The Institute of Science & Technology

The Journal

Autumn 2015

Contents

The Journal

The Official Journal of The Institute of Science & Technology

The Professional Body for Specialist, Technical and Managerial Staff

Autumn 2015

ISSN 2040-1868

Editor's welcome

Welcome to the autumn edition of the IST's Journal.

I am pretty sure that you will enjoy this edition. It's packed with interesting and varied articles, news items, and information about upcoming events. My thanks, as always, to each and all the contributors to this edition – please keep the articles and papers coming in.

This summer has been a very busy time for the institute, for our chairman, for our officers, and our administrators -with roadshows, visits, training events, and lots of networking. Terry Croft has some great news to tell you about in his Chairman's View. But, I would like to single out for my special mention our IST Technical Conference 2015, which we held in Leeds on the 10th of September. It was a terrific success. We welcomed well over 160 delegates, had two brilliant keynote speakers, and a bunch of great speakers who gave the 12 workshop sessions. There were three individual IST awards, provided by our John Robinson Fund, presented at the end of the conference. Each award recognised an outstanding achievement that was very much in the spirit of John's generous legacy to our institute. But I'll let Ben Palmer tell you more about how the whole day went – you will find his article inside.

For me, as a rather lazy chair of the conference committee, there is no doubt that the success of our conference was very much down to the conference organising team. A terrific group of innovative thinking, hardworking, enthusiastic people, who gave freely of their time and effort to plan, organise, and run the event. Their collective vision, to put on a truly ambitious conference specifically designed for technical staff across all disciplines, really was realised. Well done you lot.

I'm delighted to be able to tell you that the team has already begun the planning for next year's conference. The date has been set for the 15th of September 2016.

So make a note in you diary – **IST ONE DAY TECHNICAL CONFERENCE – 15th September 2016**

We will let you know the venue as soon as it is confirmed, so keep an eye on our web pages **http://www.istonline.org.uk/**

Much earlier this year also saw the continuing success of our two training courses in the "Leading Your Technical Team" programme. Towards the end of this edition Kevin Oxley, the programme director, explains more about the course details. Wendy Mason, LYTT's programme administrator, tells me that we already have quite a number of delegates registered for the next ones, which run in February and March 2016. So please do let her know as early as you can if you are thinking of enrolling on them.

Also inside this edition we have a new section, which shows you who make up the IST Executive, and what each of them does. Executive positions are honorary ones; each member gives their time freely.

Wendy Mason, IST administrator

But, we can't really show you the Exec without also introducing you to one of our most important people. Wendy, the "star" of our IST Office.

Ian Moulson
Editor

NEWS FLASH!

Receive the IST newsletter by email

The IST is delighted to announce that it will be sending out e-newsletters on a quarterly basis. This will enable you as members to receive up to date information regarding what's happening with the IST, scheduled events, hot news topics plus much more. The e-newsletter will be emailed out via Mailchimp from the office@istonline.org.uk email address. To ensure that you receive your e-newsletter please add this address to your contacts list.

Look out for your first e-newsletter which will appear in your inbox before Christmas!

Chairman's view

I have to start with the exciting news that Helen Sharman OBE has been appointed as our new President. Helen says more in her new blog for the Journal. You can also find a resume of her career on our website **www.istonline.org.uk**. Having worked in technical and managerial positions in manufacturing, research and education she is the perfect choice for this prestigious and challenging role. A unanimous decision by the Executive! I look forward to our working partnership through the IST on behalf of our members and the technical community at large and to further promote the profile of the Professional Technician. Watch this space.

Over the last six months the day-to-day business has never slowed down and our activities continue to expand. Our Board and teams continue to give their free time to the goals and aims of the IST and have clocked up even more train miles. They have continued to deliver workshops, seminars as well as 1 to 1 mentoring and guidance. They have covered the island from Devon and Cornwall to Scotland; all highly successful visits.

More companies and universities have taken the opportunity to form working partnerships with the IST through our "Corporate Affiliation" scheme, which gives them access to a wide range of experts and resources. Exeter University is one of the latest universities to sign up to this excellent scheme. For more information on this scheme contact **office@istonline.org.uk**

The summer ended with the Annual IST Conference this time hosted at the Met Hotel in Leeds on September 10th. The delegate list had to be closed early as we had reached capacity (but don't worry the 2016 venue will be even bigger). Ian Moulson (Chair of the Conference Committee) with support from Wendy, Joan and the rest of the team delivered a highly successful conference. More information will be released shortly on the 2016 conference. So look out for the date.

The work of the IST focussing on Professional Registration continues apace. Working with the Gatsby Foundation, Science Council, HEaTED and other bodies we have continued to demonstrate the merits of being recognised as a Professional Technician, Specialist or Manager. Our numbers have increased significantly as the message gets out there in the community. Our specialist teams are ready and waiting to answer your call and answer your questions either as an individual, institution or company.

With more and more companies, agencies and institutions engaging with the National Professional Registration Scheme the IST has created "specifically tailored" working partnerships for these groups to provide them with this professional support, which they need to achieve their strategic goals for their operations and their support staff.

If your company, agency or institution wants help or support in professionalising their technical community and related staff in any way then please contact me directly at **t.croft@istonline.org.uk** today.

In this time of change and sometimes uncertainty, our new President, the team and I will be continuing to work hard on your behalf. Particularly in all areas which have impact on you and your colleagues as well as to ensure the profile of the technical community is continued to be raised to demonstrate to employers and the public at large your key contribution not only to your employer but also to UK plc.

Last but not least, please remember this is **YOUR** professional body run by technicians for technicians so get involved and make a difference!

With sincere thanks

Terry Croft
Chairman

Welcome from our new president

Helen Sharman OBE, FRSC

I am delighted to be your new President. Having worked in technical and managerial positions in manufacturing, research and education, I am aware of the vital part that technical staff play. On my spaceflight, I trusted my life to the teams of people who worked on my spacecraft and rocket and I have experienced various team structures where technical staff have been integral to operations.

I am looking forward to working with your Chairman Terry Croft and the IST's committees to support specialist, technical and managerial staff professionally and to highlight the positive impact of these roles.

Whether it be through professional qualifications, team dynamics or otherwise, I believe that technical staff deserve full and proper recognition. This is important for individuals and also for the profession. As society relies increasingly on science and technology, we need technical staff more than ever. The country is encouraging young people to pursue careers across the STEM disciplines and the IST demonstrates what great opportunities a technical career offers. We know this, and so should everyone else!

Photo credit: Thomas Angus, Imperial College photographer

IST members' news

Science Council CPD Awards 2015

Ben Palmer receiving the Science Council's 2015 CPD Award for the best CPD submission by a Registered Scientist.

Ben is a member of the IST and is a technician in the Department of Materials Science & Engineering at the University of Sheffield. He is championing professional registration within his faculty, and in the wider world, as well as being an assessor for and active member of the IST.

Lisa Hollands receiving a high commendation from the Science Council for her CPD submission, as a Registered Scientist.

Lisa has recently been promoted to team leader within the Faculty of Engineering at the University of Sheffield. She is passionate about promoting the technician as a highly skilled individual. Lisa is also an active member of the technical networking group (TechNet) at Sheffield.

Tim Williamson receiving the Science Council's 2015 CPD Award for the best CPD submission by a Registered Science Technician.

Tim's report was described as an excellent example of good CPD; comprehensive, thorough and demonstrating a broad range of activity and engagement. Tim is a Research Technician at Durham University and, after the award, gave a fascinating presentation which included personal challenges he has faced such as the 300 mile unsupported Yukon Arctic Ultra marathon and the office chair world championship race!

Leighton Jenkins receiving a high commendation from the Science Council for his CPD submission, as a Registered Science Technician.

Leighton is a technician at Cardiff Metropolitan University and is working hard to motivate and inspire his technical colleagues to become professionally registered with the IST. He is also working to achieve Registered Scientist status.

University of Exeter joins with the IST

Dr Gail Reeves and Jonathan Cresswell receive the Affiliation certificate on behalf of their University at a recent Technical Staff Conference held on campus.

Terry Croft MBE (IST Chair) was delighted to welcome the University of Exeter as Corporate Affiliates of the IST and we look forward to working together.

2015 Higher Education Technicians' Summit – recognising the talent of technicians

On June 30th the work of university technicians was celebrated at the inaugural 2015 Higher Education Technicians' Summit (HETS2015) at the University of Nottingham.

The Summit recognised the achievements of technicians – the 'unsung heroes' of UK higher education – and was held in association with the research and innovation collaboration of the six leading Midlands universities and the Science Council.

"The Summit is the first of its kind – celebrating the achievements, skills and expertise of university technical staff. We are thrilled to have attracted inspirational speakers and the support of a number of learned societies and organisations, all of whom are fully committed to the professional recognition of technicians in higher education and beyond."
–Kelly Vere, Conference Chair

Celebrating the talent of technicians

The talent and experience of technicians were celebrated via the inaugural Papin Prizes, which were given to individual technicians across the Midlands region who have demonstrated excellence.

Victoria Wilson, University of Nottingham, was presented the Lifetime Achievement Award for her contributions as a laboratory technician. Victoria has worked with Professor Sir Alec Jeffreys and made a pivotal contribution in the discovery of the technique now known as DNA fingerprinting. DNA fingerprinting revolutionised the way in which police investigate crime and Victoria's contribution was recently portrayed in the recent ITV drama Code of a Killer starring David Threlfall, John Simm and Lydia Rose Brewley, who portrayed the character of Victoria.

"I cannot think of anybody more richly deserving of this recognition. Vicky was a technician with me throughout the 1980s, and not only did a fantastic job in keeping the very complicated show that was my laboratory on the road, but also contributed enormously to our research initially on gene evolution and then into and beyond the work that lead to the first DNA fingerprint." –Sir Alec Jeffreys, University of Leicester

Talks from an astronaut, a lord and a knight

The consortium attracted over 400 guests, who heard from high-profile keynote speakers including:

Dr Helen Sharman OBE – first Briton in space, now Departmental Operations Manager at Imperial College London.

Professor Lord Kumar Bhattacharyya Kt CBE FREng FRS – Professor of Manufacturing and Chairman of the Warwick Manufacturing Group, University of Warwick, Trustee of the Institute for Public Policy Research.

Professor Sir David Greenaway, Vice-Chancellor, University of Nottingham.

These distinguished speakers focussed on broader issues around technical skills and education including the importance of technical skills in driving forward innovation, and current initiatives to ensure the future provision of technical education to young people.

"Technicians are usually the unsung heroes and heroines of university life. More than just enabling practical laboratory classes and research, technicians are the glue without which huge chunks of university life would fall apart. Properly recognising technical skills and ensuring full developmental support will ensure universities benefit fully from this wealth of resource." - Dr Sharman

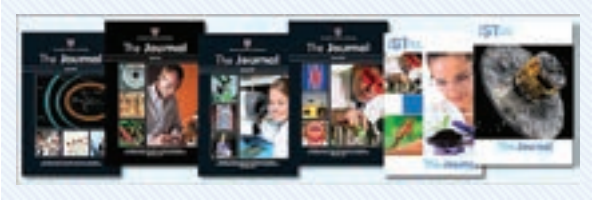
"Technicians play a vital role in supporting STEM subjects in universities and contribute enormously to research, education and outreach activities. I am delighted to see that education and apprenticeship opportunities for technical roles have increased over recent years, and this will encourage more young people to embark on a technical career." - Lord Bhattacharyya

"The summit has created a sense of community within the technical pool. It has given people the chance to come out, meet new technicians and see that technical roles can be a career not just a job. If you stripped out the technician workforce at the University of Manchester the work would stop. This event has really brought the message home that technicians are essential." - Rachael Watkins, a technician at the University of Manchester

IST Journal Publication

Back copies of our bia nnual Journal publication are ie wable online, but access is restricted to our current members only. Members can log in using their surname as the username and their date of birth f ormat: yyyym md d)a s their password.

The Journal Back Issues
http://istonline.org.uk/ist-journal-publication



If you experience any problems accessing the publications please contact us (office@istonline.org.uk), quoting your Surname, Membership Number and Date of Birth.

Article submissions for the IST Journal

We welcome article submissions from all areas of pure and applied science, and all areas of technology, including areas such as IT, media, and the arts. We like to cover existing, historical, and new technological ada nces, and also unusual aspects of science. We particularly want to encourage submissions from people who want to publish for the first time, and can offer help and assistance in putting a first article together.

Contact the editor: **i.moulson@istonline.org.uk**
O the IST office: **office@istonline.org.uk**

The guidelines for article submissions to the IST Journal are:

1. Article submission deadlines for 2015/2016 are;
   - **Autumn edition is 31st July.**
   - **Spring edition is 31st January.**

2. Articles should be submitted electronically in Microsoft Word .doc format with images sent separately as JPEG files (in the highest resolution possible please as we may not be able to reproduce low resolution images). Please cross reference to images and captions in your article text.

   This is our preferred option but other formats can sometimes be accommodated; please contact the Editor.

3. Short articles: these can be submitted in any length up to roughly 2000 words.

4. Major articles: these are normally no longer than roughly 6000 words per edition, but please contact the Editor for longer submissions as they can usually be accommodated across two or more editions.

5. All accepted articles will be edited into the IST Journal's house-style and may be corrected for grammar. Text layout and images may be changed, altered or omitted.

6. All articles must be written in UK E glish. (If E glish is not your first language, you should ask an E glish-speaking colleague to proofread your article.) Poorly translated articles may be declined by the editors.

7. Article submissions should be submitted via email to **office@istonline.org.uk**. Your email should clearly state "Journal Article Submission" and the article and images sent with it as separate email file attachments.

We can provide subscriptions for hard copies of our Journal – rates for 2016 are as below, for further details please contact **(office@istonline.org.uk)**:

UK - £25 per year (2 editions per year)
E - £40 per year (2 editions per year)
Non E - £55 per year (2 editions per year)

Communications and the IST

We are working hard to ensure that we provide our members with the best service that we can, and one of the areas that we have updated is our communications. There are now a number of ways in which we can stay in contact and provide information for our members.

Email - This continues to be our preferred method for direct contact with our members, particularly as we have a significant number of overseas colleagues for whom hardcopy mailings can be problematic (and costly).

Our main email addresses are:

office@istonline.org.uk - general enquiries

memberships@istonline.org.uk - enquiries regarding new memberships and renewals

registrations@istonline.org.uk - enquiries regarding CSci/RSci/RSciTech registrations and renewals

It is important that we have everyone's up-to-date email address so if yours changes please let us know.

Website **(istonline.org.uk)** - We post both important announcements and general information that we think will be useful for our members on our website, so visit us there on a regular basis to see updates.

Social Media – We use social media routes for quick communications, networking and hope to encourage both members and non-members alike to engage in online discussions and provide ideas and feedback. The platforms that we use are:

Twitter (@stonline) - we encourage ideas, feedback, and discussions using **#istforum**

Facebook (institute.of.science.and.technology) - feedback, ideas and comments welcome

LinkedIn and Google+ - join in group discussions, links through to these groups (and our Twitter account and Facebook page) are available on our website.

Applying for Fellowship

FIScT

Fellowship of the Institute is the most senior grade available and is an indicator of a very high level of achievement in the field and an outstanding contribution to the profession.

Fellowship candidates will require considerable experience gained over a number of years of responsible work and be able to demonstrate important achievements relating to the application of science, technology or management skills. Fellows of the Institute are elected by the Executive on the recommendation of a Fellowship Panel which comprises at least 3 Fellows of the Institute in good standing. The Fellowship Panel will take into consideration, in support of each application, qualifications, professional work experience, length of service, supervisory ability, contribution to the advancement of science and/or technology and the candidate's commitment to furthering the aims and objectives of the IST.

Individuals may be nominated for Fellowship by existing members of the Executive of the Institute or they may apply in their own right using the appropriate form available from the Registered Office or the IST's website. The same criteria apply in either case although the process differs slightly. Guidance information in respect of the application process is also available on the website.

New Fellows are expected to contribute to the advancement of the IST and to play a full and active role in promoting the institute. In their first year of membership new Fellows will also be encouraged to submit a suitable article for publication in the IST's biannual Journal.

Application forms and guidance documents can be downloaded at **(istonline.org.uk/membership/fellow)**.
T: 0114 276 3197
E: office@istonline.org.uk

Application for membership

Membership

Membership of the Institute is open to specialist, technical, and managerial staff in a broad range of environments such as science, engineering, industry, local authorities, schools, FE, HE, research/analytical/ health facilities, government departments, and many more in the UK and overseas. There are five grades of membership in the Institute. An applicant does not initially apply for a specific grade of membership, the grade offered by the Institute being dependent upon the qualifications and experience of the applicant.

Why Join?

To help us maintain, build and expand the (IST) community.

IST can help by supporting and developing your:

- career and interests
- professional standing
- knowledge and skills
- network of contacts

Together we can be a voice to be heard and listened to.

Application for membership at Junior, Affiliate, Associate and Member grades can be made by email or by post to the IST office using the standard application form which is available for download **(http://istonline.org.uk/membership/)**. The form must be accompanied by a copy of each relevant certificate, diploma etc. (scanned copies sent electronically are accepted). Completed applications should be emailed through to **memberships@istonline.org.uk** or posted to our Sheffield Office.

Membership Application Notes for those applying for membership are available **(http://istonline.org.uk/membership/).**

When an application has been accepted, the applicant will be notified of the grade offered, at which time a full subscription payment will be required (within one month of notification). After the subscription has been received the new member's name will be added to the Register of Members and a Certificate and member's card will be sent. Following entry on the Register members are entitled to the designated post-nominal letters relevant to their grade.

Membership fees are:

- Junior: £5
- Affiliate: £20
- Associate: £35
- Member: £45
- Fellow: £58

*Retired or unemployed members can claim a reduction of 50% off the normal rate

Previous members whose membership may have lapsed can apply for reinstatement by completing and returning a Membership Reinstatement Form to **memberships@istonline.org.uk**

Payment of subscriptions can now be made online

What we're about

The Institute of Science and Technology has been supporting specialists with the technical skills that the world's economy needs for more than 66 years. We represent all sorts of technicians, experts, and managers wherever they work: from science labs and engineering facilities to recording studios and IT departments.

As technology continues to develop at a tremendous pace, the IST is there to help technicians be the best they can be. We encourage our members to further their careers by pursuing professional and personal development, and by attaining a professional status that recognises the value of their experience and expertise.

In that way, we are always thinking about the future for our members and the organisations they work for. It is our mission to ensure that industry, business, research, schools, colleges, and universities have the staff they need to keep up with constant advances in science and technology.

Central to this is the IST's belief that technicians deserve formal recognition for the work that they do, the experience they've racked up and the expertise they have to share. We know that our members are skilled professionals, and now we can give them official accreditation as a Chartered Scientist (CSci), Registered Scientist (RSci), Registered Science Technician (RSciTech) or Registered Practicioner (MISCTReg) or FISCTReg)) to prove it.

By registering, technicians are promoting the professional standing of themselves and their colleagues. They are showing that they are making a vital contribution in their fields and achieving a status that makes them a key asset for the long-term.

We are working hard to bring technicians from all disciplines into our international community of specialists. Our members work across a wide range of fields, which gives each of them the chance to make contacts across business, industry, research, and education, and address the challenges these areas face together.

There is advice and guidance available for members (particularly new or young ones) through the IST's Mentoring Support Network. Our work with organisations such as HE TB and unionlearn, promotes the professional development of technicians in all areas. Together, we are ensuring technicians get the support and opportunities they need to achieve their potential.

We know how important it is for technicians to be able to develop their skills and have their expertise recognised. We know too, as we look to the future, that many more highly skilled technicians are needed. That's why the IST has dedicated itself to continuing to raise the status of specialist, technical and managerial staff and to continue to support their progression.

The IST is an organisation run by technicians for technicians.

The number of skilled technicians joining the IST's registration scheme is growing fast. That's because more and more of our members are discovering the great benefits and opportunities that professional recognition can bring.

The IST is one of the Science Council's Licenced Bodies and can now award Chartered Scientist (CSci), Registered Scientist (RSci) or Registered Science Technician (RSciTech) status to experienced technicians.

To register, you simply need to show that you have, and use, the skills that qualify for professional status, while always continuing with your professional development. A full explanation of what you need to do to get registered status can be found on the IST website: **istonline.org.uk/professional-registration**

In addition, the IST is running workshops in different organisations to explain the application process in more detail. If you are interested in one of these workshops, and there is enough interest where you work, email **office@istonline.org.uk**

You can also meet some of the people who have registered so far by visiting our website: **istonline.org.uk/professional-registration/case-studies**

The Institute of Science & Technology

Kingfisher House, 90 Rockingham Street
Sheffield S1 4B

T: 0114 276 3197 E office@ stonline.org.uk
F: 0114 272 6354 W www.istonline.org.uk

Not working in science or science technology?

IST Registered Practitioners

The Institute of Science and Technology is uniquely an organisation run by technicians for technicians. We support these incredibly important staff in all areas, not just science but technologists in all fields.

As the professional body for specialist, technical and managerial staff, we are actively involved in the professional recognition of technical staff in education, research, government, and industry. It is our view that our Registration Schemes are essential to establish your professional standing, acknowledge your expertise and to enhance your career prospects.

Technicians and technologists working in non-science fields may not be eligible to join the Science Council's Registers but the IST recognises the exceptional work that technicians and technologists working in non-science fields do. We are committed to providing all our members with a means to endorse their status and to enable them to demonstrate transferable skills, up-to-date professional competence, and continuing professional development. We do this through our **Registered Practitioner Scheme** and by the designation of **MISCT(Reg) or FISCT(Reg)** status to members who meet the criteria.

Registered Practitioners must have attained a high level of technical proficiency supported by sufficient knowledge of modern technology to enable them to relate to operating practices in their chosen field.

