice even if the service you are involved in is not an IT one, so I'd recommend a look at it if you're interested."

"Come on now, how far are we from you becoming an engineer?" She'd taken a glance at her watch and if she missed the next London train, she'd be stuck in the sticks for the night."

"Fair enough: I don't really like talking about myself you know. And I still have to work out if I like being thought of as an engineer… oh ok they have some good points.

It took yet another business change to get me into doing the engineering rather than just working with engineers. I became a manager of technology projects delivering automation to the research function: there was a real need to understand the science, the business processes and some very specialised technologies. This role developed to include the management of a team who maintained scientific equipment and so the challenges of line management, contract and supplier management, with a budget in the millions. Most recently, I've started developing a Process Improvement capability in my department using Lean Six Sigma approaches. This combines customer focus with process analysis, data driven continuous improvement and change management… good fun!"

"Last question: would you have done anything differently?"

"Looking back, yes, but I'm not sure I could have at the time. I've very much enjoyed most of my work to date. It has certainly introduced me to a lot of very capable people. I wish I'd recognised the importance of working relationships earlier and been more structured in my professional development. That's one of the many things engineers do well by the way, and the Institute of Physics has introduced a range of support in this area now. If these things had been available from my institute in the past, I hope I would have made good use of them to gain transferable skills early: time, project and people management. Some mentoring would have been useful and I'd probably have benefited from getting chartered. Becoming chartered is still something I might go for… better late than never perhaps."

"Thank you, gotta dash or I'll miss my train."

"That's a shame, I'd really like to know how you became a journalist talking to a physicist in an engineering role in the pharmaceutical industry…"

# Management of Underwater Multi-Influence Vessel Signatures

*P.G. Rawlins and S.J. Davidson*

## Introduction

The underwater mine threat to a vessel is caused by measurable influences generated by the vessel which may be affected by the ship's state and the environment around it. This is known as the vessel's 'signature' which can be broken down into two main groups: electro-magnetic and acoustic. Electro-magnetic signatures are caused by the various electric and magnetic fields that may be present around the vessel due to its structure, engine and power supplies. A standard countermeasure employed to reduce this threat is the placement of degaussing coils on the vessel. The acoustic signature is caused by any noise that the vessel may be emitting from its engine, movement and propeller. Various sound reducing techniques are followed in the design of ships in order to reduce its acoustic signature. For example, vessel structures are made of materials that do not vibrate when the vessel is underway.

As the magnetic and acoustic hygiene have improved over the years other threats, such as the alternating electric and magnetic fields from the engine, power supplies and cathodic protection system, have become more important. In order to counter the various signatures multi-influence sensor arrays have been developed to monitor and enable their reduction.

The mine threat to the operation of a vessel close to the shore (in littoral waters) can be significantly different from operation in deep-waters. Apart from the obvious threat of operating an environment where ship movement is restricted and there is radar and sonar image clutter, littoral water operation can change the various signatures of a ship by a substantial amount. Electro-magnetic and acoustic interactions with the closer proximity seabed and other environmental factors, such as more rapid changes in the conductivity and temperature of the water, can change the threat from mines and other hostile agents. Thus in order to estimate the potential threat from mines in a littoral environment it is necessary to fully account for the change of the signature due to the vessel's environment.

## Electro-Magnetic Signatures

When discussing electromagnetic signatures it is usual to break them down into static and alternating signatures. Static signatures do not change with time and so are the same at any moment of measurement. Alternating signatures are time dependent, thus low frequency measurements depends on the time of measurement although high frequency measurements may appear static because rapid variations may results in only time averages being registered.