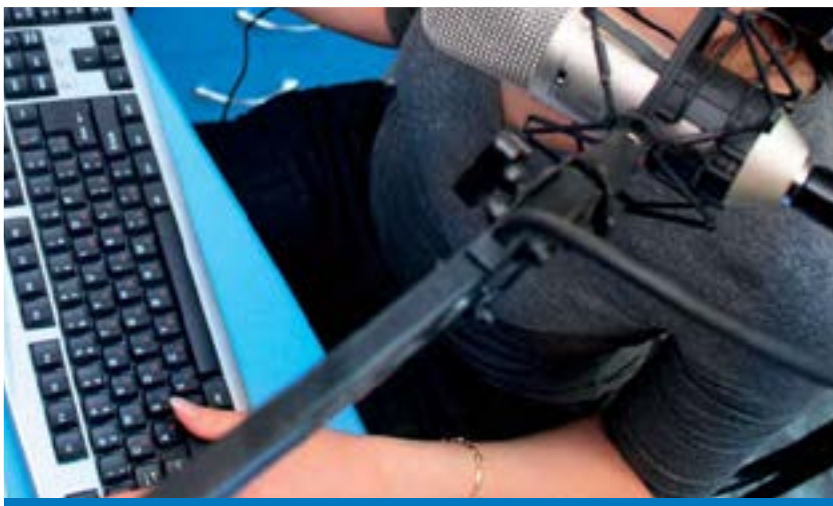
Criteria for Registration include:

- Corporate Membership of the Institute of Science & Technology
- Higher National Certificate or Diploma (other qualifications judged to be of equivalent standard also satisfy the requirements)
- NVQ/SVQ level 3 or 4 in an appropriate occupational area
- Completion of the HEaTED/IST CPD award*
- Appropriate experience (in terms of breadth, depth and length)

Importantly, there is also a route for mature applicants who have achieved a high standard of professional competence but who may not have the formal academic qualifications.

Registration is renewed each year with evidence of Professional and Personal Development. There is a small fee for admission to the Register and a nominal annual renewal fee.

* The IST CPD award can be used to demonstrate CPD activity for the RSci, RSciTech and RegPrac schemes and fulfill associated registration scheme competencies. Individuals automatically become members of the IST, and although the IST CPD award is not a qualification it does allow the individual to formally demonstrate work based experience and learning.



Want to find out more?
Visit http://istonline.org.uk/
Follow us on Twitter @istonline

The Institute of Science & Technology

Chartered Scientist
Registered Practitioner
IST CPD Award
Registered Scientist
Registered Science Technician

Since 1987, the Institute of Science & Technology has operated a Register of competent and qualified technical practitioners

New members and registrations

New members March 2015 – September 2015

Mem No.	Name	Grade
T15378	Mrs O Ekundayo	MIScT
T15379	Mr T E iamiatoe	MIScT
T15380	Dr J J Bomphrey	MIScT
T15381	Mr A D chard	MIScT
T15382	Mr E made	MIScT
T15390	Mr I Walker	MIScT
T15391	Mrs J C Fenton	MIScT
T15392	Mrs S M Cordon	MIScT
T15393	Mrs M R Killion	MIScT
T15394	Mr F D masekhomwan	AssocIScT
T15395	Mr S O gbua	MIScT
T15396	Mr D I D onsaye	MIScT
T15397	Mr S G onuwa	AssocIScT
T15398	Mr A C Hooper	AssocIScT
T15399	Mr N P Igiebor	MIScT
T15400	Miss E S K adiri	AssocIScT
T15401	Mr A K Aziegbe	AssocIScT
T15402	Mr J G obudeh diado	AssocIScT
T15403	Miss E J Ba rtkowska	MIScT
T15404	Mr S P Fletcher	MIScT
T15405	Mrs J Coaker	MIScT
T15406	Miss L G egory	MIScT
T15407	Mr A E uavoen	AssocIScT
T15408	Miss V Cottam	AssocIScT
T15409	Mr J A li	MIScT
T15410	Mr O A Ayodele	MIScT
T15411	Mr S A Mason	MIScT
T15412	Miss O N aeze	AssocIScT
T15413	Miss L J H unt	MIScT
T15414	Mr S Hale	MIScT
T15415	Mrs F G n eribe	AssocIScT
T15416	Ms P Hepplewhite	MIScT
T15417	Mr I C Raycraft	MIScT
T15418	Miss A T G b ochie	AssocIScT
T15419	Mrs F M P eseitan	MIScT
T15420	Mrs A I Omosigho	AssocIScT
T15421	Mr R S Moss	MIScT
T15422	Mr E D einne	MIScT
T15423	Mr M P Martin	MIScT
T15424	Mrs B Mangnall	MIScT
T15425	Mr E R L G nard	MIScT
T15426	Mr A J. umby	MIScT
T15427	Miss K L N holson	MIScT
T15428	Mr L Walker	MIScT
T15429	Mr J R ustidge	MIScT
T15430	Mr C Carpenter	MIScT
T15431	Mr S G b onnaya	AssocIScT
T15432	Mr C M Haaga	MIScT
T15433	Mrs M Millin	MIScT
T15434	Dr L Potiphar	MIScT
T15435	Mr A N man	AssocIScT
T15436	Mr F S Akinboro	MIScT
T15437	Mrs R G ori	AssocIScT
T15438	Mr I E N odim	MIScT
T15439	Miss N E lis	MIScT
T15440	Dr R W alley	MIScT
T15441	Mr A W l ey	MIScT
T15442	Miss L Farrell	MIScT
T15443	Mr E h aguosa	MIScT
T15444	Miss t m	MIScT
T15445	Dr C J W ittington	FIScT
T15446	Mr B E R ush	MIScT
T15447	Mr J D hama	AssocIScT
T15448	Mr H McFarlane	MIScT
T15449	Mrs S L G lloway	MIScT
T15450	Mr A Brandwood	MIScT
T15451	Dr. O A kien	MIScT
T15452	Dr J C rosse	MIScT
T15453	Dr M Hodges	MIScT
T15454	Mrs M D Bates	MIScT
T15455	Dr A C Ryan	MIScT
T15456	Mr T S G egson	MIScT
T15457	Dr V V Karloukovski	MIScT
T15458	Mr J Sellwood	MIScT
T15459	Ms V E f a	MIScT
T15460	Dr J A ndre	MIScT
T15461	Mr D L Lath	MIScT
T15462	Mrs M Biskupska	MIScT
T15463	Dr A Knight	MIScT
T15464	Dr J V Baum	MIScT
T15465	Mr P C Pickstock	MIScT
T15466	Ms M Harrison	MIScT
T15467	Mr D Andrew	MIScT
T15468	Mrs C G aingerBou ltby	MIScT
T15469	Dr E M Fitzcharles	MIScT
T15470	Mrs J Doubell	MIScT
T15471	Mr T L N pier	MIScT
T15472	Mrs R A Adedokun	MIScT
T15473	Dr O N en	MIScT
T15474	Mr P R Nott	MIScT
T15475	Miss K McLaughlin	MIScT
T15476	Mr C E J ry	MIScT

Science Council Registrations

Mem No.	Name	Grade
T15477	Mr D A Affram	MIScT
T15478	Mrs H Blagbrough	MIScT
T15479	Mrs H Murden	MIScT
T1548[illegible]	Mr M J[illegible] ford	MIScT
T1548[illegible]	Mr C [illegible] agbara	MIScT
T1548[illegible]	Mr K Wah[illegible] oon Ho	MIScT
T1548[illegible]	Mr M I McIntosh	MIScT
T1548[illegible]	Dr A J[illegible] allaway	MIScT
T1548[illegible]	Mr D Fox	MIScT
T1548[illegible]	Mr C [illegible] auf	MIScT
T1548[illegible]	Mr F [illegible] eobawaye	MIScT
T1548[illegible]	Dr C [illegible] Stevenson	MIScT
T1549[illegible]	Dr T H Bishop	MIScT
T15490	Mr D H Peet	MIScT
T15491	Mr P R Cooling	MIScT
T15492	Mrs S J[illegible] ellington	MIScT
T15493	Miss [illegible] art	MIScT
T15494	Mr A D Parsons	MIScT
T15495	Dr [illegible] rgent	MIScT
T15496	Mr [illegible] edare	MIScT
T15497	Miss N J[illegible] holson	MIScT
T15498	Mr F Bayer	MIScT
T15499	Mr K A [illegible] ringe	MIScT
T15500	Mrs B Frater	MIScT
T15501	Ms S L[illegible] mie	MIScT
T15502	Ms C Campbell	AssocISCT
T15503	Mrs D K Hurst	MIScT
T15505	Mrs H J[illegible] irk	MIScT
T15506	Mrs K Thomson	AssocISCT
T15507	Mr A [illegible] son	MIScT
T15508	Mrs Keat	MIScT
T15509	Mr D R Callaghan	MIScT
T15510	Mr T Booth	MIScT
T15511	Mr M A Foster	MIScT
T15512	Mr D C Chilton	MIScT
T15513	Ms M King	MIScT
T15514	Dr C V Manu[illegible] le	MIScT
T15515	Mr S R [illegible] dhale	MIScT
T15516	Ms R M Austin	MIScT
T15517	Mr C Lloyd	MIScT
T15518	Miss [illegible] Thomas	MIScT

Total: 133

Mem No.	Name	Grade
T14940	Miss J[illegible] Porter	RSciTech
T15128	Mr R Markwell	RSciTech
T15320	Mr [illegible] McIntosh	RSciTech
T15371	Mr L J[illegible] oore	RSciTech
T1538[illegible]	Mr A [illegible] chard	RSciTech
T15439	Miss [illegible] lis	RSciTech
T15441	Mr A [illegible] ey	RSciTech
T14917	Mr S M Haynes	RSci
T14948	Mr G J[illegible] holson	RSci
T14964	Mr [illegible] unt	RSci
T15106	Ms F J[illegible] right	RSci
T15194	Mr A Patrick	RSci
T15260	Miss K [illegible] urowska	RSci
T15277	Dr R H M Cornock	RSci
T15296	Dr Moorehead	RSci
T15361	Mr [illegible] ehton	RSci
T15375	Miss K M Lis	RSci
T15376	Mr A Townshend	RSci
T15403	Miss E J[illegible] rtkowska	RSci
T15405	Mrs J Coaker	RSci
T15409	Mr J Ali	RSci
T15413	Miss L J[illegible] unt	RSci
T15416	Ms P Hepplewhite	RSci
T15417	Mr I C Raycraft	RSci
T15421	Mr R S Moss BSc	RSci
T15424	Mrs B Mangnall	RSci
T15442	Miss L Farrell	RSci
T15468	Mrs C [illegible] aingerBou ltby	RSci
T15471	Mr T L [illegible] pier	RSci
T15491	Mr P R Cooling	RSci
T15510	Mr T Booth	RSci
T1488[illegible]	Mr S Miah	CSci
T15246	Mr G J[illegible] assmore	CSci
T1528[illegible]	Mr A Chakrav[illegible] rtty	CSci
T15324	Dr K Seunarine	CSci
T15337	Dr B T J[illegible] yer	CSci
T15359	Ms V S Affleck	CSci
T15414	Mr S Hale	CSci

Total: 38

IST Technical Conference 2015

Ben Palmer

A full main hall for the start of the 2015 IST Conference

On the 10th of September the IST was delighted to welcome the return of its annual conference aimed at technical staff across all disciplines. Over 160 delegates descended upon the Met Hotel in Leeds for an enjoyable and informative day of workshops and talks, not to mention a great opportunity for networking with other like-minded technicians!

After initial registration and refreshments the day opened with Terry Croft, Chairman of the IST, welcoming the delegates and outlining the key role the IST plays as the voice for technicians across a wide range of sectors, both within higher education and industry. Terry emphasised the important initiatives that the IST are currently involved with, such as the Catalyst Project, which aims to bolster technical career structures and lead to an understanding of future technical needs in HE. The morning's keynote talk was then delivered to a full auditorium by Professor Vanessa Toulmin, Director of the National Fairground Archive and Head of Cultural Engagement at the University of Sheffield. Vanessa delivered an enthralling talk regarding the importance of technical support in delivering successful public engagements, giving examples from several public events, such as the Festival of the Mind. The success of these events certainly wouldn't have happened without key technical staff, often operating in the background, working hard and utilising their technical prowess to deliver engaging and fun events for the public.

Professor Vanessa Toulmin delivers the morning's key note talk "All you have to do is turn up - the importance of technical support in public engagement"

Registration – over 160 delegates registered for the day

The conference's packed programme included 2 highly motivational talks from keynote speakers, plus 3 technical workshops (chosen from the 12 available) throughout the day.

Delegates had the choice to attend workshop sessions covering a wide range of topics. This broad spectrum of topics, all relevant to the technical community, seemed to have great appeal to the diverse and varied technical audience. I know that the IST was extremely delighted to welcome the presenters of this year's conference workshops. They were all from a very wide range of backgrounds, and had kindly given their valuable time to lead the workshops.

The opening session saw workshops being delivered concerning: understanding chemical labelling and data sheets led by Philippa Nobbs, approaches on how to effectively plan your technical career by Natalie Kennerley and Kevin Oxley, how to apply for the Science Council's technical registration scheme presented by Michelle Jackson and Krystena Callaghan, and a presentation regarding 3D printing and the future of additive layer manufacturing by James Hunt of the Mercury Centre. All the workshops were well subscribed and warmly received by the delegates.

Following refreshments a second suite of workshops began in earnest. Again, a diverse range of topics were on offer to appeal to the wide membership of the IST.

Neil Windle, Counter Terrorism Security Advisor - West Yorkshire Police, delivering his workshop

Presentations included a talk on counter terrorism by Neil Windle, from West Yorkshire Police. Neil led a gripping discussion about the current state of affairs regarding the terrorist threat in the UK and also what positive actions can be taken in the workplace to mitigate any potential threats. Other workshops included how to develop a taught course in your area of expertise in order to generate income, presented by Natalie Kennerley, food technology and how flavours are created by Geoff Passmore, and finally a presentation by Dr Rachel Crossley and Sue Churm from HEaTED detailing how the organisation supports the professional development of technical staff.

Rachel Crossley and Sue Churn presenting their workshop "Supporting the professional development of technical staff"

Natalie Kennerley presenting her workshop on how to develop a taught course

Lunch soon followed and as well as key time of networking, this allowed time to peruse the posters that had been brought along by some of the delegates which were later to be subject to a poster competition and the chance to win an IPad Mini! The food hall was bustling with activity as people discussed the events of the day so far and also took the opportunity to visit the suppliers' exhibition and speak directly with representatives from companies, including Mazurek Optical Services, Thermo Scientific, HEaTED, SLS and Sarstedt. Comments from other delegates so far regarding the conference were positive, with many people stating how good it was to be able to come away from the workplace for the day and be able to chat to so many other like-minded individuals.

After a satisfying lunch the second keynote of the day was delivered by Roger Dainty MBE, UK Managing Director of Future Health Technologies Ltd. Roger gave a gripping account of his career history and rise through the ranks from working as a molecular biology technician to leading the largest stem cell repositories in the UK. Roger highlighted how technicians in academia can often pigeon hole themselves into thinking the transition to industry would be difficult, whereas quite the opposite is often the case given the wide ranging skill sets that many technicians in academia do possess. It was pleasing to hear about what a success Roger had made of his career and the strength of his business, and also to hear of real world examples of successful treatments utilising stem cells.

"The wide range of workshops included specific career development sessions as well as more general interest sessions on subjects of interest to the technical community, meaning there was something for everyone. I found the session on 3D printing particularly interesting, and a great opportunity to learn about this exciting innovation from an expert in the field. Both keynote speakers gave thought provoking presentations that had a broad appeal, and the conference also provided the opportunity to network with colleagues from other institutions"- Jennifer Louth, Technician at the University of Sheffield

The final set of workshops of the day included presentations from Tim Dennet of the Environment Agency regarding quality assurance and guidelines, three mini workshops concerning laboratory awareness by representatives from Thermo Scientific, a talk by Dr Jane Blunt, Safety Officer at the Cavendish Laboratory, about how to correctly select the appropriate gloves and respirators for handling chemicals, and a workshop by David Luckhurst, Technician at the University of Wolverhampton, about how to film and create teaching media for others. David described the process taken to successfully create teaching media, particularly in the laboratory, as well as what specific hardware and software may be required.

"David's workshop on producing learning media was well presented, and full of practical tips that will be very useful. The conference as a whole was well organised and enjoyable." - Beverley Lane, Departmental Safety Officer at the University of Sheffield

Following the final workshop sessions delegates congregated in the conference auditorium for Terry's closing remarks. He thanked all those who had been involved with the conference and also outlined the IST's plans for an even larger conference next year so watch this space!

Finally, Nate Adams, who started his career from a technical background to become a university researcher and a TV presenter, announced the three separate IST Awards. Each award winner received a certificate and an IPad Mini.

Nate announces the IST Award winners

The three awards were provided by the IST's John Robinson Fund, for recognising achievements very much in the spirit of John's generous legacy to our institute.

IST Award for Outstanding Contribution 2015

James Trout, Environment Agency

The IST Award for "Outstanding Contribution" acknowledges the exceptional contribution that James has made to his workplace, sector, the technical community, and the IST, and recognises his effort and dedication to professional development initiatives.

James accepting his award from Terry Croft, IST Chairman

IST Award for Outstanding Trainee/Apprentice 2015

Stephen Burgess, University of Leeds

The IST award for "Outstanding trainee or apprentice" acknowledges the exceptional and much valued contribution that Stephen, as a newly-trained technician, has brought to the technical workforce where he works. It recognises his commitment, dedication, and performance in his work for the School of Earth & Environment Instrument Workshop.

Stephen accepting his award from Terry Croft, IST Chairman

IST Award for Best Conference Poster Presentation 2015

Michelle King, British Antarctic Survey

The IST Award for "Best Poster Presentation" recognises the most outstanding poster presented during the IST Conference 2015. Michelle's poster "Life in the freezer, Bubbles Boulders & Beasties" won for its clarity of the submitted material, novelty, and visual impact.

Michelle receiving her award from Terry Croft, IST Chairman

The whole conference had been an engaging and thoroughly enjoyable day, an excellent opportunity to network with other like-minded technicians, with a wide range of interesting and informative workshops and talks. I'm really looking forward to next year's conference!

Thanks to the sponsors of The IST's Technical Conference 2015

"For over 50 years, Sarstedt has been one of the world's leading providers of laboratory and medical equipment. We develop, manufacture and distribute consumables in the field of medicine and research. Our company is well known for 'High quality, High-performance and Made in Germany' products and an uncompromising commitment to customer requirements"

SARSTEDT

Instruments and Disposables for Medicine and Science

MAZUREK Optical Services

SCIENTIFIC LABORATORY SUPPLIES

Thermo SCIENTIFIC

SARSTEDT

HEaTED

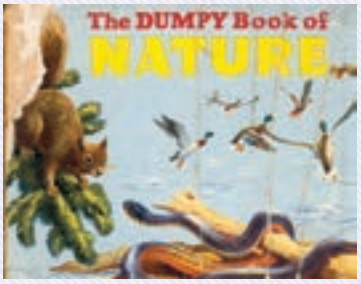
Watkins & Doncaster, the naturalists

Alan Gall, IST Archivist

English Swallowtail, used as the basis for the Watkins & Doncaster logo (courtesy of Robert Goodden, Worldwide Butterflies)

Catalogue covers (courtesy of Amy Wells, Watkins & Doncaster)

Preamble



Well-worn, the 1957 edition of The Dumpy Book of World Nature

A fondly remembered Christmas present from childhood is *The Dumpy Book of World Nature*, still in my possession over fifty years later. Browsing chapter thirty on the subject of butterflies and moths (lepidoptera) inspired me to contemplate studying insects and so I acquired a Watkins & Doncaster catalogue, price one shilling. A chance conversation with a business acquaintance in much more recent times revealed that his company was sharing a building in Kent with none other than Watkins & Doncaster. I mentally tagged the little green catalogue for further consideration. After the passage of a few more years, or possibly longer, it is the inspiration for this article.

Introduction

The nice thing about the firm of Watkins and Doncaster is this: throughout its history it has been run by people whose interest, passion and business activities were one and the same. It has also survived for approximately 140 years. Locations have varied but the name has endured as a tribute to the reputation that began with the original partnership of William Watkins and Arthur Doncaster.

Watkins & Doncaster catalogue acquired by the author c. 1960

In nearly a century and a half, William Watkins was involved in the enterprise for only a year or two. Yet his story is, I believe, worthy of telling at length (and we share the same date of birth, 99 years apart). He operated in a world where rich Victorians spent vast sums on building up collections of butterflies and moths. It was an obsession that William Watkins shared. He compromised his health by joining a regiment destined for India where cholera and other tropical diseases afflicted the troops, and as a result was discharged as unfit for duty, dying at the age of 51 after several bouts of illness. His death seems to have unhinged his daughter who subsequently spent a number of years in lunatic asylums.

Arthur Doncaster ran the firm for 46 years. Deaf from birth, he managed dialogue with customers by means of a slate and chalk. The Doncasters were an influential business-owning Quaker family, related to the Rowntrees of chocolate fame. Arthur's brother Samuel was also a keen lepidopterist, although he confined this to a hobby. Samuel's son Leonard became a professor of zoology.

From 1925 to 1940, Watkins and Doncaster operated under Arthurs on etim e assistant, Frederic Metté. It has been said that during this period the business declined. If Frederic lacked commercial acumen, he was just as keen on natural history as his predecessors. After his death, however, there was about a year when the firm was "rudderless" because Frederic's son had been called up to join the forces.

In the paraphrased words of Winston Churchill, another butterfly lover, this was not the beginning of the end but the end of the beginning. Control passed to Richard Ford. Under the Fords, the stuffed animals, eggs and insects moved from the original site at 36 Strand, London, to Welling, then Four Throws in Kent and finally to Golderfield, in Herefordshire. During that time, three successive generations of the family held the reins. Robin Ford joined his father Richard straight from school. Later, Robin's wife Julia became a partner. Almost three-quarters of a century after Richard Ford took over the ailing naturalists, Watkins and Doncaster is still functioning, now in the hands of his granddaughter Amy.

Part 1: William Watkins, "The Butterfly King"

... he is happy in the enjoyment of remarkable health and vigour. In fact, he is something of a Hercules in build. A n interie w with W liam Watkins, *Eastbourne Gazette*, 30 May 1894.)

Appearances can be deceptive. The reporter who enthusiastically penned the above was no doubt unaware of William's long-standing heart disease, and generous in his description of a stature that measured less than five and a half feet. Within six years of the interview, newspapers declared: "The Butterfly King is dead".

William Watkins as shown in the Eastbourne Gazette, 30 May 1894

The son of Cornelius Dav d Watkins, W liam was born 8 M ay 1869 a t the G l den Horse on Aldersgate Street, London. Cornelius's father, Harry, ran the pub and Cornelius moved on to become licensee of the "Man Loaded with Mischief" at 414 X ford Street.[1] The *Eastbourne Gazette* spoke of W lliam's "Welsh extraction". If true, this must have been from ancestors further back than his grandparents.

Around the age of nine, William Watkins attended Ebenezer Lodge, a boarding school in the village of Lingfield, about 3 miles north of East Grinstead, Surrey. There, his growing infatuation with collecting received a boost from the proprietor of the school, Lemuel Allingham Westcott. Westcott had studied botany and encouraged young William in studying natural history.

W lliam's parents persuaded him to take up a position at the London ship and insurance brokers Cheeswright & Miskin as an articled clerk. This time there was even more incentive to continue with a "hobby" that soon became a consuming passion. Stimulation now came from one of the partners, W lliam Thomas Miskin, himself an av d collector.

On the 27 April 1886, W lliam captured a *Notodonta carmelita* moth at West W ckham. He was particularly proud of this and wrote to *The Entomologist*: "I had the pleasure of taking a fine female specimen of this rare insect off the Bishop's Fence;[2] it had only just emerged from the pupa, as the wings were not dry. I took it at exactly 8 A.M." Twenty-eight years later he still remembered that day and elaborated for the E stbourne G zette's reporter: "An old collector was an hour later, and very much regretted that he did not get the *carmelita*, as he would have no difficulty in selling it for £8. "

The location of The Man Loaded with Mischief. It was rebuilt in 1900, by then known as The Primrose and by 1915 The Shamrock. As a result of renumbering it is now at 53 Oxford Street (image credit: Stephen Harris, photographed December 2009)

At the time of the *N. carmelita* episode, W lliam was still living with his parents at the "Man Loaded with Mischief" public house, although his father gave up the licence in the same year. Life as a clerk with Cheeswright & Miskin did not suit W lliam, but what to do next?

Army career

Map of Indian subcontinent

At the age of nineteen, on 1 September 1868 William joined the 76th Foot, a regiment originally raised to serve in India. The regiment returned to India in 1863 and in 1868 moved to Burma. William was posted to the Thayetmyo base in the south of Burma, situated on one bank of the Irrawaddy river. Shortly after arriving on 10 March 1870, there was an outbreak of cholera. A report by the Army Medical Department notes that in the 76th Foot there were 28 cases and 21 deaths amongst the men.[3] By the 24 April William was able to leave camp, butterfly net in hand, and on 27 April captured a *Sphinx convolvuli* (The Convolvulus Hawk moth).[4] William would later name his house at Eastbourne "Villa Sphinx".

Private Watkins became Corporal Watkins on 31 May 1870. Three months later the regiment was on the move again, this time only travelling about two miles further up the Irrawaddy. William reported:

Tay-au-goon is a delightful place, but the heat is intense compared with Thayetmyo, which is not much to say: plenty of insects, and plenty of Lepidopterists (for half the regiment seemed entomologically struck), but no mosquito hunters; these infernal pests were terribly annoying; at night one would hear them apparently a great distance off, and in a second they would dart right into one's ear.[5]

The spelling Tayaugoon may be incorrect, as no such name seems to exist. There is, however, a reference to Taraugon camp, sited at Allanmyo, at the appropriate location on the Irrawaddy.[6] Temporary barracks were constructed there for the transfer of troops during an outbreak of disease. William made use of the jungle location: "For the collection made this month I can thank the generous-hearted government for ordering our shift."

Further promotion came. On 5 October 1870 William achieved the rank of Sergeant and in February of the following year the 76th Foot made its way to Secunderabad, where William acted as Orderly Room Clerk. At the ripe old age of 22, he was diagnosed with heart problems, although the condition didn't immediately affect him enough to disrupt duties. On the subject of collecting insects at Secunderabad, William had this to say:

Undoubtedly I could have done better than I did if I had the time and health: in common with many others this failed me in that wretched station, most appropriately named the Graveyard of India.[7]

In February 1872 William was sent to the Convalescent Depot at Wellington, in the Neilgherry Hills, running along the southwest of India. A difficult journey since the nearest railway station was about 50 miles away by road and transport between the two came in the form of bullock carts.

The *Army Medical Department Report* of 1870 makes Wellington sound like a Butlin's holiday camp, with a racquet court, swimming pool, gymnasium and skittle alley. Men were given a daily allowance of beer (2 pints) and a dram of arrack (the local fire-water). Meals were at 8 am, 1 pm and 4 pm. The meat supplied alternated between beef and mutton (1 pound per day) and the rations included the strangely precise quantities of $^{5}/_{7}$ ounce of tea and 2 $^{1}/_{3}$ ounces of sugar. Obtaining fresh water was an interesting process.

It is conveyed thence [from wells in the hillside] by a pipe to a place close to the barracks, whence it is carried, in large mussacks (bags made of hide) slung over the backs of bullocks, by the puckallies (water-carriers), and by them distributed to the filters, which are placed in the different barrack verandahs. These filters consist of three chatties (pots made of burnt clay) placed one above the other on tripod stands. The upper two contain some course sand and charcoal, and have a small hole in their bottoms to allow the water to percolate to the chatty below. I am unable to give an analytical report of the qualities of the water as the Government box of apparatus and reagents for chemical analysis has not yet been supplied to this station.[8]

Chinese Oak Silkmoth (courtesy of Robert Goodden, Worldwide Butterflies)

William wasted no time and his net was soon in action again. It seems that others shared his enthusiasm: "Many of the men employ their leisure time in making collections of moths, butterflies and beetles, and of ferns, all of which there are a great many, and beautiful varieties to be found on these hills."[9]

The ancient Egyptian and Middle Eastern art of "sugaring" is the removal of body hair with the aid of a sugary paste. To the lepidopterist, the term has an entirely different meaning. The discovery that moths were partial to something alcoholic and sweet began to be exploited at least as early as the 1880s. There were many variations on a theme, as collectors experimented with ingredients like beer and molasses. Sugaring gave spectacular results for William Watkins who smeared treacle and rum on trees: "You get moths larger than bats by 'sugaring' in Burmah."

Robin Moth (courtesy of Robert Goodden, Worldwide Butterflies)

By November 1873 it was time for William to move out. This time to Poonamelle, on the other side of the country.

After arriving, his heart condition started to cause problems and a medical examination determined that this was likely to increase in severity. A regimental board held on 14 January 1874 found William unfit for further service and final discharge from the army came on 24 May 1874.

Back to England

On returning, William took up residence at 25 Rutland Road, Hampstead Road, London. He had accumulated quite a number of specimens in India and turned this collection into cash by selling it to the tea merchant Frederick John Horniman. The famous entomologist of the day, Henry Tibbatts Stainton said: "Take a pleasure in your business and make a business of your pleasure"[10]. William did just that, trading from Rutland Road. A valuable contact was William Chapman Hewetson who helped by providing the addresses of collectors abroad. William Watkins proceeded to build up a network of agents who could supply him with rare and exotic varieties.

Kelly's 1879 London directory lists the following: "William Watkins, Naturalist; British & exotic insects, entomological apparatus, cabinets & c 36 Strand W.C." Since entries for Kelly's directories were collected in the year before publication, he must have set up the shop no later than 1878. Watkins & Doncaster would eventually occupy the majority of 36 Strand, but initially William Watkins moved into only one of the five floors. Neighbours came and went. Shortly after arriving, business may have been conducted to the strains of J.S. Bach's Toccata and Fugue in D Minor, courtesy of Walter Venning Southgate. Southgate established an organ studio on one of the floors, offering lessons and the chance for more proficient players to practise. He was official organist at St. Michael's Church, Stockwell Park Road, London. Other occupants of the building in the early days were blue brick manufacturers Wood & Ivery Ltd, the Lift & Hoist Manufacturing Company Ltd and the National Vigilance Association.

The coleopterist (a specialist in beetles) George Lewis notified the *Entomologist's Monthly Magazine* in 1879 that he had discovered a new species of the scarab beetle. "I have named this species after Mr. W. Watkins, the well-known dealer, from whom my specimens were obtained."[11]

The background to Arthur Doncaster and William Watkins becoming partners in 1879 is not known. Perhaps William advertised for a partner, as he did later in his career. Whatever the circumstances, the collaboration lasted only a short time. Although the firm continued to be styled Watkins and Doncaster, the partnership was officially dissolved as of 16 November 1880.[12]

The reason for the split may well have been William's appointment to set up and supervise an insectarium (insect house) for the Zoological Society, in Regent's Park Gardens. It opened on 25 April 1881 and William wrote reports of the progress for the *Proceedings of the Scientific Meetings of the Zoological Society of London*. A visitor from the Royal Aquarium noted:

It is curious and amusing to walk after Mr Watkins as he goes from cage to cage, explaining their contents to numerous visitors, and to listen to their remarks, some pertinent, whilst others make me feel sad at the dense ignorance of well dressed and "educated" people.[13]

There were health issues for William while at the insectarium. He reported to the Zoological Society: "I have not been able to add a number of species that I should have wished, owing to severe illness, which suddenly attacked me on the 14th instant [14 May 1881]."[14] On and off, he reported other incapacities over the following years.

William married Amelia Widmer, eleven years younger than himself, on 23 February 1881. The couple went to live at The Hollies, Vicarage Road, Croydon, where William continued his entomological activities. Croydon lies to the south of Crystal Palace Park, once the site of the Crystal Palace buildings. The structure was originally erected in Hyde Park to house the Great Exhibition of 1851, and then reconstructed at Sydenham Hill with an official opening by Queen Victoria in 1854 (burning down in 1936). William set up his "insectarium" inside Crystal Palace, within 3½ miles of Vicarage Road as the crow flies. At this time he published a 42-page book under the title *Directions for Collecting, Rearing, and Preserving British and Foreign Butterflies and Moths*.

The births of six children have been traced to the period when William and Amelia were at Croydon. Antoinette Annie arrived first (1881) followed by Harry (1883), Casimir (1885), Leonard (1887), Daisy (1890) and Philip (1892). Daisy died at the age of one.

Poplar Admiral (courtesy of Robert Goodden, Worldwide Butterflies)

Entomologist Richard Jones notes that the curator of the Surrey House Museum at Forest Hill, London, set up by F. J. Horniman to display his natural history specimens, was a Mr C. D. Watkins (from 1888 to 1890).[15] Could this person be related to William Watkins as Richard Jones suggests? Recall that William sold the specimens collected in India to Horniman so may have had the influence to secure the job for his father, Cornelius David. Unlikely as this sounds, given Cornelius's previous profession as a pub landlord, he is listed in the 1891 census as a museum curator.

Feeling the need of a central London base, in 18 W liam advertised as a N turalist at 1 Buckingham Palace Road. He did not use this address for long. By 190 h e had opened a branch establishment at 21 Piccadilly, opposite to the Museum of Practical Gol ogy (ater the Gol ogical Museum, demolished in 1935). His displays attracted quite a bit of favourable press. The London correspondent for the *Manchester Guardian* sent this report:

Mr Watkins of Piccadilly has on view a remarkably fine collection of butterflies rarely seen in the very best museums. Amongst them is a deep blue butterfly from the Solomon Islands, not obtained without loss of life. The first naturalists who attempted to find it were eaten by the natives, together with their spoil.

"Mr Watkins" was not averse to expanding his business interests outside of serious collecting circles. He advertised mounted butterflies, then a fashionable adornment for ladies. *Myra's Journal of Dress and Fashion* commented in the January issue of 1891:

There is one point about the wearing of butterflies that renders the practice far less objectionable than that of using birds as ornaments for the dress or for the hair, and this is that the life of a butterfly is so short that it is but little curtailed by its capture ... of course no one dreams of running a pin through a butterfly's head until it is dead ..." And then went on the praise the merchandise:

... not even diamond butterflies can vie in beauty with the lovely specimens of the real insect which Mr William Watkins, formerly Entomologist to the Zoological Society, supplies for collectors, and mounted for wear.


REAL TROPICAL BUTTERFLIES.

Magnificent Specimens for Collections, correctly named, or mounted for dress adornment, evening wear and for table decoration. Six different lovely specimens 10/6. Sample one 2/6, free. Trade supplied. 100,000 specimens to select from.—WILLIAM WATKINS, (formerly Entomologist to Zoological Society), The Hollies, Croydon.—Only Address.

From Myra's Journal of Dress & Fashion, December 1890

There were even some sales of a moth repellent: "Clothes moths routed – absolutely infallible remedy against these pests; Heterocite; Tins 1s & 2s 6d: all stores or from Proprietor William Watkins, E tomologist, E stbourne."[16]

Villa Sphinx

The rather u gue address of "E stbourne" given in the Heterocite advertisement referred to Villa Sphinx, Selwyn Road, E stbourne, where W liam had taken up residence in about 192. He promptly joined a local group -th e E stbourne N tural History Society.


Colville House School, formerly "Villa Sphinx" (from the Schools' Archive of the Eastbourne Local History Society)


A statement of account sent to Ernst Hartert at the Tring Museum, a private museum owned by Lionel Walter Rothschild (© The National History Museum)

From a later sale notice we have an idea of the space available at Villa Sphinx. There were nine bedrooms, three reception rooms, a dressing room, bathroom, kitchens, larders, housemaid's pantry and about three quarters of an acre of land.[17] William set about installing butterfly cages in the garden.

The shop at 21 Piccadilly continued in tandem with E stbourne for a while. An advertisement for a manager of the London branch gives the impression that this carried on into 196, [18] although a letter to the Zoological Museum at Tring dated 4 September 195 states that it had been closed.[19]

For a 21st birthday present, Nathan Mayer Rothschild, wealthy banker and politician, gave his son a new museum building. Lionel Walter Rothschild had been amassing zoological specimens since childhood. It grew to such a size that it was worthy of opening to the public and required two curators: E nst Hartert as ornithologist (appointed 192) and Dr Karl Jordan as entomologist (appointed 193) . The Zoological Museum, Tring, provided W lliam with a customer for the, often very expensive, selections of lepidoptera sent by collectors in foreign lands.

A letter to Karl Jordan adv sed that: "I have recently taken on a very excellent Collector who has been some years collecting in Canada and also in Florida."[20] W lliam received parcels from the collectors, inspected the contents and sent them to Karl Jordan, who in turn consulted with Rothschild about the price to be offered on whatever was selected. This seemed to work out for both parties except for one particular occasion.

Dear Dr Jordan,
I sent some butterflies from Aden a few days back & yesterday received them back with my forwarding letter. Will you please tell me what this implies? that none are wanted or that I have offended by sending them. I sincerely hope that it is not the latter.[21]

Cordiality must have resumed as further letters followed, adv sing on new supplies.

Letter to Dr Karl Jordan about a collection from Toronto (22 November 1895): "I fear that there is little of interest in it but may be a few specimens will be of interest & therefore I send them." (© The Natural History Museum)

Rothschild, Jordan and Hartert edited and composed articles for the Tring museum's own journal, *Novitates Zoologicae*. William Watkins subscribed to the publication, which often contained his advertisements adjacent to those of Watkins & Doncaster, placed by Arthur Doncaster. It would be interesting to know how the two regarded each other.

The formation of William Watkins Ltd on 11 June 1895 was an attempt to raise funds. Shortly after, the scheme collapsed as a letter to the Tring museum confirms: "I want to reduce my enormous stock having lost about £600 in vain trying to convert my business into a Company so that more capital would be at command to subsidise collectors ..." The subscribers to the short-lived venture, with £10 worth of shares each, were: William's wife Amelia with four of her relatives, Cornelius David Watkins, Frederick Lowe (an entomologist) and an accountant.

To carry on the business of Commercial Entomologists and General Natural History Dealers in all its branches, to purchase and sell all Entomological Specimens, Books, etc., and to purchase, buy, or manufacture appliances usually appertaining thereto, and generally to make, sell or purchase materials, substances, and things required for or incidental to the aforesaid business.

(Clause 3b of the Memorandum of Association for William Watkins Ltd)

Health problems started to plague William in the 1890s: "Being medically advised to retire, I am desirous of negotiating for partnership or sale outright of my world-known, successful entomological business."[22] It is clear that this, and other attempts, did not produce any acceptable results and William was still trying to recruit assistance towards the end of 1899. On 9 June 1900 he died.

In the wake of William's death came further upset at the Watkins' household. Daughter Antoinette Annie started to rant and rave. Doctor A. E. Russell examined Antoinette on 18 July and wrote: "She is in a state of acute maniacal excitement, shouting constantly. She has hallucinations of vision s seeing animals where none are present."[23] Antoinette was immediately admitted to Bethlem Hospital where she stayed until May the following year.

Unfortunately, the symptoms reappeared: "She laughs long and loudly at nothing in particular and then weeps and howls also without reason ..."[24] A second spell at Bethlem followed, from April 1902 to June 1903. We know that she eventually returned to normal life because of her marriage to Walter Evan Scoggins in 1948.

Just prior to William Watkins' death, his son Casimir was moved from a private school in Eastbourne to live with a relative, Daniel Jones, and attend the Boteler Grammar School at Warrington. Casimir continued at the school from age 12 to 14. The next sighting of him is in 1910. Like his father at around the age of 20, he longed for adventure and with brother Harry travelled to Peru. The two are recorded in the Madre de Dios region, southeastern Peru, collecting fishes. This appears to have been at least partly a commercial venture as "the fish material" was sent to the natural history dealer William Frederick Henry Rosenberg, who sold the items to the British Museum (Natural History).[25] The brothers are also mentioned in connection with a collection of 17000 bird skins[26] and Hiram Bingham wrote: "... I secured in Arequipa the services of Mr Casimir Watkins, an English naturalist." These were exciting times as the Yale University expedition led by Hiram Bingham resulted in the discovery of the Inca city of Machu Picchu.

Part 2: Arthur Doncaster

The Doncasters outside the family home at 17 Broomhill Road, Sheffield, c. late 1860s/early 1870s. Left to right (standing): Samuel (1853-1934), Hannah Mary (née Barber, wife of Charles, 1845-1913), Charles (1841-1884). Left to right (sitting): David Kenway (1837-1881), Jane Eliza (1845-1897), Lucy Maria (1843-1934), Arthur (1856-1931), Anna Mary (1849-1938), Daniel (1807-1884), Maria (née Mallinson, wife of Daniel senior, 1811-1880), Phebe (1847-1924), Mary Jane (née Miller, wife of Daniel junior, 1845-1916), Helen (1833-1920).

Arthur had the disadvantage of deafness from birth but on the other hand was part of a well-to-do Quaker family with connections. His grandfather Daniel had formed Daniel Doncaster & Sons in 1778, steel makers and merchants.[27] Daniel's son, also Daniel, married Maria Mallinson in 1832 and Arthur was the last of ten children, born in 1856. A strong connection with the Rowntree family existed – now famous because of the branch that ran the chocolate factory in York. Grandfather Daniel's second wife was Jane Rowntree (1765-1837) and Arthur's sister Anna Mary (1849-1938) married William Stickney Rowntree (1848-1939). Another sister, Helen (1833-1920) married John Stephenson Rowntree (1834-1907), a reformer of the Quaker movement and a director of the firm that later brought us products like Smarties and the Kit-Kat. When J. S. Rowntree died, Phebe Doncaster (1847-1924), another of Arthur's sisters, compiled a memoir in his honour.[28]

Arthur followed his elder brother Samuel in the hobby of entomology although only Arthur developed it into a full-time occupation.[29] Samuel evidently sent specimens to other collectors. In 1872 he appealed via the pages of *The Entomologist* for help in finding robust postal boxes. An unknown reader responded: "I am like Mr. Doncaster. I have found nothing that will withstand the sledge-hammer of post-office officials."

Arthur's nephew Leonard became a distinguished academic. He held the post of superintendent of the Museum of Zoology at the University of Cambridge from 1909 to 1914, took the degree of ScD in 1913 and became an FRS in 1915 on the basis of research into the theory of heredity proposed by Gregor Mendel. Leonard Doncaster died at the age of 42 while professor of zoology at the University of Liverpool. A colleague wrote that his death was "nothing less than a calamity to Liverpool University".[30]

An invoice signed by Arthur Doncaster. Like William Watkins, Watkins & Doncaster supplied the Tring Museum (© The Natural History Museum)

Around the time that Arthur Doncaster became William Watkins' partner in 1889, the *Sheffield Independent* covered a meeting of the Sheffield Naturalists' Club. Arthur sent a case of butterflies and larvae, although he seems not to have attended in person. Other collections were displayed to members of the club.

He [a Dr Merryweather] *sent skulls of a fox, a hedgehog, a ferret, a stoat, a rat and a mouse, a pair of elephant molars and a very handsome ibex horn.*

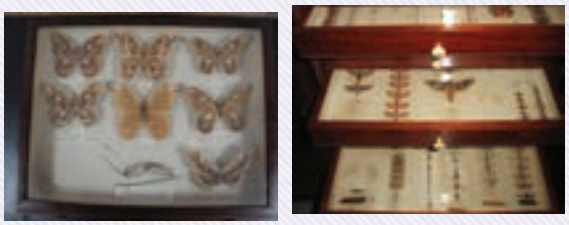
Mr D. Roebuck of Leeds, one of the Secretaries of the Yorkshire Naturalists Group, was represented by a large number of specimens of the ichneumon fly.