Static Influences:

- *Permanent Magnetism*. Some vessels are constructed using ferromagnetic materials such as iron and steel. These have, or can acquire by being aligned in the Earth's magnetic field, a permanent magnetisation. In the simple case this makes the ship look like a bar magnet with an associated magnetic field that contributes to its magnetic signature.
- *Induced Magnetism.* A ship is always in the presence of an external magnetic field, the Earth's magnetic field. The Earth's field induces an associated field in the vessel which depends on the vessel's heading and location. Some vessels are fitted with degaussing coils. These, by their very nature, since they carry currents, generate magnetic fields which can, in the case of steel vessels, induce further magnetic fields in the vessel. In this case the effect is beneficial since the degaussing coils if properly implemented reduce a vessel's magnetic signature.
- *Static Electric.* Hull corrosion and the cathodic protection system. These sources may be thought of as batteries. Although the conductivity of sea water is typically a million times less then that of copper, they still cause electrical currents to leak into the sea. The currents cause a measurable voltage in the sea which contributes to the vessel's electric signature. This component is known as the Static Electric (SE) or Underwater Electric Potential (UEP).
- *Corrosion Related Magnetic field (CRM)*. These fields are also due to the fact that there are electrical currents in the sea. As with degaussing coils the corrosion currents in the sea have an associated magnetic field. Close to the

vessel the CRM is measurable, although generally it is a lot smaller then the permanent magnetic field. However, for vessels constructed using non-magnetic materials the CRM can be a large percentage of the ship's overall magnetic signature. The fall off with distances from the ship for the permanent and induced magnetic fields is more rapid than that of the CRM. Thus far from the vessel the CRM field may be comparable to permanent magnetism regardless of the materials of vessel construction.

Alternating Influences:

- *Extra Low Frequency Electromagnetic (ELFE).* This can be caused by currents flowing between the hull and the propeller, for example. As the propeller rotates the electrical resistance between the hull and the shaft changes with time over the period of propeller rotation. Since the resistance changes with time any electrical currents, and hence the electrical potential, change with time. Other important sources of ELFE include power supply frequencies and their harmonics from the various electrical power systems and sub-system aboard the ship.
- *Power Supply Ripple.* It is possible that there are small voltage ripples in the power supplies that drive the cathodic protection system. These lead to time dependent currents in the sea, which give rise to a time dependent electrical signature.
- *Alternating Magnetic.* Turbines on the ship contain large rotating current carrying coils. These act as rotating magnetic dipoles, which generate an AC magnetic signature. Because the sea is an electrical conductor sympathetic eddy currents induced in the sea also contribute to the alternating electric component of the signature. Likewise for the ship's electric motors and transformers.
- *Alternating CRM.* Power supply ripples lead to time dependent currents in the sea. In a similar fashion to the DC CRM this leads to an AC magnetic field due to AC currents flowing in the sea.

## Acoustic Signatures

Acoustic waves typically propagate in the sea four to five times faster then in air, and without substantial loss over much bigger distances. Any source of sound from a vessel may be detected in the air or sea surrounding it. There are many sources:

- The engine and power supplies and any mechanical / non-mechanical sound producing movement.
- Vortices generated by the ship's progress through the sea.
- Rotation of the propeller causing frictional vibration, vortices and cavitation.
- Motion of vessel, or its wake.
- Waves generated from the propeller or propulsor.

Acoustic waves can propagate in silt and rock which comprise the seabed. In these materials the waves are usually understood as seismic waves and these can be measured as disturbance in the particles that make up the seabed. There are two types of seismic waves; compression waves and shear waves. Compression waves occur where the disturbance of the particles in the seabed is in the direction of motion of the wave. Shear waves are associated with the disturbance of the particles in the seabed perpendicular to the direction of propagation of the wave.

Hydrophones, operating over a range of between 1 and 100 KHz, are generally used to measure acoustic waves in the sea. The various mechanical or pressure waves generated by a vessel travel at different speeds from acoustic waves and generally have frequencies of between zero and 1Hz. These can be detected by pressure sensors in the sea and / or geophones on the seabed.

## Signatures in Littoral Waters

In littoral waters the electro-magnetic signature of a vessel is changed with respect to deep waters. Several factors and operation conditions need to be taken into account.

- Variation of sea depth
- Seabed
- Seawater
- Temperature
- Water Speed

The acoustic signature with respect to deep water is also changed, notably by reflections.

## Multi-Influence Signature Measurement Sensor Array

Signatures can be measured at any location using a transportable signature measurement array. Such ranges need to be easily transportable and quickly deployable, for example by all being contained with an ISO container. It generally takes two days using a three man team to deploy a range. Such packages of multi-influence sensors were deployed in the 'First' Iraq War's 'Operation Desert Storm' and have otherwise been successfully deployed in the United States, Saudi Arabia, Australia, Norway, the Falklands, Gibraltar, Denmark and Portugal.