Miss Gatty showed her collection of British and foreign seaweeds.[31]

The club's president, F. Brittain, gave a talk on "Lower Vegetable Organisms" with illustrations "by means of the oxy-hydrogen light". There was even a band to provide musical entertainment.

A note found in a drawer of the Doncaster moth collection housed at the Alfred Denny Museum (see appendix) is signed PD, likely to have been written by Phyllis Doncaster, Arthur's niece and sister to Leonard. This shows that Arthur's other niece, Gertrude Mary, was attracted to the study of moths.

Leonard's friend, Prof. William Bateson, mentioned in the note, later wrote: "[Leonard] Doncaster was one of the clearest-headed men I have known, and, being full of both enthusiasm and knowledge, he taught extraordinarily well."[32]



Part of the Doncaster collection at the Alfred Denny Museum, Sheffield (courtesy of Dr Nicola Hemmings)

Arthur Doncaster as seen through the eyes of artist John Hipkins 30 May 1912 (© National Library of Scotland)

The wording next to the caricature of Arthur Doncaster shown here reads: "Arthur Doncaster sent by the Government on behalf of the Nat: Hist: Museum to collect Maurice Sand's moths and butterflies from George Sands[33] home at Nohant! Alpine climber Picture Collector Quaker – related to the Cadburys and Rowntrees Our host 30.5.12".

Arthur received terrible news about an accident that had occurred at the family steel works in Sheffield. Newspaper reports spoke of "600 to 1000 tons" of steel and iron bars stored against a warehouse wall which then collapsed taking the roof with it. The mass of metal and building material fell on a group of children who were playing in the street outside. At least seven were killed.[34] This would have had a profound affect on the socially responsible Doncasters.

In the 1890s there were at least 50 naturalists in London offering supplies to the public. One naturalist might approach another to obtain a trade discount on items that could then be resold. William Sear decided to take advantage of this system by falsely claiming to represent one of the well-known businesses. Somehow, he acquired a piece of Watkins and Doncaster headed notepaper, which he used to buy bird feathers at a reduced price from George B. Ashmead & Co. It emerged that he had employed a similar ruse elsewhere, using forged letters from different naturalists to obtain goods without payment. Arthur's assistant, Frank Woodham, attended court to confirm the Watkins & Doncaster connection as bogus and explained the absence of his employer: "Mr. Doncaster can write very well, but he is deaf and dumb, and persons converse with him on their fingers."[35] Sear received eight month's hard labour at Pentonville prison.

Part 3: Frederic Metté

Frederic Metté with the Gregory family: Alice was the mother of Lilian & Florence (Alice, is middle of the centre row; Frederic is on the rear row far right, Florence to his left next to him & then Lilian) (courtesy of the Metté family)

Writing to the *Entomologist's Record and Journal of Variation*, R. R. b thoffK aufmann recalled his own childhood experiences and contact with "... that most reliable firm, Watkins and Doncaster of the Strand, long since moved."

Frederic in WWI uniform with Florence (courtesy of the Metté family)

Mr Frederick [sic] *Metté wrote such polite and encouraging letters to youngsters. His catalogue was a treasure-house and joy to read. Of course, the beetles were not named nor labelled* [Kaufmann had bought ten shilling's worth of mixed beetles] *but the selection was catholic and included a Carabus nitens L.*[36]

Frederic (spelt without a k) Mettév as born at Melbourne in 18, a few years after his father, also called Frederic, went to Australia. His grandfather Henry Anton Mettéor iginated from HesseK essel, born c. 1781 (a t that time part of the Kingdom of Westphalia, under the French). Henry Anton worked as a tailor in partnership with several others in London and Frederic senior followed in the trade as a salesman for drapery goods.

By 1895, the Mettéf amily had returned to E gland. It seems that Frederic junior was originally destined to take up the tailor's scissors but by 1911 had become an assistant to a naturalist, probably Arthur Doncaster by then. At some point he entered into full partnership and succeeded to the business on the retirement of Arthur, dated 31 O tober 1925.[37]

WATKINS & DONCASTER

Naturalists and Manufacturers of

CABINETS AND APPARATUS

FOR COLLECTORS OF INSECTS, BIRDS' EGGS AND SKINS, MINERALS, PLANTS &c.

N.B.—For excellence and superiority of Cabinets and Apparatus, references are permitted to distinguished patrons, Museums, Colleges, &c.

A LARGE STOCK OF INSECTS, BIRDS' EGGS AND SKINS

SPECIALITY.—Objects for Nature Study, Drawing Classes, &c.

Birds, Mammals, &c., Preserved and Mounted by First-class Workmen true to Nature.

All Books and Publications (New and Second-hand) on Insects, Birds' Eggs, &c., supplied.

36 STRAND, LONDON, W.C.2.

(Five Doors from Charing Cross.) Telephone: GERRARD 9431.

FULL CATALOGUE POST FREE.

An advertisement, a year before Frederic Metté succeeded to the business (Nature, 7 June 1924)

Frederic married Florence Maud Gregory in 1915 and her sister Lilian Victoria Gregory in 1926. It is believed that the first sister died but no record of the death has been found. Marriage to Florence resulted in a son and a daughter. Lilian and Frederic did not have any children.

W th his brother Burton, Frederic joined the forces to fight in France during W – as privates in the Queen's Regiment and Middlesex Regiment, respectively. Burton did not return. He died on 27 March 1916 at the age of 20.

Little has been discovered about how Frederic Metté became a naturalist. Michael A. Salmon[38] and W lliam T. Blows[39] describe him as an authority on bird eggs. Perhaps his expertise just developed from a childhood interest without any formal training.

Macmillan had published Edward Meyrick's 843-page *Handbook of British Lepidoptera* in 1895. By the 1920s it was out of print and in need of revising. Frederic approved the publication of an updated version and *A Revised Handbook of British Lepidoptera* appeared in 1927 under Watkins & Doncaster.

The Second World War was a turning point for Watkins & Doncaster. Frederic died on 1 December 1940, just a few months after the start of hostilities. His son was called up which meant that continuity of the business rested in the hands of Lilian Victoria Metté. Effectively, the employees were left to "get on with it".

Part 4: The Ford family

The Strand premises, demolished 1956/7 (courtesy of Amy Wells, Watkins & Doncaster)

Richard Lawrence Edward Ford was born on 10 March 1913 at Bexley, the son of Leonard Talman Ford. Leonard qualified in both chemistry and the law but made his mark in entomology. Although lacking his father's academic achievements, Richard proved himself later as an expert in the subjects of palaeontology, ornithology and entomology. After working on a butterfly farm he joined the Imperial Bureau of E tomology under Douglas W lkinson, collaborating with W lkinson on the study of microgastrinae, a subfamily of parasitic wasps.

Someone who knew Richard Ford quite well over the period from the 1960s to the early 1990s is William Blows. In an article for the *Geological Curator*, "Conversations with a Naturalist: The Life and Geological Work of Richard Ford 1913-1996",

he draws on an interview and a number of less formal conversations. What seems to have become confused is the dating of Watkins' arrival at Eastbourne According to William Blows' paper, and other historical accounts since then,[40] William Watkins started in business at the Villa Sphinx, Eastbourne, in 1874. As we have discovered, Watkins left the army to take up residence in London and the move to Eastbourne did not occur until nearly twenty years later. The source of this error is most likely the result of linking the Villa Sphinx address and "founded 1874", printed on a surviving William Watkins catalogue.

For about a year after Frederic Metté's death, Watkins & Doncaster ran without much direction. The firm now faced an uncertain future. These events did not escape the notice of Sir Guy Anstruther Knox Marshall, Director of the Imperial Bureau of Entomology. Marshall was "an insect man" from school days. An obituary of Marshall records: "... in Charterhouse butterfly collecting was apparently regarded as an eccentricity so he adopted the less conspicuous hobby of beetle collecting."[41] Sir Guy consulted with Richard Ford and as a result Ford bought the ailing enterprise in 1941.

These were the war years and Watkins & Doncaster did its bit to support the fight against Germany, not always knowingly. An order from the government for glass owl's eyes turned out to be part of a plan to assist escaping prisoners-of-war. Wooden owls attached to calendars concealed miniature maps in the eye sockets.[42]

Another story is reminiscent of Roald Dahl's hairy-faced Mr Twit, who captured birds by smearing Hugtight glue on the branches of a tree (Wednesday was bird-pie day for the Twits). In the case of Watkins & Doncaster, the birds were carrier pigeons and the glue something known as birdlime. The incident began when a visitor speaking virtually no English called at the Strand offices, asking for birdlime. Now the sale of this substance was illegal, but the stranger carried an official letter from a certain department in Whitehall. There were no stocks to be had so Richard Ford set about its preparation by distilling the inner bark of holly, helped by some fellow members of the home guard. When the visitor returned, he received the adhesive in a 2lb jam jar and explained its purpose with the aid of some impromptu drawings. The Germans were using pigeons to send messages. Perhaps these could be intercepted by sticky means? Richard Ford demonstrated, using a stuffed bird and warm water, that the feet would need to be freed after reading any messages. Nothing more was heard about the scheme.

After Metté, the focus returned to lepidoptery. In the 1940s Watkins & Doncaster published a number of books by Philip Bertram Murray Allan, such as *Talking of Moths* (1943) and *A Moth-Hunter's Gossip* (1947).

Richard Ford with a batch of Atlas moths in 1950 (courtesy of Amy Wells, Watkins & Doncaster)

Number 36 stood on a stretch of road where the Strand narrowed and the decision to widen the thoroughfare meant demolition of the buildings on Watkins & Doncaster's side. Closure of the shop received national press attention. *The Manchester Guardian* lamented: "The days when one can buy a pair of glass eyes for a stuffed tiger, a fossilised mammoth tooth, or a case of beautiful butterflies within two hundred yards of Trafalgar Square are almost over ... schoolboys and older lepidopterists in search of English fritillaries or some rare tropical specimens will have to penetrate the comparative wilds of Welling, Kent, to make their purchases."[43]

Richard Ford using a Robinson moth trap in 1950. They were most effective at attracting moths when fitted with mercury vapour lamps (courtesy of Amy Wells, Watkins & Doncaster)

Collectors in typical garb. Richard Ford's father, Leonard Talman Ford, is in the centre flanked by Drs Mansfield and Young. Photo taken in 1913 (courtesy of Amy Wells, Watkins & Doncaster)

Welling

Watkins & Doncaster at 110 Parkview Road, Welling, Kent (courtesy of Amy Wells, Watkins & Doncaster, photograph Keith C. Lewis)

The cabinet room at Welling (1960 catalogue)

The location of 110 Parkview Road (1960 catalogue)

Moths for sale (1960 catalogue)

Richard Ford now moved the business to familiar territory. The chosen location at 110 Parkview Road, Welling, was close to the place of his birth at Bexley. Hardly "the comparative wilds", this description of Welling might have applied back in the 1890s when the area consisted mostly of open fields and woods. By the 1950s the north side of 110 Parkview Road was well populated, although the expanse of Danson Park lay to the south. For visitors to the premises, the recommended transport from central London was a number 701 or 702 Green Line Coach running from Ascot to Gravesend.

Robin Ford joined his father as a partner in 1963 and it was at Parkview Road that the postal side of the business really expanded. The catalogue of those days advised: "Where a long shaped article such as a net handle or setting board is ordered together with a round bulky article such as a killing jar, these will be sent in two parcels, and may possibly arrive at different times." Richard Ford retired to the Isle of Wight in 1969, leaving Robin and his wife Julia to continue the business. A comprehensive description of Richard Ford's contributions to the study of entomology and fossils is to be found in the article by William T. Blows (see bibliography).

Four Throws

The Watkins & Doncaster building at Four Throws (courtesy of Amy Wells, Watkins & Doncaster)

The butterfly shop at 21 Brighton Square (courtesy of Robert Goodden, Worldwide Butterflies)

The next move for Watkins & Doncaster, in 1973, did take them into the "wilds". Four Throws is a village in Kent between Hawkhurst and Sandhurst, along the A268, the nearest railway station, at Etchingham, a five-mile journey by road. A building previously used by a coal merchant provided the next home and quite a bit of work had to be done to restore the place to a decent condition.

While at Four Throws, an opportunity to reach more customers presented itself. Worldwide Butterflies, started from very small beginnings by Robert Goodden in 1960, had taken on the lease of a shop in Brighton. Situated at 21 Brighton Square, the ex-florist's premises offered entomologists and collectors a range of lepidoptera and other insects. This ran successfully for ten years until Robert needed to marshal all his resources for an ambitious move to the imposing Compton House in Dorset. Robin Ford and Robert Goodden were good friends so the lease, still with a number of years left to run, passed to Watkins & Doncaster. Trading at the shop then continued until 1985 when the cost of rent became uneconomical. Robin & Julia Ford's daughter Amy joined in 2004, bringing to the company her expertise in business and marketing.

Operations at Four Throws continued until 2013, a period of 40 years. Amy Wells (née Ford) then moved Watkins & Doncaster to Herefordshire, with showrooms at Golderfield, near Pudleston – to the north of the A44, between Leominster and Bromyard.

And finally

Premises at Golderfield (courtesy of Amy Wells, Watkins & Doncaster)

An interior shot of the building at Golderfield (courtesy of Amy Wells, Watkins & Doncaster)

Although the emphasis in this article has been on lepidoptera, the firm of Watkins and Doncaster is, and has been, associated with most aspects of natural history supplies. Indeed, at one time a team of taxidermists was employed to satisfy the Victorian liking for stuffed birds. Be it for decoration, adornment, serious study, or recreational pursuits, the flow of goods from 36 Strand and its successors has continued unabated since 1878. Times have changed, of course, and even when the firm moved to Welling in 1956, natural history as a hobby was on the decline. But with a customer base spanning the globe and the ability to adapt to changing markets, Watkins & Doncaster has survived and will hopefully continue with, perhaps, a fourth generation of the Fords.

Appendix

Transcript of a note found with the Doncaster moth collection, now at the Alfred Denny Museum, Sheffield.

Rhōea Neuara [Rhodinia newara]

These moths were reared at Fernwood, Abbeydale in the 1890ies by Gertrude Mary Doncaster later Holdsworth. Their cocoons exhibit a marvellous instinctive skill always woven perpendicularly on a branch of Oak with a leaf curled around the cocoon.

A tray of moths, with note, from the Doncaster collection at the Alfred Denny Museum, Sheffield (courtesy of Dr Nicola Hemmings)

Rain water can thus enter between the beautifully selv ged [selvedged] edges which fit closely together. To prevent their pupãe being drowned they make a cleverly "buttonholed" drain hole at the bottom. To prevent ants or other insects entering through this drain hole, they weave a grate with tiniest-holes above it. See in this cut open cocoon. Leonard's friend Prof. Bateson seeing this specimen said it was the most wonderful example of instinctive foresight he had ever seen. P.D.

Bibliography

Army Medical Department Report for the Year 1870, 12 (L ondon: HMSO, 1872)

Blows, W lliam T., "Conversations with a Naturalist: The Life and Geol ogical Work of Richard Ford 1913-1996", *Geological Curator*, 6/9 (1998 , 323-331.

Salmon, Michael A., *The Aurelian Legacy: British Butterflies and Their Collectors* (L os Angeles: U iversity of California Press, 2000).

Other references are contained in the notes

Acknowledgements

G ateful thanks go to:

Martin Clarke, relative of Frederic Metté.

Sophie Cook, great granddaughter of Samuel Doncaster.

Stephen Doncaster, grandson of Samuel Doncaster.

Joe Easton & Sammi Hide of Eastbourne Reference Library.

Robert Goodden, proprietor of Worldwide Butterflies, Compton House, Dorset.

Sally Harrower, Manuscripts Curator, National Library of Scotland.

Nicola Hemmings, Post-Doctoral Research Associate and Public Engagement Officer for the Alfred Denny Museum of Zoology, Department of Animal & Plant Science, The University of Sheffield.

Richard Jones, alias Bugman Jones, past president of the British Entomological and Natural History Society.

Roy Metté, grandson of Frederic Metté, and Roy's brother-in-law Lesley Arnold.

Ian Moulson for preparing the map of India and putting up with delays.

Vic Silvey, Managing Director of New Force Ltd.

Sue Thompson, relative of Frederic Metté.

Kate Tyte of the Natural History Museum, Cromwell Road, London.

Amy Wells, proprietor of Watkins & Doncaster.

Thanks to Doug Cutts for checking the manuscript.

A special thanks for the assistance given by numerous members of E stbourne Local History Society, coor dinated by Michael O kenden.

Michael has a personal interest as his relative George Richard Ockenden collected specimens for Lionel Walter Rothschild and G orge may have known W lliam Watkins personally. G R. Ockenden died of typhoid on an expedition for Rothschild in 1906.

Notes

[1]At various times, Cornelius David Watkins was landlord of other London public houses: the Woodman, Coachmakers Arms, Queens Head, and Freemasons Arms (Information from Kevan at pubshistories.com).

[2]A reference to land owned by the Archbishop of Canterbury.

[3]*Army Medical Department Report for the Year 1870*, 12 (London: HMSO, 1872), 166.

[4]William Watkins, "Notes on Southern Indian Lepidoptera", *The Entomologist*, 6 (1872-73), 507.

[5]William Watkins, "Notes on Southern Indian Lepidoptera", *The Entomologist*, 6 (1872-73), 509.

[6]http://deriv.nls.uk/dcn9/7510/75108513.9.htm [Accessed 24/05/2015].

[7]William Watkins, "Notes on Southern Indian Lepidoptera", *The Entomologist*, 6 (1872-73), 544.

[8]*Army Medical Department Report for the Year 1870*, 12 (London: HMSO, 1872), 477.

[9]*Army Medical Department Report for the Year 1870*, 12 (London: HMSO, 1872), 479.

[10]Quoted in Michael A. Salmon, *The Auralian Legacy: British Butterflies and Their Collectors* (Los Angeles: University of California Press, 2000), 39.

[11]George Lewis, "Description of a New Species of Plaesiorrhina (*Cetoniidae*), and a Note on an Apparently New Species of *Ceratorrhina*, both from West Africa", *Entomologists Monthly Magazine*, 15 (1879), 198. Thanks to Richard Jones for leading me to this reference.

[12]*London Gazette*, 23 November 1880, 6058.

[13]*The Entomologist*, July 1881, 151-153.

[14]Zoological Society, *Proceedings of the Scientific Meeting of the Zoological Society of London for the Year 1881* (London: Longmans, Green, Reader & Dyer, 1882), 655.

[15]Thanks to Richard Jones for drawing my attention to the possibility that the curator of the Horniman's Surrey House Museum was a relative of William Watkins.

[16]*The North-Eastern Daily Gazette,* 19 April 1898.

[17]*Sussex Agricultural Express*, 30 June 1900.

[18]*The Times*, 15 April 1896. The advertisement for a manager states "reopening immediately with new exhibition".

[19]Letter dated 4 September 1895, William Watkins to Karl Jordan, Natural History Museum Archive, TM/1/17/6, items 234 & 235.

[20]Letter dated 17 May 1895, William Watkins to Karl Jordan, Natural History Museum Archive, TM1/1/17/6, item 379.

[21]Letter dated 20 October 1895, William Watkins to Karl Jordan, Natural History Museum Archive, TM1/17/6, item 349.

[22]*The Times*, 28 April 1899.

[23][24]"London, Bethlem Hospital Patient Admission Registers & Casebooks 1683-1932", Archive Reference CB-164, page 39 [Accessed 20/03/2015 on findmypast.co.uk].

[24][44]"London, Bethlem Hospital Patient Admission Registers & Casebooks 1683-1932", Archive Reference CB-168, page 87 [Accessed 20/03/2015 on findmypast.co.uk].

[25]Sven O. Kullander, *Cichlid Fishes of the Amazon River Drainage of Peru* (Stockholm: Swedish Museum of Natural History, 1986), 19.

[26]François Vuilleumier, "Dean of American Ornithologists: The Multiple Legacies of Frank M Chapman of the American Museum of Natural History", *The Auk*, 122/2 (April 2005), 393.

[27]As the Doncaster Group, Daniel Doncaster & Sons is now a multinational company. See http://www.doncasters.com [Accessed 28/03/2015].

[28]Phebe Doncaster, J*ohn Stephenson Rowntree: His Life and Work* (London: Headly Brothers, 1908).

[29]Samuel Doncaster became a director of Daniel Doncaster & Sons.

[30]W. Bateson, "Obituary: Prof L. Doncaster FRS", *Nature*, 105/2641 (10 June 1920), 461-462.

[31][44]"Sheffield Naturalists' Conversazione", *Sheffield Independent*, 15 February 1879.

[32]W. Bateson, "Obituary: Prof L. Doncaster FRS", *Nature*, 105/2641 (10 June 1920), 461-462.

[33]George Sand was the pseudonym of the female French novelist Amantine Lucile Aurore Dupin (1804-1876). Maurice was her son.

[34]An account of the accident at the Doncaster steel works can be seen on www.gracesguide.co.uk/Daniel_Doncaster_and_sons [Accessed 28/03/2015].

[35]A fraud case heard at the Old Bailey 8 September 1896, http://www.oldbaileyonline.org/browse.jsp?path=sessionsPapers%2F18960908.xml [Accessed 14/06/2015].

[36]R. R. Uhthoff-Kaufmann, "Looking Back: reflections of a Quondam Coleopterist", *The Entomologist's Record and Journal of Variation*, 96 (1984), 103.

[37]*The London Gazette*, 19 February 1926, 1288.

[38]Michael A. Salmon, *The Aurelian Legacy: British Butterflies and Their Collectors* (Los Angeles: University of California Press, 2000), 404.

[39]William T. Blows, "Conversations with a Naturalist: The Life and Geological Work of Richard Ford 1913-1996", *The Geological Curator*, 6/9 (1998), 324.