The standard system manufactured by one manufacturer comprises the various sensors coupled to an underwater junction box, which collects the data and transmits it to shore via a fibre optic cable. The multi-influence array consists of; magnetic, electric potential, acoustic and pressure sensors fitted to non-conducting, nonmagnetic tripods to facilitate the measurement of the principle

types of ship signatures. Tracking a vessel across a range is normally achieved by interfacing directly to data collection computers and referring to GPS stations. Ship positions can generally be given accurate to within a few centimetres.

## Modelling the Signature

The data gathered from the multi-influence range is used by the range computers to determine the electro-magnetic and acoustic state of a vessel. Once the range computer has gathered data of a single ship run across the range, computer modelling is used to determine the various signatures of the vessel. Using 2 inter-cardinal runs can determine the entire electromagnetic state of the vessel. This enables prediction of a vessels signature at any location, in any local environment, anywhere in the world.

The electro-magnetic model of the vessel is achieved by technique known as dipole modelling. This technique produces a model of the ship by representing the ship as a distribution of magnetic and electric dipoles, Figure 1. DC dipoles are used to represent the static electric and magnetic signatures and AC dipoles are used to represent the time dependent electric and magnetic signatures.

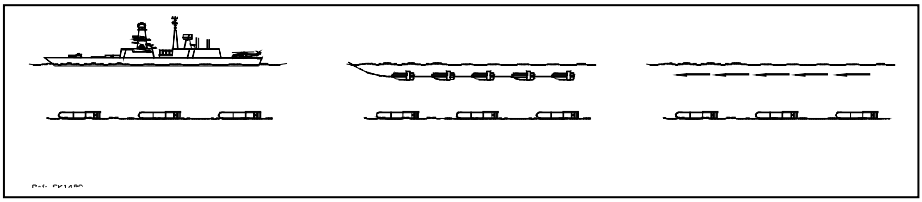


Fig. 1. The figure shows how a ship may represent a source of dipoles above the sensor array in a similar manner to a mine sweep configured to represent a vessel

Regardless of the exact physical form of the electric and magnetic dipoles, the basic idea is that these magnetic and electric dipoles can be thought of as being known sources of magnetic and electric fields. By changing the; magnitude, orientation and number of dipoles used, a representation of the ship's signature can be built up. Obviously the prescription by which this is done is quite sophisticated. The magnetic and electric fields measured at the sensors by the multi-influence array are related to their source, the ship, in a known way defined by Maxwell's equations. Since Maxwell's equations can describe the interaction of electric and magnetic field in any conceivable environment allowance can be made for the effects of the environment in which the vessel is measured. The result is that a ship's signature can be identified not only in the range but in any other seawater environment.

## References

[1] G.J. Webb, S.S. Tut, S.J. Davidson and A.J. Wilkinson, Multi-Influence electromagnetic and Acoustic Ranging, UDT Conference Proceedings, UDT Pacific 98, Sydney, Australia.
[2] S.J. Davidson, T.D. Cassel, G.J. Webb A.M. Cross, Transmag-a transportable degaussing range, UDT Conference Proceedings, UDT 94, London, UK.
[3] G.J. Webb and S.J. Davidson, Why Bother With Signature Reduction, UDT Conference Proceedings, UDT Pacific 98, Sydney, Australia.


# Careers Development Survey

*Samantha Davidson*

The aim of this survey is to find out about the views of members of the EPG group concerning training and career progression of IoP members in engineering related careers.

We aim to use this information to benefit the members of the group via training or careers support relevant to members in industry.

About you:

1) Do you have a physics or engineering degree?
Physics [ ] Engineering [ ] Other [ ] Please state.....

2) Do you have think of yourself as a physicist or engineer?
Physics [ ] Engineering [ ] Other [ ] Please state.....

3) How many years have you been in employment? [ ]
In your place of employment:

4) a)How many employees are there at your office or site? [ ]

5a) What percentage are on the pay role as physicists? [ ]
b) What percentage are on the pay role as engineers? [ ]

6) Is your company engineering or physics based?
Physics [ ] Engineering [ ] Other [ ] Please state.....