[40]Michael A. Salmon, *The Aurelian Legacy: British Butterflies and Their Collectors* (Los Angeles: University of California Press, 2000), 403.

[41]W. R. Thompson, *Biographical Memoirs of Fellows of the Royal Society*, 6 (London: The Royal Society, 1960), 170.

[42][44]"A Haunt for Naturalists: Famous London Shop Has to Find a New Home", *Manchester Guardian*, 16 April 1956.

[43][44]"A Haunt for Naturalists: Famous London Shop Has to Find a New Home", *Manchester Guardian*, 16 April 1956.

The 100,000 genomes project

Stephen J Gamble

A genome is an organism's complete set of DNA, including all of its genes. Each genome contains all of the information needed to build and maintain that organism. In humans, a copy of the entire genome (more than 3 billion DNA base pairs) is contained in all cells that have a nucleus.

The Hundred Thousand Genomes is an exciting project being run by Genomics England[1]. Genomics England is a company set up and wholly owned by the Department of Health. Over approximately the next two and half years the project plans to sequence 100,000 genomes from about 70,000 patients. It is one of several similar projects being run in different countries worldwide.

Genomics England is run by a board which includes Sir John Chisholm as Chairman (Sir John is a former chairman of the Medical Research Council) and Professor Mark Caulfield as Chief Scientist.

Genomics is one area where the UK has constantly been able to contribute above its expected share. One of the big scientific achievements at the end of the 20th and the beginning of the 21st century was The Human Genome Mapping Project. One of the great expectations from this project was that it would help improve diagnosis and treatment of a wide range of conditions. In The Human Genome Mapping Project the UK contributed around a third of the data, much of it from the Wellcome Trust Sanger Institute in Cambridge.

The new project is a step further towards this goal. Obtaining the first complete human genome sequence took about 15 years and cost worldwide several billion US dollars. The advances in sequencing technology now mean that a patient's genome can be sequenced for £1000-£2000 and data produced at a rate equivalent to between one and two complete genomes per hour.

Genomics England has established, initially, 11 regional hubs around the country through which it will run the project. During the course of the project it is possible that additional hubs will be established. It is expected that by the end of the project these hubs will have become the basis of an ongoing genomics service for the NHS.

The actual sequencing of the genomes has been contracted to the company Illumina, which is one of the major suppliers of sequencing technologies. Much of the work will be carried out in a new sequencing facility on the Wellcome Trust Genome Campus at Hinxton near Cambridge[2].

Although the sequencing of all these genomes will be a major task in itself it is only part of the overall project. Once all the raw data has been generated it needs to be analysed and interpreted. The interpreted data then needs to be reduced to a form that can be relayed in an understandable form to patients via their clinicians. Particularly important will be providing genetic counselling to patients.

Around 40% of the genomes sequenced will be from patients with different forms of cancer. In these cases both the patient's normal tissue and one or more samples from their tumour tissue will also be sequenced. Even within the same form of cancer there may be different combinations of genetic mutations. The hope is that by being able to identify a patient's specific combination of mutations that better directed treatment will be possible.

The rest of the genomes sequenced in this project will look primarily at the possible genetics underlying rare conditions.

The Genomics England website estimates that 1 in 17 people suffer from one of these rare conditions. Specialised software developed by the company Congenica[3] will be used to help identify the genes involved in these conditions.

In a wide ranging article[5] Shirley Hodgson, Professor of Cancer Genetics at St George's Hospital, University of London looks at how some of the information generated from this and similar large scale sequencing projects might be used. Whilst we already know that some gene mutations greatly increase the risk of certain conditions, there might be other illnesses where specific genetic mutations only slightly increase a patient's risk. How important would this slightly increased risk be? For example, if the overall incidence of a particular disease in the population is one in a million, would a particular gene variant which increases that risk to 1.1 in a million really be significant? Work by Alexandrov et al[6] has found very specific "signatures" for genetic damage caused by things like too much sun exposure or smoking. Would these environmental exposures swamp any small inherited changes in risk?

Another area that will need to be addressed is incidental results. For example, if a person is being investigated for one condition but in the course of this investigation they are found to have genetic variants that put them at high risk of some other condition. Hodgson asks if they should be informed of this especially if this additional condition is untreatable.

Although the main sequencing project is designed to bring benefits to patients, the 100,000 Genome Project has other, secondary, objectives. One of these additional objectives is to give a boost to the UK genomics industry.

When the Human Genome Mapping Project started there was little in the way of a biotech industry in the UK. Various research groups in academia and industry developed biological reagents which could be useful to other researchers. The Medical Research Council established the Human Genome Mapping Project Resource Centre through which these reagents could be provided to researchers, and this probably did much to create a market into which industry providers could move and expand the UK biotech industry. It is hoped that the new project will give a similar boost to the developing area of genetic medicine.

Another objective of the project is to build a cohort of health professionals educated in applying genomics to medicine. To achieve this e project is working in association with Health Education England, who have created a special section of their website devoted to genomics education[4]. This includes some online training. Health Education England are also running some grant schemes for NHS staff to attend more detailed training courses.

As has been seen, this project is a very important part in the continuing evolution of genomic medicine. Over the next few years genomic medicine will be an exciting field as it moves from the research lab into production medical care. The 100,000 Genomes Project will be at the forefront of this.

References

1. http://www.genomicsengland.co.uk/ (Accessed online 25 July 2015)
2. http://www.sanger.ac.uk/about/press/2014/140801.html (Accessed online 25 July 2015)
3. http://www.cambridgenews.co.uk/Congenica-takes-role-phase-genomics-England-8217/story-26642388-detail/story.html (Accessed online 1 August 2015)
4. http://www.genomicseducation.hee.nhs.uk (Accessed online 1 August 2015)
5. Hodgson, S.V. (2015) Sequencing genomes: we need to think ahead. The Biologist Vol 62, No 4, p9.
6. Alexandrov, L B et al (2013) Signatures of mutational processes in human cancer. Nature 500, 415-421 doi:10.1038/nature12477

Measurement Level

John McCormick

Introduction

In part 1 of this discussion [IST Journal, Spring 2015] the formal nature of the measurement process was examined and the logical process whereby a measurement procedure could be defined by intention was developed. This formal definition is required when, as is almost always necessary, raw measurement data must be processed to extract the meaning and content. As it is only by understanding the formal nature of the measurement process that suitable analysis techniques can be deployed to extract the true meaning of the measurement results.

Until this point in the discussion the nature of the relationships between members of the measured class has only been superficially examined. These relationships can have a big impact on the type of measurement procedure undertaken and the type of subsequent analysis that would be appropriate. In part 1 of this examination of the nature of measurement the majority of the examples exhibited a binary relationship between the members of the measured class of the form greater than or equal to (≥). Meaning that if the set of temperatures was the measured class then for two measured temperatures in this class one would either be greater than the other or they would be equal.

However, other types of relationships other than ≥ can exist between the members of the measured class, and measurement procedures can be devised that preserve these other relationships in the representational set that the measurement process maps the measured class onto, and thus form a measure of the measured class at a different level. Much of the impetus behind attempts to define measurements of a range of attributes that cannot be easily defined in terms of physically observable features, e.g. in physiological examinations and experiments, has in recent years contributed to a re-examination of what might be termed a measurement processes in terms of these other possible relationships between members of the measured class. These theories fall under the general heading of operational theories of measurement[1], and this has led to the concept of levels of measurement.

Measurement Scales Based on Relationships

As already stated so far the representation of physical quantities has been based on the existence of a relationship between the elements of the measured class in the form a binary relationship of the form ≥ between members of any class. It is inherent up to this point that the binary relationship shown above has been of an interval nature and not merely of an ordinal nature. i.e. that not only is one member of a class ≥ to any other but the extent to which the one member could be greater than another is quantifiable.

To give an example if the temperature in Celsius changes by 1˚C degree from 10˚C to 11˚C this is the same change as when the temperature changes from 40˚C to 41˚C degrees. Thus, there is significance to the distance between any two scaled values and to any fraction between the numbers.

This can be contrasted with a purely ordinal relationship where the binary relationship > applies, thus one value may be greater than another but there is no significance to how much bigger. Again to provide an example; were we to order or rank different species of salmon from biggest to smallest then we would be arranging them according to an ordinal scale. As it would not matter how much bigger or smaller they were only that they were bigger and smaller.

If we categorised the salmon in terms of sub class of the class of salmon, e.g. Atlantic salmon, Pacific salmon, or young, mature or old salmon we would be defining a nominal relationship between the members of the class of salmon by nominating them into different categories.

Finally, for interval data for which we can define an absolute zero we can define a further level of relationship that is of a ratio nature. Again for example 20˚C and 40˚C degrees on the arbitrarily defined Celsius scale are the same as 293˚K and 313˚K degrees on the Kelvin temperature scale. So superficially the ratio of the two temperatures in degrees Celsius may appear to be 2:1 but if looked at on the Kevin scale the ration between the two temperatures is only 1.07:1. However, as there is an absolute zero, rather than an arbitrarily defined zero for Celsius, in the Kelvin scale the ratio of 40˚K to 20˚K really is 2:1.

These concepts of different scales, nominal, ordinal, interval and rational has formed the basis of an extension of the concept of representational measurement, and a range of scale mappings based on these relationships has been used to define different levels of measurement[2].

Nominal measurement level:

In nominal measurements members of the measured class are nominated into specific categories that are subsets of the measured class which are to be mapped into specific subsets of the representative class. So, any one subset of the measured class will have all its members mapped onto the same subset of the representational class, where the mapping only depends on the membership of specific subsets.

Ordinal measurement level:

In ordinal measurements the ranked members of the measured class are mapped onto the ranked members of the representative class where the mapping only depends on this ranking and not on any other characteristic of the data.

Interval measurement level:

In this form of measurement the mapping between members of the measured class onto the representational class is dependent on the order and the exact relationship between members of the representational class mirroring the relationship between the members of the measured class.

Rational measurement level:

Interval measurements where an absolute zero level and therefore an absolute ratio between the members of the representational and measured class can be identified are measurements on a ratio scale.

Since traditional representational measurement theory envisaged the assignment of symbols to individual members of a class the inclusion of the concept that members can be nominated to fall within sub-classes or categories within the measured class that must be mirrored as sub-classes of the representational class means that the definition of measurement must be enlarged to include this concept.

Thus:

"Measurement of some attribute of a class is the process of assigning numbers or other symbols to represent the members or the subsets of the measured class in such a way that the relationships of the numbers or the subsets of the representational set are equivalent to the relationships between the members or subsets in the measurement class. A particular way of assigning numbers or symbols to measure something is called a scale of measurement".

Measurement Context

Below in table 1 the data shown on radio frequency power flux density (PFD) at radio frequencies (RF) at positions relative to a large transmitter antenna can be used to illustrate different levels of information and their levels of measurement. As per the figure the data initially refers to PFD in watts per metre Wm^{-2} at a range of distances from a transmitter tower.

Distance from transmitter tower in m	PFD in Wm^{-2}	PFD above reference level in Wm^{-2}	Order of agency to transmitter	Hazard category
	Rational	Interval	Ordinal	Nominal
1	500	490	1	High
2	250	240	2	High
3	55	45	3	Intermediate
4	31	21	4	Intermediate
5	20	10	5	Intermediate
6	14	4	6	Intermediate
7	10	0	7	Intermediate
8	8	N/A	8	Low
9	6	N/A	9	Low
10	5	N/A	10	Low

Table 1: Measurement data at different levels for transmitter

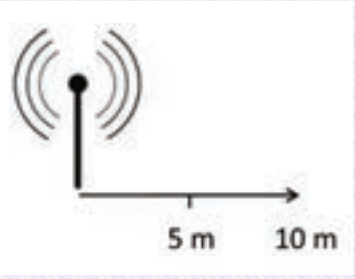


Figure 1: Measurement distances from RF transmitter

If our interest is simply in the PFD at different ranges from the transmitter then little analysis of the data is required since the data is measured in Wm^{-2} and there is an absolute zero on this scale therefore these are clearly ratio level measurements. If the context in which these measurements were made was to find the location of or direction to the transmitter and it was known that the closer the measurements were made to the transmitter the higher the recorded levels would be then an ordinal measurement that merely ranked the measurements would be sufficient for an analysis of the data to provide the answer.

However, if the context in which we were making these measurements was in terms of health and safety and the possible effects of these PFD levels, then more analysis would be required. The International Commission on None Ionising Radiation Protection (ICNIRP)[3] defines a number of reference levels for PFDs that are considered to be hazardous.

At the frequency measured these limits were less than 10 Wm^{-2} integrated over any 6 minute period to give 3600 J and not more than 20 times the reference level of 10 Wm^{-2} instantaneously.

Thus, from the data, closer than 2 metres from the transmitter there is instantaneous exposure to a PFD that is considered to be hazardous. Until you are at least 7 metres from the antenna you will be exposed over a 6 minute period to a non-ionising radiation dose with a total energy of 3600J, and thus over any 6 minute period you would be considered to be in a hazard zone. Beyond 7 metres continuous radiation exposure would be considered to not represent a hazard. If instantaneous exposure to 20 times the reference level is categorised to be high risk area, exposure over 3600J over any 6 minute period is categorised to be intermediate risk, and less than 3600J over any 6 minute period low risk, then the measured data points can be nominated to fall into different categories. If the context in which the measurements are made is to categorise the areas around the transmitter into high, intermediate and low risk areas then clearly measurement at a nominal level would be sufficient.

Thus, although in this case the data is measured on a ratio scale an ordinal scale measurement would be sufficient for direction finding and a categorical scale that merely nominated the measured results into different categories would be sufficient from a health and safety point of view.

Finally, if the context in which the data was obtained was to ascertain how much above the ICRIRP reference level the recorded levels were and how much they had to be reduced by, then by making interval measurements above an arbitrarily defined zero level set at 10 Wm^{-2} would be sufficient.

Clearly measurements can be made at different levels with different types of scale at each level and the appropriateness of the use of any scale is directly related to the context in which the measurements are to be made and the meaning to be extracted from the results. Ineivtably, rational level measurements require the highest level of accuracy, precision and sensitivity and therefore are the most demanding in terms of the fidelity, robustness, and repeatability in their defined measurement procedure. Measurements on scales made at other levels, e.g. Ordinal data can often be easier to obtain and dependant on the context in which they are being made often contain all the information required.

In the example above it is clear that the measurement raw data that was acquired on a ratio scale could be processed to provide measurements on the other scales, i.e. interval, ordinal categorical but this is not always the case and data acquired at other levels can provide sufficient information for many purposes. In part 1 of this discussion on the nature of measurement it was postulated that;

"The formal scientific method, from observation to hypothesis and onward to test and confirmation or falsification is essentially based on the idea that there are measurable predictions from any scientific hypothesis that can confirm the relevance or accuracy of the predictions of the theory".

Given that any scientific hypothesis by definition must be must be falsifiable[4], i.e. subject to being tested with respect to data can be found to be verified or proved to be incorrect. Then often measurements at only a nominal level that only categorise data can be sufficient to test the data.

For example using historical data shown in table 2 below, if the hypothesis was advanced that the performance of school leavers in certain subjects was dependent on the sex of the school leavers this hypothesis could be tested scientifically at a nominal level with only categorical measurement data.

	(a)	(b)	(c)	(d)	Row total
Males	82	13	176	112	383
Females	74	23	184	85	366
	156	36	360	197	749

Table 2: Performance of English school leavers in mathematics 1970-80 cohort

This so called contingency table[5], has categorised the results of the examinations as passes at either a,b,c, or d in columns and as either male or female in the rows.

From the data in the table, which lists counts of students achieving certain pass grades and their respective sexes, the formal null hypothesis Ho can be advanced:

Ho: Sex and performance of English school leavers in the 1979-80 mathematics examinations are independent

And the following alternative hypothesis can be advanced

Hi: Sex and performance of English school leavers in the 1979-80 mathematics examinations are not independent

The measurement data in the contingency table could be tested statistically to establish the validity of the null hypothesis and by inference the alternative hypothesis for example using a χ^2 test[6]. The details of the test are listed in the reference but for completeness the result was that Ho cannot be rejected at a 95% significance level so there is no relationship between the performances in the school levers in mathematics on the basis of their sex.

This is an example of when purely nominal data collected on a categorical scale can be used to establish the va lidity of a scientific hypothesis but hypotheses can of course be tested on the basis of, rational, interval, ordinal, or categorical measurement data. Table 3 below illustrated the types of statistical tests that can be deployed to test measurement data to confirm or falsify hypotheses.

Type of data	Categorical	Ordinal	Ordinal	Ordinal	Interval and rational	Interval and rational	Interval and rational	Interval and rational
Nu mber of samples	N/A	On e or two paired	Two not paired	Two not paired	One or two paired	One or two paired	Two not paired	Two not paired
Sample size	Large	Small	Large	Small	Large	Small	Large	Small
Suitable test	χ^2	Sign test	Mood's Median test	Mann Wh ittney test	One sample Z test	Wi lcoxon matched pairs test	Two sample Z test	Two sample t-test

Table 3: Applicable statistical tests for different levels of measurement data

Note: the inclusion of two and two paired terms in the samples areas relates to nature of the measurement data obtained from the inclusion of control groups, for example in blind and double blind trials or other comparison type experiments[7].

As has already been emphasised in part 1 of this discussion the nature of the structured formal output from any measurement process is inherently based on the nature of this measurement process itself. Therefore the types of analysis that is appropriate for any measurement data set is fundamentally dependant on the formal structure of the measurement process itself, so a thorough understanding of this process at a formal level is necessary to decide on the correct type of results analysis to adopt. Table 2 illustrates an indicative but not an exhaustive array of the type of data analysis that can be deployed to test hypotheses using measurement data acquired at different scale levels.

Hypothesis testing is included as an appropriate example that shows how the nature of the measurement process is directly related to the type of measurement data acquired, and thus the appropriate options ava ilable for data analysis. A wide range of other analysis and processing options that relate to the context and meaning to be extracted from measurements are available, but the applicability of these options is fundamentally related to the formal structure of the measurement process, and the use of techniques that are not appropriate for a given measurement process or level will inva lidate any conclusions drawn from the data.

Conclusions and Comments

The nature of the structured formal output from any measurement process is inherently based on the nature of this measurement process itself and therefore the types of analysis that are appropriate for any measurement data set is fundamentally dependant on the formal structure of the measurement process itself so a thorough understanding of this process at a formal level is necessary to decide on the correct type of results analysis to adopt.

Different levels of measurement produce very different types of data and clearly there is a hierarchy inherent within these different types of data. Dependant on the nature of the categorical subsets that are to be defined, the Ratio data may well contain the information to form these. By definition the interval and ordinal aspects of the data will be included in the ratio data produced in a measurement. Nominal may well be, and the ordinal aspects of interval data will be included in interval measurements and purely ordinal aspects often can be used to define categorical sub sets.

Thus, it can be seen that this hierarchy allows the examination of measurement data in a wide variety of ways. Non parametric statistical analysis[8] techniques can be employed on the nominal and ordinal aspects of all measurement data sets along with the more usual parametric statistical techniques usually employed only on interval and ratio measurement data.

An understanding of the different levels of measurements opens up the opportunity to assess and process measurement data sets in a number of ways that do not normally occur if the data is only vi ewed at the interva l or ratio level.

The use of a wide range of analysis techniques is important as the context in which the measurements are taken and the type of knowledge which is to be extracted from the data is intimately related to the nature of measurement process.

Additionally a firm basis in the understanding of the nature of the measurement process is an important precursor to the identification and implementation of effective measurement techniques and almost even more important in identifying and isolating important features in measurement data from which meaning and content can be extracted.

Finally it is more than 2,400 years since Plato first proposed his theory of knowledge where, knowledge was defined as true justified belief (JTB)[9]. If we accept that, subject to the constraints of the Gettier problem[10], the JTB theory of knowledge is still a valid summation of the theory of knowledge then an important question to be answered is what can be considered to be a better form of justification for any belief than measurement based confirmation of the predictions formed as a result of the belief. As such the process of measurement might be considered by some to be the final arbiter of what can actually be considered to be knowledge.

Author

Dr John McCormick is a Fellow of the Institute of Science & Technology, as well as a Fellow of the Institution of Engineering Technology and a Fellow of the Institute of Physics. In a career that has ranged from assistant chemistry technician in a teaching laboratory to Lead Antenna Engineer in a major multi-national engineering manufacturer he has published extensively in peer reviewed journals and presented papers at a range of scientific and engineering conferences. Additionally he has co-authored a range of text books devoted to measurement techniques with an emphasis on free space electromagnetic metrology. Currently his research interests revolve around air and space borne remote sensor design, implementation and test.

References

[1] Stevens S., S., On the Theory of Scales of measurement, Science, Volume 103 No. 2684, 1946, pp. 677680()
[2] CK Foundation Advanced Probability and Statistics, 2nd Edt, Volume 1, 2012, < http://www.ck12.org >
[3] Vol 15, N0 2, 2004, Documents of the NRPB, Advice on Limiting Exposure to Electromagnetic Fields (0-300 GHz), Appendix Summary of ICNIRP Exposure Guidelines, Page 32.
[4] Cottingham Edit., Western Philosophy an Anthology, Blackwell, 1996, Oxford, pp342349, ISBN0631 -18 263.
[5] Course team, Statistics in society Unit B3, The Open University, 1998, Milton Keynes, page 9, ISBN 0-335-14133-1.
[6] Course team, Statistics in society Unit B3, The Open University, 1998, Milton Keynes, pp 2033, ISBN 0-335-14133-1.
[7] Hilton P.R., Statistics explained, Routledge, London, 2004, pp207-212, ISBN0415332 8- 2.
[8] Hilton P.R., Statistics explained, Routledge, London, 2004, pp798 , ISBN0415332 6- 2.
[9] Chapell T., Plato on knowledge in the Theaetetus,Stanford Encyclopedia of Philosophy < http://www.seop.leeds.ac.uk/entries/plato-theaetetus/>
[10] Gettier E., Is Justified True Belief Knowledge? Analysis, Vol. 23, pp. 121–23 (196 3)

The Environmental Quality Standards Directive[1]: A new challenge for laboratories.

Rob Carter

The Water Framework Directive[2] sets out "Strategies against pollution of water" outlining the steps to be taken.

Of interest to a laboratory like the National Laboratory Service is the "First List" of priority substances which was later superseded by a new list within The Environmental Quality Standards Directive, also known as the Priority Substances Directive; which set environmental quality standards (EQS) for the substances in surface waters (river, lake, transitional and coastal) and confirmed their designation as priority or priority hazardous substances. The European Commission further reviewed the list in 2012. It put forward a proposal for a Directive amending the WFD and the EQSD as regards priority substances. In 2013 revised EQS values, based upon practiced environmental and toxicological effects, were confirmed and new substances were included.

Quality Assurance Quality Control Directive[3]

In addition to the list of substances a daughter directive of WFD, referred to as the Quality Assurance Quality Control Directive (QA QC), and national guidance[4] from the Chemicals Task Team (CTT) of the United Kingdom Technical Advisory Group (UKTAG), set out a series of required and recommended quality criteria which are necessary for the reported data to be used to assess compliance against the EQS and subsequently describing whether "good" chemical status has been demonstrated for the relevant water body.

What are these and how does it affect the National Laboratory Service?

1. Minimum performance criteria for all methods of analysis are based on an uncertainty of measurement of ≤50 % estimated at the level of relevant EQS

2. In order to achieve this Limits of Detection (LoD) approximately ≤ one seventh of the EQS must be achieved.

ISO 13530 defines LoD as 2 x √2 x t0.05 x SD within-batch where t0.05 is the tabulated value of Student's t (single-sided) at the 95% probability level and SD is the standard deviation. This equates to 4.65 x SD within-batch. Limit of Quantification = 10 x within-batch standard deviation x Recovery Factor = 2.15 x LoD

3. In the absence of meeting the minimum performance criteria, monitoring is carried out using best available techniques (BAT) not entailing excessive costs.

4. That the methodology is demonstrated to be in control at the value of the LoD.

The Challenge

In October 2013 the Environment Agency requested that its laboratories examine the revised list of substances with EQS values and determine whether they could meet the new criteria. This list included 112 substances, in terrestrial and transitional and coastal surface waters, with a designation of Priority Substance, Priority Hazardous Substance, Specific Pollutant and a UK designation of Other Substances. Of these, 8 had never before been quantifiably analysed in water by the NLS. A further 18 (plus a range of dioxins and dioxin like substances) were required in biota (fish and shellfish), of which 6 had also never been analysed before by the NLS.

Of the 112 substances, 42 in water and 6 in biota would require either a new method or a method improvement and of these, 34 would require either advancement in instrument sensitivity or greater concentration of environmental samples than the current methodology used.

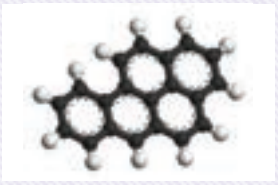
Some of the Specific Pollutants, Priority and Priority Hazardous Substances requiring advancement in methodology

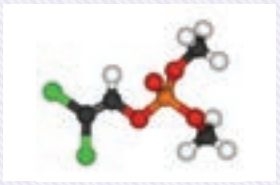
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(ghi)perylene
Benzo(k)fluoranthene
Cybutryne
Cypermethrin
Diazinon
Dichlorovos
Endosulfan
Fluoranthene
Heptachlor
Heptachlor Epoxide
Hexachlorocyclohexane
Methiocarb
Nonylphenol
Octylphenol
Pentachlorobenzene
cis and trans permethrin
perfluorooctane sulfonate (PFOS)
Terbutryn
Tributyl tin chloride
Polybrominated diphenyl ethers
Alconifen
Alachlor
Benzyl butyl phthalate
Bifenox
Dicofol
Hexabromocyclododecane

The following substances demonstrate the largest challenges with respect to improvements in Limits of Detection (LoD) ranging from 10 to 30,000 fold improvements on existing capabilities.

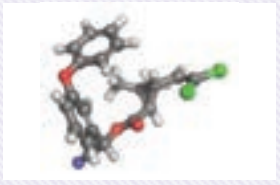
- Heptachlor target LoD 0.00003ng^{-1}
- Benzo(a)pyrene LoD 0.02 ng^{-1}
- Dichlorvos LoD 0.09 ng^{-1}
- Cypermethrin LoD 0.01ng^{-1}
- PFOS LoD 0.09 ng^{-1} & 1ugkg^{-1}


Heptachlor


Benzo(a)pyrene


Dichlorvos


Perfluorooctane sulfonate (PFOS)


Cypermethrin

Bridging the Gap

The programme of bringing suitable methods on line was to be done over two years bringing all methods up to a standard so that they might be considered to be BAT by April 2016 and where possible report the required LoQ values. The following activities were undertaken.

- Split the various developments down into separate projects of which 10 were considered of high enough importance to resource.
- Identify methodology and instrumentation which offered the best opportunity to deliver the required results and identify the cost of monitoring.

A significant proportion of the Environment Agency monitoring programmes are the cost of the laboratory analysis, and a significant proportion of this can be the capital outlay in instrumentation. With a typical instrument capable of analysing the substances shown here costing between £50 k and £300 k it is vital that any monitoring programme is fully justified.

The laboratories then conducted an extensive procurement process to identify instrumentation which provided the right balance between sensitivity, quality and value for money, environmental impact and Health and Safety. Trials were undertaken with various instrument companies and two instruments types were identified. Gas chromatography-mass spectrometry (GC-MS) and liquid chromatography-mass spectrometry (LC-MS)

These instruments, whilst sensitive in their own right, also offer very good signal to noise ratios. However, this still leaves the laboratory to extract from the sample the compounds of interest. Even with these sensitive instruments this still leaves a minimum of 2000 fold concentration step, extracting and concentrating at the same time. This is routinely performed by extracting the compounds of interest by either dissolving these organic compounds in an organic solvent such as dichloromethane, or by adsorbing them onto a so called Solid Phase material and eluting them off; in both cases prior to concentration.

The Environment Agency has concluded that sampling anything more than one litre of water at a time in a routine monitoring would be impractical. In the case of heptachlor this still won't be sufficient, and in order to achieve the required LoD, in excess of 100 litres per sample would be necessary.

This is where the laboratories fall back on the premise of BAT, not entailing excessive cost.

The greatest challenge for laboratories however is not just the low level of detection now required but is in controlling the background level of some of the compounds in the environment and their impact upon validating the methodologies.

The real challenge now starts. Having established your methodology it needs to be validated according to various guidelines[5,6,7] before it can be determined the method works and data generated is fit for purpose. This is where this article concludes with the challenging job of validating the methodology and monitoring the environment.

Developing our People

The National Laboratory Service as reported in the IST's spring 2015 Journal edition have joined forces with IST and the Science Council, and are actively promoting the development of its people. The technical challenges presented by the EQS and QA/QC Directives are a fantastic opportunity for NLS people to develop methodology whilst challenging and developing themselves and the organisation; identifying new ways of working and new scientific solutions. Many of our staff have been taken "off-line" to focus on these projects enabling other staff to fill the void and therefore spread the development opportunities to more of our people.

Author

Rob Carter is the National Laboratory Services Product Manager and has 25 years experience in developing analytical tests and leading and managing chemistry teams. Rob is currently in the process of applying for the Science Councils Chartered Scientist award.

References

1. Environmental Quality Standards Directive 2008/105/EC (EQSD)
2. Water Framework Directive 2000/60/EC (WFD)
3. Quality Assurance Quality Control Directive (Directive 2009/90/EC)
4. UK TAG chemistry task team guidance on the implementation of the QA/QC Directive
5. Environment Agency, National Laboratory Service, Systems Quality Manual (Version 18.29/04/15)
6. RSC, A Manual on Analytical Quality Control for the Water Industry, ISBN 0902156683, WRC plc, Marlow UK. Cheeseman, R.V. and Wilson, A.L. (revised by Gardner, M.J.)
7. ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories

Novel molten salt electrochemical reactors

Charles Osarinmwian

The dominant feature of industrial development in the nineteenth century was the use of power, but closely associated with it and of scarcely less importance was the enormous increase in the use of metals made possible by metallurgical progress[1]. The discovery that alkali metals could be electrolyzed from their molten salts from multiple Volta cells connected in series dates back to the early nineteenth century. Since then the first industrial electrolytic cell for electro-refining copper was introduced in 1869[2] and aluminium production by the electrolysis of molten cryolite containing alumina was invented by Charles Hall and Paul Héroult in 1886[3]. Nowadays the electrolytic production of metals, alloys, semiconductors and oxides via the electrochemical reduction of solid compounds in molten salts has been well demonstrated in many sectors including spent fuel reprocessing[4]. Herein novel molten salt electrochemical reactors in metallurgy and spent fuel reprocessing with associated materials engineering is reported.

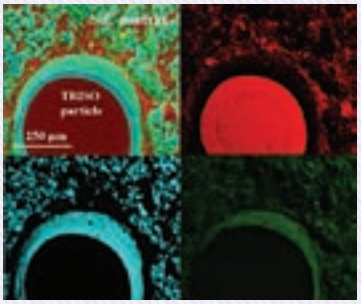


Figure 1: Surrogate Generation IV fuel. *TRISO fuel particle embedded in SiC (Red - 57.1 wt.% Carbon; Blue - 19.7 wt.% Silicon; Green - 20.8 wt.% Oxygen).*

The feasibility of dissolving surrogate fissile material embedded in a neutron-transparent SiC inert matrix (Figure 1) in molten salt is important for developing electrochemical reactors for spent fuel reprocessing. Conventional pyro-processing involves the dissolution of spent fuel in molten LiCl-KCl eutectic followed by separation using electro-refining[5]. For Generation IV fuel, reprocessing fissile UC could involve molten salt electrolysis of UC, dissolution of the dendritic uranium deposit in hot mercury and then the conversion of the uranium in quasi-amalgam to UC by distillation in a hydrocarbon gas atmosphere[6]. Also, reprocessing the SiC matrix could involve molten $CaCl_2$-CaO corrosion at 800°C for 2 h (see Le Châtelier conditions from 1883) to generate water soluble double salt $Ca_3SiO_4{\cdot}CaCl_2$ mixed with $Ca_3SiO_4Cl_2$ (Figure 2 and 3). This novel reprocessing scheme could be used for TRISO fuel[7]. It is important to note that molten salt reactors have the potential to solve almost all the problems of nuclear energy in a far more elegant way than existing light-water reactors[8].

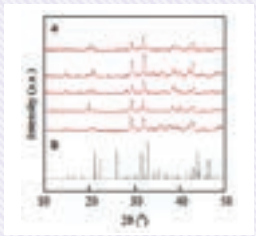


Figure 2: X-ray diffraction spectra. a, *Double salt $Ca_3SiO_4{\cdot}CaCl_2$ mixed with $Ca_3SiO_4Cl_2$. b, $Ca_3SiO_4Cl_2$ (JCPDS 23-0873) showing a monoclinic crystal structure (space group: P21/c) consisting ~ ccp arrangement of SiO_4^{4-} tetrahedra and Cl^- anions with the Ca^{2+} cations occupying interspersed octahedral sites in a distorted NaCl-type structure.*

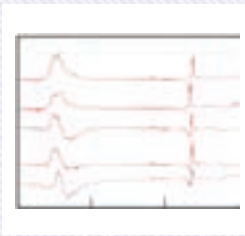


Figure 3: Infra-red spectra. *Hygroscopic double salt $Ca_3SiO_4{\cdot}CaCl_2$ mixed with $Ca_3SiO_4Cl_2$ show O-H bending modes at 1630 cm^{-1} and sharply resolved doublets for a 3400 cm^{-1} band consisting of O-H symmetric stretching modes at 3220 cm^{-1} and O-H anti-symmetric stretching modes at 3445 cm^{-1}.*

The cathodic protection of Generation IV reactor vessels to withstand the corrosive nature of molten salts will prove a major challenge. Matson et al.[9] found that vessels experienced severe corrosive attack in contact with a molten fluoride-based salt. Similarly, Andriiko et al.[10] tested sacrificial anodes for the cathodic protection of graphite crucibles in the electro-deposition of germanium from a molten fluoride-based salt. The required cathodic current density was difficult to obtain with a graphite crucible anode where cathode degradation by oxidation near the anode resulted in product contamination. Further, the corrosion resistance of copper and nickel was significantly better than iron. Kolosov et al.[11] found that imposing an impressed current density provided sufficient corrosion protection of process vessels containing a molten chloride-based salt.

However, Ives and Godard man[12] recommended a lower operating temperature as opposed to cathodic protection as it failed to provide corrosion protection of a storage vessel in the vapour regions of a molten carbonate-based salt.

The development of inert anodes enables Hall-Héroult reactors to minimize process control problems such as large anode-cathode gaps and disturbances from daily changes of monolithic self-baked (Soderberg) or prebaked anodes. An empirical approach based upon process experience guides material selection since selecting an optimum anode material on a theoretical basis is impossible. Copper-nickel, copper and tin oxide anodes generate more uniform current distributions along horizontal undersides due to smooth release of more than 95 % smaller gas bubbles (bubble contact angle ~ 0°) from 60 % thinner bubble layers than graphite anodes[13]. The bubble contact angle of 120-130° for graphite anodes tends to induce a high ohmic drop with low electrical conductivity in the bubble-free anode-cathode gap. To compliment inert anode technology, the installation of 0.57-0.61 cm sloped drainable cathodes coated with titanium diboride would offer aluminium wettability with low alumina deposition while the development of wing-pattern stub designs would minimize potential drops in anode-stub connections[8,14].

The design of an inert anode underside affects the potential distribution in Hall-Héroult reactors[14]. In practice, flat undersides contribute to the physical manifestation of anode effects and alumina concentration gradients leading to non-uniform current distributions and alumina deposition.

In contrast, undulated and 0.5-3° sloped undersides minimize aluminium re-oxidation by inducing efficient circulation patterns, low electrical resistance in shorter anode-cathode regions, and few localized regions of high current density[16,17]. A series of anode plates inclined at 45° above shaped cathodes in a grid-like assembly have also been proposed[14]. Finally, perforated undersides comprising a series of parallel horizontal rods that are spaced apart in a generally co-planar arrangement, which form longitudinal flow-through openings, offer a large surface area with relatively uniform current distributions[18].

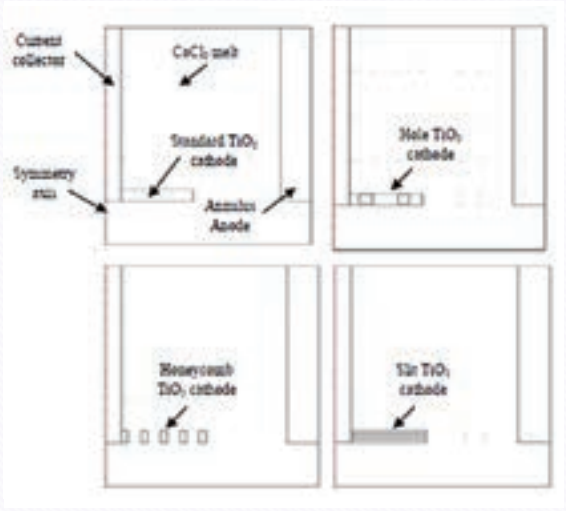


Figure 4: Near net shape cathodes. *Porous titanium dioxide cathodes (porosity = 32 %) within rotationally symmetric electrochemical reactors.*

The Alcan-Ishizuka, Metalysis and Alcoa reactors for magnesium, titanium and aluminium production respectively have utilized (or will utilize) a terminal anode and cathode with vertically stacked bipolar electrodes. In relation to the latter, the production of aluminium could be optimized in a Hall-Héroult reactor equipped with inert bipolar electrodes provided that certain technical issues are addressed[8]:

- Deploy electrodes in closely-spaced horizontal arrays to ensure high electrode packing density and low capital outlay per unit of aluminium production;
- Anode and cathode materials with dissimilar expansion coefficients within a monolithic structure;
- Maintain internal stability of bipolar electrodes during extended reactor operation while protecting the perimeter of the anode/cathode interface from corrosive attack.

The anodic and cathodic side of a bipolar electrode could consist of cooled pipes or flow-channels carrying cooling fluid embedded in the anode while a layer of material (with a higher electrical resistivity than the cathode) is inserted into the bipolar electrode to provide heating.

The cathode of the bipolar electrode could be heated by means of reducing the active surface area of the cathode so that the electrode has a cathode to anode surface area ratio of 0.5-1. Heating and cooling schedules could be imposed to maintain the temperature at the anode and cathode surface slightly lower than the molten salt temperature with careful monitoring of the rate of fluid transport through flowe hannels to avoid excessive cooling.

The design of an anode annulus with near net shape titanium dioxide cathodes in FFC Cambridge reactors indicate that Slit cathodes are preferable because they generate the most uniform current density distribution (Figure 5). This innovation supports the direct electro-reduction of metal oxide mixtures into near net metal alloy components while addressing the relationship between product design, operating costs and titanium production capabilities in different countries based on 2003-2012 census data on U.S. and foreign produced titanium prices[19]. Further, limitations of the Kroll process have held back the widespread use of titanium where titanium prices have been 15 times higher than aluminium and 60 times higher than steel. Also, the worldwide production and consumption of 40 million tons of aluminium and 1.2 billion tons of steel in 2009 dwarfed ~ 100 thousand tons of titanium. This was compounded by a forecast that world titanium consumption between 2011 and 2025 will increase at a 4-10 % average annual rate[19].

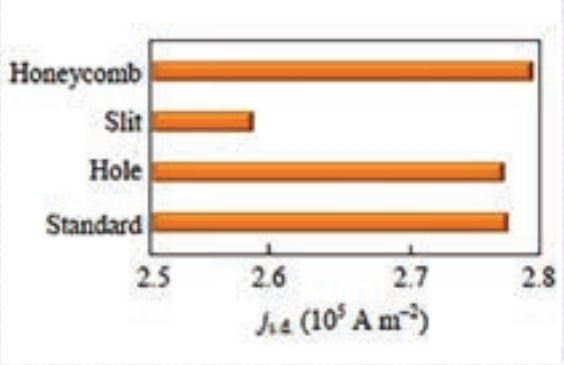


Figure 5: Primary current distribution. *Standard deviation in current density $j_{s.d.}$ along the current collector/TiO_2/melt 3PI. Details of model development can be found in my previous work[15].*

In future, a next generation highp urity metal production plant could avoid labour intensity, poor spacetim e yield and inefficient mass transport by operating bipolar reactors in semieon tinuous mode. In titanium production, incorporating a continuous pumping loop in a bipolar reactor to increasingly raise current efficiency by lowering background current since repeated re-circulation of fresh molten calcium chloride from a reservoir would increasingly lower the concentration of calcium oxide[19].

Further, the electronic conductivity of the molten salt[15,20] could lower current efficiency from bypass currents between neighbouring bipolar electrodes. This problem could be minimized by increasing the current and height of the bipolar reactor; bounding bipolar electrodes with an upwardly extending rim around the electrode edge, and electrically insulating the internal wall of the reactor (see the Ishikawa-Konda approach).

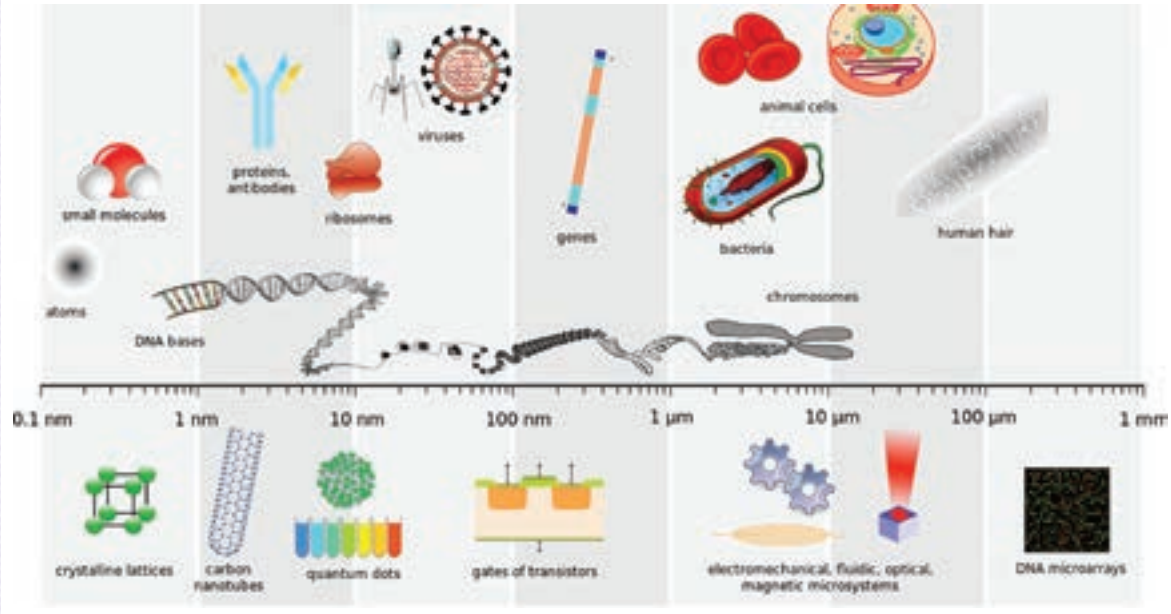
Author

Charles Osarinmwian, MIScT, RSci, is in the School of Chemical E gineering and Analytical Science, The University of Manchester, Oxford Road, Manchester M13 9PL, United Kingdom.
Email: charles.osarinmwian@manchester.ac.uk

References
1. H. Hartley, al ture 150 (1942)594.
2. F. Habashi, (W ey-VCH Weinheim, Gr many, 1997).
3. D. Rabinoic h, al ture Chem. 5 (2012)76.
4. W. Xa o, D. Wang, Chem. Soc. Rev. 43 (2014) 3215.
5. J.J. Laider, J.E. Battles, W. G y, (Argonne al tional Laboratory, Illinois, 1993).
6. W.N Hansen, A ASR -7660, 1963).
7. K. Bari, C. Ga rinmwian, E. LópezH onorato, T.J. Abram, Nucl. E g. Des. 265 (2013)668
8 C. Ga rinmwian, (arXiv1312. 2258 2013).
9. L.K. Matson, E.F. Stephan, P.D. Miller, W.K. Boyd, R.P. Milford, Corrosion 22 (1966)194.
10. A.A. Andriiko, Y.K. Delimarskii, R.V. Chernov, Sov. Powder Metall. Met. Ceram. 18(1979)290 .
11. V.N Kolosov, E.S. Matychenko, A.T. Belyaevskii, Protection of Metals 36 (2000)545.
12. J.K. Ives, B.J. God man, A mer. Chem. Soc., San Diego, 196) .
13. L. Cassayre, T.A. Utga rd, S. Bouvet, JOM 54 (2002) 41.
14. C. Ga rinmwian, A. Dutton, J. Osarinmwian, (arXiv1411 .1639, 2014).
15. C. Ga rinmwian, I.M. Mellor, E.P.L. Roberts, E ectrochim. Acta 164 (2015)48
16. R. Shekhar, J.W. Ea ns, Metall. Mater. Trans. B 27 (1996)19.
17. R.L. Troup, G E. Carkin, D.R. Careatti, (Patent S 6511590 B1, 2003).
18 V. De hir a, E ectrochem. Soc. Interface 11 (2002)20 .
19. C. Ga rinmwian, E gD Thesis, The U iversity of Manchester, 2012).
20. C. Ga rinmwian, E.P.L. Roberts, I.M. Mellor, Chem. Phys. Lett. 621 (2015)18.