7) Does your company have a published career structure?
Yes [ ] No [ ] Don't know [ ]

8) If there are both physicists and engineers in your company do they have the same career structure?
Yes [ ] No [ ] Don't know [ ] N/A [ ]
Comment:

9) If there are both physicists and engineers in your company do they have the same training opportunities?
Yes [ ] No [ ] Don't know [ ] N/A [ ]
Comment:

10) Is there an accredited training scheme (e.g. via ACTS, IET, IoP)?
Yes [ ] No [ ] Don't know [ ]
If yes which:

11) Do you believe that physicists and engineers have the same opportunities in your place of employment as other employees?

12) Are there any examples of best practice that have been of benefit to you in your career?

13) Do you believe there are any practices within this or a previous place of employment that have hindered your career progression?

14) Is there any one thing that the IoP or EPG could do to assist you in your career e.g. training, information, gaining chartered status?

15) One aim of the EPG is to assist physicists isolated in engineering industries in gaining chartered status. Were you aware of this?

16) Do you participate in a Continuing Professional Development scheme (e.g IoP)?
Yes [ ] No [ ] N/A [ ]
If so which?
If yes what is your reason for doing so?

16) Any other comments?

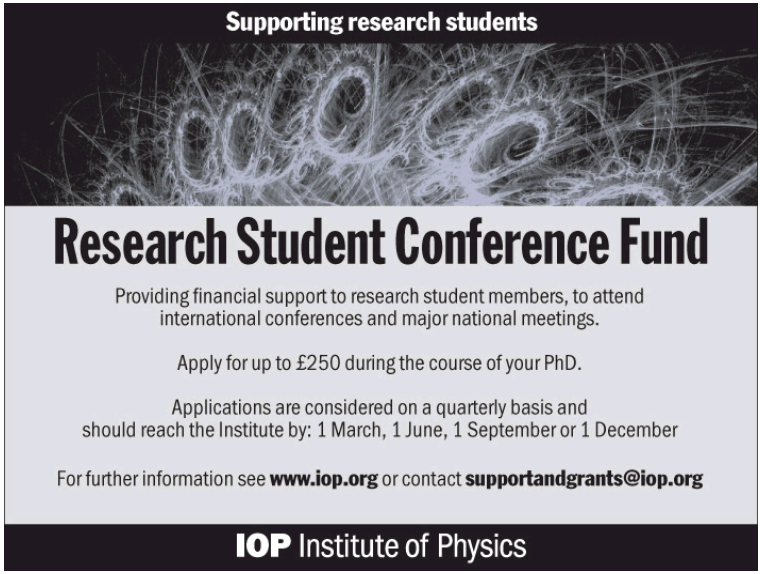
Please send your replies to: Dr Samantha Davidson, Ultra Electronics PMES, Staffordshire WS12 1DR, UK or scan it and e-mail to samantha.davidson @ultra-pmes.com.

We will soon e-mailed you the same survey which you may find easier to complete and return on-line.

## Grants

For those of limited financial means we offer a few travel grants for those wishing to attend visits to places of scientific and engineering interest that we organise. Please e-mail our secretary, Samantha Davidson (s.davidson@physics.org) both if you wish to apply for a place on a visit and, making your case, if you wish to request assistance with travel costs.

## Bursaries




## Thoughts, comments and ideas please

We, your committee, are very keen to hear of any thoughts, comments or ideas you may have. Perhaps some have been stimulated by the reading of this Newsletter. Please e-mail them to our secretary, Samantha Davidson.

## Events of interest

- *Friday 24th October* 2008: 12.30pm to 1.30pm: **Annual General Meeting** in the Ada Lovelace Room, IOP, 76 Portland Place, London, W1B 1NT

- *Friday 24th October 2008*: The Engineering Physics Group's **Conference**, "Physics & Engineering". Coffee 9.30am, Start 10am, Finish 3.15pm. The aim, reconnecting physics and engineering. Location: Ada Lovelace Room, IOP, 76 Portland Place, London, W1B 1NT

For these and other events see our website at: http://eng.iop.org

## Your Engineering Physics Group Committee 2007/08

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