When size matters: the importance of nanoscale for pharmaceutically active substances

Raffaele Conte



Comparison of various biological assemblies and technological devices[1]

Background

The nanoscale affects all our lives and in many different areas, including medicine and pharmacy. The transformation of materials into the nano dimension changes their physical properties, and is used in pharmaceutics to develop a new innovative formulation principle for poorly soluble drugs: the drug nanocrystals. This article discusses the physics behind the drug nanocrystals and the changes of their physical properties, along with the industrially relevant production technologies. Also discussed are the benefits and the disadvantages of the various ways forward with some examples of products marketed or in the development pipelines.

Introduction

The nanoscopic scale (or nano scale) refers to structures with at least one dimension in the length scale of 1–100 nanometers. Nanoscience is the study of nano scale materials. Due to their small dimensions these structures exhibit remarkable properties, functionality, and phenomena. Nanotechnology is a discipline that is based on the manipulation, control, and integration of atoms and molecules to form nanosized materials, structures, components, devices, and systems. Nanotechnology is the application of nanoscience, especially to industrial and commercial objectives[1]. Nowadays, the appellation "nano" is widely encountered in our daily lives. For example it is included in the production of nano components of computer microchips [2], in biotechnology [3], in research regarding cosmetic, food and pharmaceutical products [4,5].

In medicine, nanotechnology has the potential to improve the whole care process. There are diagnostic tools, imaging agents, drug delivery systems, pharmaceuticals, implants and tissue engineered constructs, of nanoscopic scale ava ilable that are aimed toward making medical practice safer, less intrusive and more personalised[6]. In pharmacy, nanotechnology can enhance the bioava ilability. This characteristic has a positive implication due to the fact that, over the last ten years, the number of poorly soluble drugs has steadily increased. Es timates indicate that 40% of the drugs in the pipelines have solubility problems[7]. Adva nces in high throughput screening methods can lead to a greater volume of newly discovered drugs, and about 60% of them could have poor water solubility[8]. Poor solubility in water correlates with poor bioava ilability (if th e drug is not solubilised it will not be able to be absorbed from the gastrointestinal tract into the bloodstream and it will not reach the site of action). No notechnology responds to this problem through the functionalisation of the drug by the incorporation into soluble vectors, or the formation of nanocrystals. The chemical modification of the drug is limited by drug solubility properties and because of the use of surfactants and/or cosol vents, (their residues can lead to increased side effects)[9]. The synthesis of nano drug delivery systems (D DS)en hance the efficacy and decrease side effects through a site-specific targeted delivery, help to increase the stability of drugs, and possess useful controlled release properties[10.] Un fortunately, in this synthesis there is also the need to use surfactants.
However, the formation of nanocrystals, on the other hand, will permit improved bioava ilability of the substance and avoid the use of excipients.

Properties of nanocrystals

Drug nanocrystals are crystals with a size in the nanometer range that are totally composed of drug without carrier material. They are administered in the pharmaceutical forms of “nanosuspensions”, that are dispersions of nanocrystals in liquid media. The dispersed particles are stabilised using surfactants or polymeric stabilisers. Ex amples of dispersion fluids are water, aqueous solutions, or nona queous media (e .g., liquid polyethylene glycol, oils). The process of nano crystallisation leads to the formation of crystalline or amorphous products, depending on the production technologies. Physically, the transformation of drug into nanocrystals increases the dissolution velocity by surface area enlargement. The size reduction induces an increase in the surface area and thus, according to the No yesW itney equation, to an increased dissolution velocity.

Rate of dissolution:

$$\frac{dm}{dt} = A^* \frac{D}{d} * (Cs-Cb)$$ (Noyes and Whitney 1897) [11]

Wh ere: m, mass of the dissolved material; t, time; A, surface area of the interface between the dissolving substance and the solvent; d, thickness of the boundary layer of the solvent at the surface of the dissolving substance and the solvent; Cs, mass concentration of the substance on the surface or “saturation solubility”; Cb, mass concentration of the substance in the bulk of the solvent.

Therefore, the transformation of drug into nanoscale enhances the bioavailability of drugs where the dissolution velocity is the rate-limiting step.
In addition, drug nanocrystals possess increased saturation solubility (below a critical size of 1–2 µm , the Cs rises with decreasing particle size) hav ng the advantage that the dissolution velocity is further enhanced (because dm/dt is directly proportional to the saturation solubility) and that, with the increased saturation solubility, the concentration gradient between gut lumen and blood is raised, improving the absorption by passive diffusion[12]. The rate of dissolution and, thus, the bioava ilability can be further boosted enhancing the saturation solubility through the increase of the dissolution pressure[12], or producing nanocrystals in the amorphous state, due to the fact that amorphous drug nanoparticles possess a higher Cs compared to equally sized drug nanocrystals in the crystalline state[13].

In general, optimal drug nanocrystals should have a size of ranging from 50 nm to 20 nm and be amorphous.

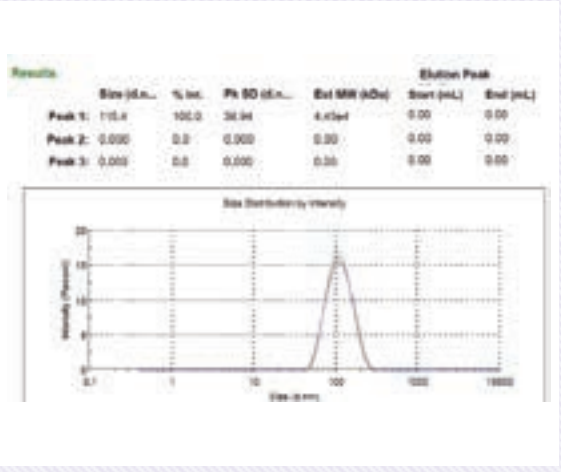


*Figure. 1 Dynamic Light Scattering (DLS) spectrum (* a characterisation technique able to inspect the size and morphology of nanoparticles) of Poly(Lactide-co-Glycolide) nanocrystals obtained with Malvern Zetasizer Nano ZS instrument at the “Institute of Biosciences and BioResources” in Naples*

Production of nanocrystals

The three main methodologies used to produce nanocrystals are milling, precipitation, and homogenisation. Among these, milling is currently the industrially most relevant technique, but homogenisation is experiencing a growing interest. Both are "top down technologies" (nanocrystals are obtained starting from a large-size drug powder). Precipitation, on the other hand, is a "bottom up technology" (nanocrystals are formed from dissolved molecules) and is currently not used in the production of commercial products due to the poor solubility of some drugs in aqueous and organic media, the need of solvent removal and the difficulty in controlling the process.

Precipitation methods

In this technique, the drug is dissolved in a solvent and subsequently added to a nonsolvent, leading to the precipitation of finely dispersed drug nanocrystals. The formed crystals are stabilised with a surfactant in order to avoid their growing at a micrometer range. This preparation method cannot be used for drugs insoluble in both aqueous and organic media[14]. This limitation prevents the industrial development of the precipitation.
A modified method contemplates the use of an oil/water (O/W) two phase system that permits the formation of amorphous drug nanocrystals. In this technique a solution of the drug, together with a surfactant in lipophilic phase, is mixed with an appropriate solvent at a specific temperature with the addition of a protective colloid[15].

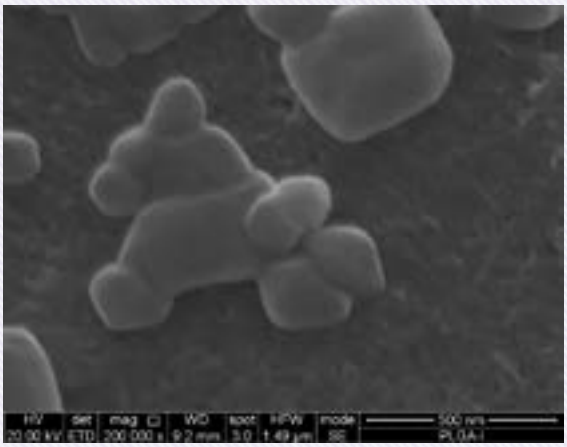


Figure. 2 Scanning electron microscopy (SEM) image of Poly (Lactide-co-Glycolide) nanocrystals obtained by FEI Quanta 200 FEG instrument at the "Electron microscopy facility" of the "Institute for Polymers, Composites and Biomaterials" in Pozzuoli

Milling methods

Milling methods are a class of techniques that have a common theory but different procedures. In this approach, the particle size diminution is achieved through a bead or a pearl mill.

Specifically, milling media, dispersion liquids (generally water), stabilisers, and drug are charged into the milling chamber. The movement of the milling media generates size reduction by the shear forces of impact. The different strategies are due to the usage of smaller or larger pearls as milling media or in the different material composition (e.g. ceramics (cerium or yttrium stabilised zirconium dioxide), stainless steel, glass or highly cross linked polystyrene resin). Disadvantages are in the erosion from the milling material and in the adherence of product to the inner surface area of the mill. A solution for the first problem is in the coating of milling beads[16] while, to decrease the loss in the production, two basic milling principles are used: the milling medium is moved by an agitator, or the complete container is maneuvered in a complex dynamism. The milling time lasts from minutes to days depending on the surfactant content, hardness of the drug, viscosity, temperature, energy input, and size of the milling media[17].

Homogenisation methods

Nanocrystals derived from homogenisation methods are produced according to three main technologies: microfluidiser technology, piston gap homogenisation in water and piston gap homogenisation in non-aqueous solvent. The "microfluidiser technology" generates small particles through a frontal collision of two fluid streams under pressures up to 1700 bar, inducing shear and cavitation forces (= a dynamism provoked by shockwaves)[18]. Homogenisation requires surfactants able to stabilise the desired particle. The disadvantage is in the high number of cycles (50 to 100 passes) necessary for a sufficient particle size reduction[19]. In contrast, piston-gap homogenisers act producing nanoparticle suspensions in water at room temperature. Specifically, drug powder is dispersed in an aqueous surfactant solution and subsequently forced by a piston through the tiny homogenisation gap (5 to 20 μm) with pressures from 1500 to 4000 bar. The width of the homogenisation gap depends on the viscosity of the suspension and on the applied pressure. This stress causes the formation of gas bubbles that collapse immediately when the liquid leaves the homogenisation gap and returns to the normal air pressure of 1 bar, resulting in shockwaves. Consequently, the drug particles are reduced in size due to high shear forces, turbulent flow and shockwaves[20]. Piston-gap homogenisers have disadvantages related with the use of water (e.g., hydrolysis of water-sensitive drugs; necessity of drying steps such as lyophilisation). Therefore this technology is most suitable for the formulation of aqueous suspensions of nanocrystals[21]. Alternatively, the piston-gap homogenisers in non-aqueous solvent use dispersion media with a low vapour pressure.

In this technology the cavitation forces are very little or nonexistent and the remaining shear forces, particle collisions and turbulences are sufficient to achieve nanoparticles[22]. Optional low temperatures during the homogenisation allow the processing of heat labile drugs[22]. In addition the use of non-aqueous media protects drugs from hydrolysis. Suitable nonaqueous eluents are oils or hotmelted polyethylene glycols (PEG)[23].

New technologies of nanocrystals production

The research in nanocrystals has also resulted in new synthetic technologies. For example, precipitation methods with subsequent annealing steps have been developed through the application of high energy (e.g., high shear and/or thermal energy)[24], and a spraydrying pre-treatment step prior to homogenisation, to produce particles below 100 nm[25] and supercritical fluid methods such as "rapid expansion of supercritical solution" (RESS), "rapid expansion from supercritical to aqueous solution" (RESAS), "solution enhanced dispersion by the supercritical fluids" (SEDS), "spray freezing into liquid" (SFL), "evaporative precipitation into aqueous solution" (EPAS), and "aerosol solvent extraction" (ASES)[26,27].

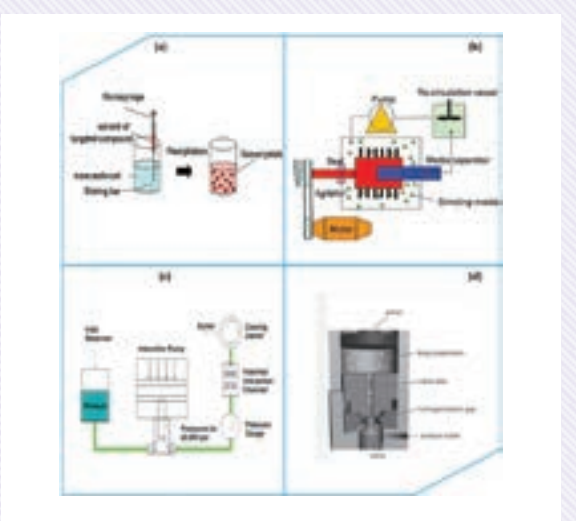


Figure. 3 Simplified scheme of nanocrystal precipitation (a), milling technology (b), Microfluidizer materials processor (c) and piston-gap homogenizer (d)

Nanocrystals in the market and their applications

Nowadays, all major pharmaceutical companies have realised the potential of drug nanocrystals and include this formulation approach into their medicinal development process, taking advantage of the versatility of nanosizing technology[28]. In fact, there are currently six FDA approved nanocrystal products on the market and several others are in different stages of clinical trials. Rapamune® (Rapamycin) by Wyeth, Emend® (Aprepitant) by Merck, Tricor® (Fenofibrate) by Abbott, Megace ES® (Megestrol) by Par Pharmaceutical Companies, Triglide® (Fenofibrate) by Sciele Pharma Inc., Invega®(Paliperidone palmitate) by Janssen are marketed, while Semapimod® (Guanylhydrazone) by Cytokine Pharmasciences, Theralux® (Thymectacin) by Celmed, Nucryst® (Silver) by Nucryst Pharmaceuticals are in Phase II trials and Paxceed® (Paclitaxel) by Angiotech is in Phase III[12].

The pharmacologic/pharmacokinetic advantages of nanocrystals correlate with the drug administration modality. For dermal application, nanocrystals of poorly soluble cosmetics and pharmaceuticals have enhanced skin penetration.

Moreover the increased concentration gradients, consequent to the improved skin adsorption, promote passive penetration. The marketed cosmetic products containing nanosized rutin give evidence of the efficacy of dermal nanocrystals preparations. Compared to the water-soluble rutinglucoside these formulations possess a 500 times higher bioactivity (measured as sun protection factor)[29]. Similarly, oral nanocrystals preparations of poorly soluble drugs have enhanced bioavailability due to the fast dissolution of crystals that cause the improvement of the absorption in the gut, the reduction of the difference in drug activity between fed and non-fed state, the possibility to make nanosuspensions more concentrated in order to decrease the application volume, and the production of less viscous formulations[23,30]. Disadvantages are related with the presence of electrolytes that reduce the nanocrystal zeta potential leading to aggregation and to a slower dissolution[17]. Finally, nanosuspensions are used to mime intravenously injected solutions thanks to their capacity to minimise the uptake by the liver. This property is due to the fact that molecules above 200 nm are taken up by the macrophages of the liver, potentially causing toxicity, while nanocrystals below 100 nm dissolve much faster and lead to a pharmacokinetics similar to injected drug solutions.

Conclusion

At the present stage, nanocrystal technology offers some excellent pharmacological benefits. The particle size diminution results in increased contact surface, saturation solubility, and dissolution velocity. These factors are able to solve solubility problems and lead to a more acceptable bioavailability. In addition, nanocrystal technology enables the development of formulations free of surfactants that can cause enhanced side effects or adverse reactions.

Furthermore, nanocrystals have a fast action onset, a similar absorption in fed and fasted conditions, and decreased side effects due to the smaller doses required. It is possible that in the future more new drugs will be poorly soluble and, thus, there will be an increased need for a more targeted drug delivery systems based on drug nanocrystals. Research is likely to be focused on the linkage of the nanosized drug particles with special ligands or other surface modifications to their target site in order to further increase the performance of these systems.

Acknowledgments

The author would like to thank colleagues from the nanotechnology group of Dr. Peluso at the "Institute of Biosciences and BioResources" of the Italian National Research Council (CNR), Naples, who provided insight and expertise that greatly assisted the research and the "Electron microscopy facility" of the "Institute for Polymers, Composites and Biomaterials", CNR, Pozzuoli for the acquired SEM image.

Author

Raffaele Conte, MIScT, RSci is a research fellow for the "Institute of Biosciences and BioResources" of the Italian National Research Council (CNR) in Naples, Italy. His scientific activity is focused on the development of biomaterials and on the synthesis of drug delivery systems. Moreover, he follows additional projects as independent researcher. Raffaele is the author of several publications in various areas of biological, chemical and pharmaceutical sciences and a reviewer for different peer-review journals. His last qualification is a postgraduate master as "Expert in innovative processes of bimolecular synthesis techniques applied to epigenetic".

His email address is **raffaele.conte86@tiscali.it**

[i] Image credit: "Biological and technological scales compared-en" by Guillaume Paumier, Philip Ronan, NIH, Artur Jan Fijałkowski, Jerome Walker, Michael David Jones, Tyler Heal, Mariana Ruiz, Science Primer (National Center for Biotechnology Information), Liquid_2003, Arne Nordmann & The Tango! Desktop Project - Top (from left to right) File:Water molecule.svg, Philip Ronan, domaine publicFile:Chromosom. svg, NIH, domaine publicFile:Antibody scheme.svg, Artur Jan Fijałkowski, cc-by-sa-2.5File:Ribosme symbol.svg, Jerome Walker, cc-by-sa-2.5File:Tevenphage.svg, Michael David Jones, cc-by-sa-2.5File:Virus Replication.svg, Tyler Heal, cc-by-sa-2.5File:Gene symbol.svg, Guillaume Paumier, cc-by-sa-2.5File:Average prokaryote cell- en.svg, Mariana Ruiz, domaine publicFile:Osmotic pressure on blood cells diagram.svg, Mariana Ruiz, domaine publicFile:Celltypes.svg, Science Primer (National Center for Biotechnology Information), domaine publicFile:Human hair SEM.svg, Guillaume Paumier, cc-by-sa-2.5Bottom (from left to right)File:Symbol cristallography2.svg, Liquid_2003, adapted from Image:Symbol cristallography.svg, Guillaume Paumier, cc-by-sa-2.5File:Carbon nanotube.svg, Guillaume Paumier, cc-by-sa-2.5File:Quantum dots.svg, Guillaume Paumier, cc-by-sa-2.5File:Scheme of metal oxide semiconductor field-effect transistor.svg, Arne Nordmann, cc-by-sa-2.5File:Planar microinductor.svg, Guillaume Paumier, cc-by-sa-2.5File:Applications-system.svg, The Tango! Desktop Project, cc-by-sa-2.5File:VCSEL symbol.svg, Guillaume Paumier, cc-by-sa-2.5File:DNA microarray.svg, Guillaume Paumier, cc-by-sa-2.5Final patchwork is my own work.. Licensed under CC BY-SA 2.5 via Wikimedia

References

1. Hornyak, G bor L. (2009) . Fundamentals of N notechnology. Boca Raton, FL: Taylor & rancis G oup.
2. Kanellos M. 2005. Moore says nanoelectronics face tough challenges. CN t N ws [online]. 9 March. URL: http://www.news.com/Mooresays-nanoelectronics-facet oughe hallenges/2100-10063-5607422.html? ag=st.nl
3. Merkle RC. 1999. Biotechnology as a route to nanotechnology. Trends Biotechnol, 17:271-4.
4. Müller RH, Pardeike J, Hommoss A. N noparticles in therapeutics: drug nanocrystals and lipid nanoparticles. MSTIC ongress NanoTrends 2006. Berlin, Ger many.
5. VelikovK . 2006. Colloidal delivery systems for functional food design. 9th Annual S TI N notechnology Conference and Trade Show, N notech 2006. Boston, Massachusetts, S A.
6. T. Kubik, K. BoguniaK ubik and M.Sugisaka, N notechnology on duty in medical applications, Current Pharmaceutical Biotechnology 2005, 6,1733.
7. 7.Speiser PP. 1998 Poorly soluble drugs: a challenge in drug delivery. In Müller RH, Benita S, Böm B (ed s). Em ulsions and nanosuspensions for the formulation of poorly soluble drugs. Medpharm Stuttgart: Scientific Publishers, pp. 15–28
8 MeriskoL iversidge E. 2002. Nanocrystals: resolvin g pharmaceutical formulation issues associated with poorly watersol uble compounds. Particles, April 20–23, 2002. O lando, Florida, USA.
9. W lems L, an der G est R, de Beule K. 2001. Itraconazole oral solution and intravenous formulations: a rev ew of pharmacokinetics and pharmacodynamics. JC lin Pharm Ther, 26:159-61 .
10. G oneberg DA, Ger sig M, Welte T, Pison U. N noparticle-based diagnosis, and therapy. Curr Drug Targets. 2006; 7(6): 643-648
11. N yes A, W itney W. 1897 . The rate of solution of solid substances in their own solutions. JA m Chem Soc, 19:930-4.
12. ón sW e A H ul nghanns, Rainer H Müller. Nanocrystal technology, drug delivery and clinical applications. International ou rnal of N nomedicine 2008:3(2)295-309
13. Hancock BC, Parks M. 2000. W at is the true solubility adu ntage for amorphous pharmaceuticals? Pharmacol Res, 174:397-404.
14. Fessi H, Puisieux F, Dev ssaguet JP, Amoury N Benita S. Int. J. Pharm. 198; 113:r1-r 4.
15. Shackleford DM, Faassen WA, Houwing N et al. 2003. Contribution of lymphatically transported testosterone undecanoate to the systemic exposure of testosterone after oral administration of two andriol formulations in conscious lymph duct-cannulated dogs. J Ph armacol E p Ther, 3063:925-33.
16. Bruno JA, Doty BD, G stow E. 1992. Method of grinding pharmaceutical substances. US Patent 5518-7 . USA.
17. MeriskoL iversidge E, Liversidge G Copper R . 2003. N nosizing: a formulation approach for poorlyw atersol uble compounds. E r J Pharma Sci, 18:113–20.
18 Bruno RP, McIlwrick R. 1999. Microfluidizer processor technology for high performance particle size reduction, mixing and dispersion. E r J Pharm Biopharm, 56:29-36.
19. Müller RH, Becker R, Kruss B, et al. 1999. Pharmaceutical nanosuspensions for medicament administration as systems with increased saturation solubility and rate of solution. US Patent 5858-10 . USA
20. Muller RH, á cobs C, Kayser O. 2001. N nosuspensions as particulate drug formulations in therapy: Rationale for development and what we can expect for the future. Adv Drug DeliV R ev, 471:3–19.
21. Müller RH, Jacobs C, Kayser O. 2003. DissoCubes -a novel formulation for poorly soluble and poorly bioa ilable drugs. In Rathbone MJ, Hadgraft J, Roberts MS (ed s). Modified- elease drug delivery systems. New York: Marcel Dekker, pp. 135-49.
22. Bushrab FN , Müller RH. 2003. N nocrystals of poorly soluble drugs for oral administration. JN w Drugs, 5:20–2.
23. Keck CM, Bushrab FN , Müller RH. 2004. N nopure® nanocrystals for oral delivery of poorly soluble drugs. Particles, April 20–23, 2002. Orlando, Florida, S A.
24. Kipp JE, Wong C T, Doty MJ, et al. 2003. Microprecipitation method for preparing submicron suspensions. S P atent 6607-8. S A.
25. Müller RH, Möschwitzer, P . 2005. Method and apparatus for the production of ultrafine particles and coating of such particles. DE 10 2005 053-2. 2 Application, Ger many.
26. Müller BW, Bleich J. 1996. Production of drug loaded microparticles by the use of supercritical gases with the Aerosol Solvent E traction System A SES)p rocess. JM icroencapsulation, 132:1319.
27. Lee S, Nam K, Kim MS, et al. 2005. Preparation and characterization of solid dispersions of itraconazole by using aerosol solvent extraction system for improvement in drug solubility and bioa ilability. Arch Pharm Res, 28 :86– 74.
28 á n P. Möc hwitzer. Drug nanocrystals in the commercial pharmaceutical development process. International Journal of Pharmaceutics Volume 453, Issue 1, 30 August 2013, Pages 142–156.
29. Petersen R: N nocrystals for use in topical cosmetic formulations and method of production thereof. S p atent application No. 60/86, 233, 2006
30. Cornelia Keck, Szymon Kobierski, Rachmat Mauludin, Rainer H. Müller. Second generation of drug nanocrystals for delivery of poorly soluble drugs: smartcrystals technology. Dosis vol.24 n:02/2008

Looking for mercury

Andy Welham

At end of 2014 I was tasked with developing a method in line with requirements of the Chemical Investigation Programme (CIP2) to look at mercury analysis in waters. This is a project being undertaken by all of the Water Utility companies in partnership with the United Kingdom Water Research (UKWIR), as part of the response to the Water Framework Directive (2000/60/EC) (WFD).

A Limit of detection of 0.001ug/l was required and this was always going to be a challenge. However, the National Laboratory Service (NLS) had achieved similar detection limits during the first Chemicals Investigation Programme, and after months of further developments we have achieved this in many different water matrices.

We analyse for the presence of mercury in many different water matrices including groundwater, trade to controlled waters, treated sewage, river water, and crude sewage using cold vapour atomic fluorescence spectrometry equipped with a gold trap amalgamation system. See figure 1.

Once the sample has digested it is reducted with stannous chloride, this converts the inorganic mercury species to elemental free mercury Hg (0). A stream of argon carries the mercury vapour to Au/Pt gauze which subsequently collects the mercury by amalgamation. After 2 minutes the gold trap heats to 800 degrees and the mercury is released by thermal desorption and the resulting mercury is transported to a cold vapour flameless atomic fluorescence spectrophotometer for measurement.

Figure 1. Cold Vapour Flameless Atomic Fluorescence Spectrophotometer

Where does mercury come from?

Mercury is a highly toxic element that is found both naturally and has been introduced as a contaminant in the environment. Mercury is used in thermometers, barometers, mercury-vapour lamps, advertising signs, mercury switches, and batteries, electrical appliances, in the chlor-alkali industry, and in dental fillings. In the past mercury was also used in pesticides, pharmaceutical products, and in paints. In the UK the main sources of mercury to air and water are from waste incineration, chlorine manufacture, metal production, coal combustion, dental surgeries, crematoria, and from hospitals.

Challenges

The previous method, used routinely, was based around the United States' Environment Protection Agency's method 245.7. Using this method we were able to achieve a detection limit of 0.01 $\mu g l^{-1}$. During the installation of our new cold vapour atomic fluorescence spectrometry "gold trap" equipped instrument, we decided to use the EPA method 1631.

The "gold trap" works by passing gas with the mercury vapour in over Au/Pt wire gauze; this collects the mercury from the gaseous vapour via amalgamation. After two minutes the gauze is super heated to 800 degrees releasing the mercury via a thermal desorption, and this is moved via a Argon to the detector for measurement.

There were many challenges to overcome before samples could be accepted, these included bottle type, preservative validation of the method in different water types, and gaining UKAS accreditation to ISO/IEC 17025.

A new bottle type

We routinely use 125ml Pyrex glass bottles. However, at very low levels there is the possibility that desorption of mercury through the glass would be significant. It was decided therefore to trial a 125ml fluorinated bottle. Suitability test and trails on different sizes and makes commenced, with the successful product used being a Nalgene 125ml fluorinated bottle. See figure 2.

Our method uses fluorinated bottles, which are sent to the field containing 5mls of HCl as a mercury preservative.

Figure 2. Image of Fluorinated bottles

Faced with high throughputs and short turnaround times, a 250ml bottle would have been preferred from an analytical perspective, to give ample opportunity to repeat analysis as the method uses nearly 30mls of sample per analysis. However, balancing cost, H& , and the likely risk of repeat analysis 125ml was decided upon.

Preservative

Mercury can be present in the enir onment in the elemental form (Hg0), as well as a wide ra riety of inorganic and organic forms (b oth as HgI and HgII). However, as mercury is volatile and has a high chemical mobility a presera tive is required to help to keep the mercury in solution. Hydrochloric acid is currently thought to offer suitable properties for 'fixing' the mercury at the time of sampling.

The routine mercury method uses a "low-grade" Hydrochloric Acid (HCl). However when used in the new low level method it was found to contain small quantities of mercury, and this level changed from bottle to bottle and manufacturing batch to batch. However after extensive tests a source of HCl with very low background levels was identified.

This does typify the new challenges in environmental trace analysis. Levels of detection derived from E ir onmental Q ality Standards, which in turn are often based upon extrapolated toxicological studies, have led to detection limits set at ubiquitous levels in the enir onment, which in turn increases the risk of positives results from non enir onmental samples.

In line with our quality procedure a full validation exercise was undertaken by testing the proposed method in the types of water sample required, across a method range of 0.001µg-1 0 .02µg-1. See figure 3.

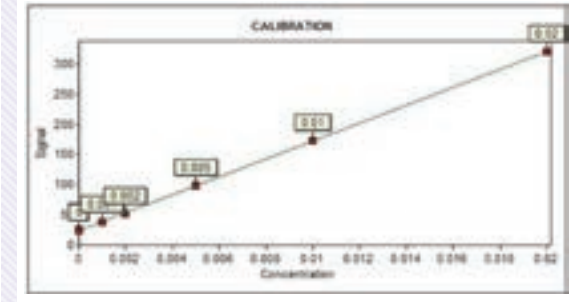


Figure 3. The instrument calibration range is 0.001ug/l-0.020ug/l.

0 er a two- eek period Surface Water, G oundwater, Treated Sewage E fl uent, and Trade to Controlled Waters were tested and the detection limit of 0.001µgl-1 as shown in Table 1 was achieved. A typical instrument response can be seen in figure 4.

Materials	Targets Detection Limits	Achieved Detection Limits
H P p olished water)	0.001µgl-1	0.001µgl-1
Surface water f iver)	0.001µgl-1	0.001µgl-1
G ound water	0.001µgl-1	0.001µgl-1
Treated sewage effluent	0.001µgl-1	0.002µgl-1
Trade to controlled waters	0.001µgl-1	0.002µgl-1
Untreated (sewage) effluent	**0.001µgl-1**	**0.005µgl-1**

Table 1. Method Detection Limit Targets and Achievements

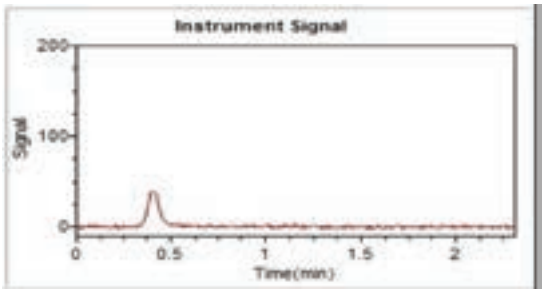


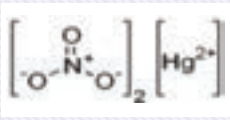
Figure 4. A typical 0.001ug/l peak in river water.

Materials	Nom. Conc^n.	7% RSD target	10% BIAS target	Recovery
Surface water f iver)	0.016µgl-1	3.27%	0.58%	97.5%
G ound water	0.016µgl-1	1.99%	0.656%	96.9%
Treated sewage effluent	0.014 µgl-1	3.56%	5.07%	95.3%
Trade to controlled waters	0.016µgl-	2.44%	4.16%	8 7%
Untreated (sewage) effluent	**0.014 µgl-1**	**9.72%**	**25.7%**	**92.9%**

Table 2. Method Performance Targets and Achievements

Untreated sewage effluent has been listed in the tables differently because it required a different approach. W en analysing it neat, hai ng high solids content, samples recoveries were unacceptably low in the region of 40-60%, but after a period of 1 week this had decreased to around 20%. In addition a "matrix effect" was seen that suppressed the fluorescence in samples analysed immediately after the untreated effluent.

Samples are routinely digested with 0.25ml of potassium bromate & potassium bromide (see figure 5). Other digesting reagents were considered such as aqua regia, or microwave digestion, however this would have taken the preparation away from both the routine mercury method and the analysis of other material, increasing the complexity for both the sampling and analytical teams.



Once the samples arrive back to the Laboratory a portion of the sample is digested using potassium bromate/ potassium bromide. This stops biological activity, oxidises organic/inorganic mercury compounds and Solubilises Hg2+.

Figure 5. Digestion reagents the analysis of Hg

The untreated sewage effluent was then diluted on a 5,10 and 20f old dilution to try and eliminate the matrix and allow the mercury to be removed from the now smaller amount of solids in the sample. This was a large task which took many days and hours, but once we had the entire set of data the quality section on site passed the 5 times dilution in crude sewage, with a recovery of 93% (see table 2).

The final challenge was to gain a UKAS accreditation against ISO/IEC 17025 for this new method; a process known as an Extension to Scope. This was a critical success factor for our customer. Being awarded UKAS Accreditation is not a given and requires, in addition to a suitable methodology, evidence that the method is working routinely for the materials being analysed, but also a full and previously audited Quality System. We additionally demonstrated stability times for samples at these very low levels within the new calibration range in a difficult sample matrix; external proficiency testing schemes and to matrix match our quality control samples by adding preservative, which was not previously the case. Subsequently, UKAS accreditation was awarded. The method is now in routine operation. Daily contamination checks have been introduced due to the very low detection levels required and the risk of in-lab contamination. Figure 6 shows the Shewhart chart.

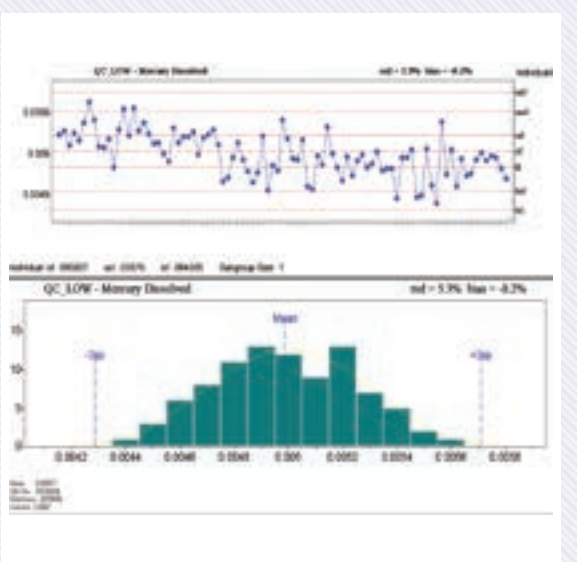


Figure 6 the Shewhart chart

The entire process has taken a year, from the time method development was instigated to when contracts were awarded and samples analysed. The process has involved the whole of the Metals Chemistry Team at the Environment Agency's National Laboratory Service.

This article has given just a snapshot of the work we at NLS are involved in, and a brief insight into the typical work of the Environment Agency laboratories.

Author

Andy Welham joined the Environment Agency in 1996. In Andy's own words, "I started work as an assistant scientist in the metals section of the laboratory on our old site in Exeter. I have spent 16 years working in this section and 3 years working in the organics section of the lab. I am currently one of 3 scientists that oversee the metals analysis at the National Laboratory Services Starcross Lab nr Exeter. During my 16 years working in this section, a large part of this has been spent working on mercury analysis in both soils and waters."

Skelton transmitting station: a brief history

Russell W. Barnes

On 25th April 1943, the first official BBC transmission from the Skelton Transmitting Station, up in rural Cumberland, eight miles north of Penrith and twelve miles south of Carlisle, was broadcast into Europe, illuminating the occupied countries with a powerful radio beam that spread from Norway to Portugal.

In November of the same year, further transmissions from the 750 Acre site – the biggest in Europe and arguably the largest shortwave site in the world – were broadcast into the last vestiges of the British Empire, as far away as New Zealand and the Americas. Skelton Pasture included three farmsteads: Gizebeck, Priestfold and Skelton Glebe. Gizebeck Hall and Priestfold are long-since demolished, but served as living quarters for engineering staff and their families until the 1970s. Skelton Glebe is a ruin, left eerily abandoned by the family whose land was compulsorily acquired three generations ago: a deed borne of wartime necessity which evokes bitter memories to this day.

A BBC agreement on 28th October 1931 resulted in the building of a high-power short-wave Empire Broadcasting Station at Daventry, in Northamptonshire. Two ST&C transmitters were installed and eighteen aerials erected. Hitherto, short-wave radio had been the preserve of radio amateurs and had not been taken seriously by either the GPO or the BBC. Its potential was then recognised, and SW Broadcasting began in earnest at Daventry on 19th December 1932 with the start of the Empire Service, to be followed six days later with King George V's Royal Christmas Message to the peoples of the British Empire.

In 1940, the BBC had fourteen short-wave transmitters, mostly at Daventry (OSE1 and 2), but others at Start Point in Devon (OSE4) and a converted transmitter at Clevedon in North Somerset. In an attempt to meet the radio power of Germany, a new station at Rampisham in Dorsetshire was built, up and running in 1941 with four Marconi SWB18 100kW transmitters. A single short-wave transmitter, Sender 51, was built at Lisnagarvey (OSE7) in the same year.

A Ministry of Information edict set out at the end of 1940 decided that eighteen more high-power transmitters were required to broadcast the requisite material and languages, so a concerted effort to increase shortwave broadcasting power went ahead with the construction of Woofferton, near Ludlow in Shropshire and Skelton in Cumberland.

'OSE', in BBC parlance means 'Overseas Station Extension', being an extension of Daventry.

Skelton was chosen as a location for four reasons:

- It was on the main telephone trunk-circuit route from London to Glasgow and so was relatively easy to feed programme to.
- A reliable source of electricity was available from the Mid-Cumberland electricity supply. The maximum demand of the station during WWII was 4MVA, a not inconsiderable load at that time.
- It was geographically suitable, being at a sufficient distance from the target audience area of occupied Europe such that the 'skip' distance (shortwave is propagated by bouncing the signal off the ionosphere, the conditions of which change from day-to-night; winter-to-summer and over the eleven-year sunspot cycle, and back earthwards again to the listener, who will be hundreds of miles away) was just right for target coverage.
- It is also on a plateau 600' above sea-level between the Caldew and Eden valleys, allowing the transmitted signal take-off angle of between 7 and 11 degrees to hit the ionosphere, unfettered by obstacles.

The Skelton Transmitting Station and the station at Woofferton in Shropshire were built in 1942 and OSE1 (Skelton A) went on-air on 25th April 1943 (after transmitter testing in March that year). OSE9 went to air in anger following the acceptance of transmitter plant with Senders 71 and 72 signed off on 20th November 1943. Senders 73, 74, 75 and 76 had been accepted and tested in three months earlier.

This programme of essential wartime construction, along with aerodromes and defence infrastructure, was the largest civil engineering programme undertaken in Britain, with hundreds of Irish labourers employed in the completion of the site, which took just over a year to complete from inception.

Skelton A (OSE8) Senders 65 and 66. 1940s. Copyright Skelton Transmitting Station.

The two austere brick, reinforced concrete and steel buildings that housed the twelve British designed and manufactured transmitters were separated by a distance of a mile, to minimise the effects of an enemy air attack. Each building was hardened sufficiently to withstand all but a direct hit. It was claimed that it would withstand a direct hit from a 500lb bomb, but this is doubtful, even though there were 18" thick blast walls interlocked with a concrete floor and skeletal steel girder-work dividing the transmitter halls into three 'cells' of two transmitters each. There were two diametrically-opposite subterranean air-raid shelters and escape chambers in each building, and the buildings themselves were enveloped in camouflage netting during the hostilities.

Six Marconi SWB18 100kW transmitters and six dual channel Standard Telephones and Cables (STC) 100 kilowatt transmitters were capable of directing a total power output of one-and-one half Megawatts into a selection of 53 aerials designed by the BBC, each supported by 31 masts erected by J. L. Eve Ltd., with the BBC designed feeder groundwork being contracted to British Industrial Callender's Cables. Three intersite feeders allowed any transmitter from either site to drive any aerial array, if required. The dual-channel transmitters at OSE9 (later known as Skelton B) consisted of two RF stages with a common modulator so that two frequencies could be broadcast simultaneously, but carrying the same programme. The original requirement was that either channel could be used in isolation, so a high frequency could be set up for day working and a lower frequency for night working.

The programmes broadcast from Skelton were appended with *'messages personnels'* whereby innocuous news items would be punctuated with whimsical phases such as: 'tonight, Aunt Polly's tea-party begins at moon-rise'. This would be a message to the French Resistance to expect a parachute drop of arms, or a coded signal to demolish a section of railway line.

The Skelton Transmitting Station played an important role in the run-up to 'D'-Day, when 'Messages Personnels' were broadcast in such secrecy that even the engineers who ran and maintained the transmitters knew nothing of their meaning. Morse code was also transmitted from Skelton during wartime: one-and-one-half hours per night in English, French and German. Any secrecy associated with these transmissions was negated simply because all the lights in Penrith flickered in sympathy with the transmitted signal!

Upon cessation of hostilities, the Skelton site was found to be in an ideal location for the next chapter in history: the 'Cold War', and on 26th March, 1946, the BBC launched the Russian Service, aimed at the Soviet Union and Eastern Europe.

The Russians became adept at 'jamming' the BBC's transmissions within seconds of them being directed into the east, and to this end, a system of 'Barrage' transmissions were instigated, with eighteen different radio frequencies all carrying the same message. A system of 'crash-starting' transmissions was also undertaken, costing the Soviets valuable jamming time and allowing the message to get through. Short-wave broadcasting, unlike the stable frequencies expected of domestic broadcasters, was undertaken on a range of frequencies between just below 4MHz and 21MHz (later extended to 26MHz) dependent on time of day and time of year, and distinctive 'interval signals' were generally broadcast two minutes and twenty-nine seconds prior to the start of transmission to allow the listener to tune in. The famous 'V-for-Victory' interval signal, created during WWII on an African war-drum by percussionist James Blades and unable to be exactly replicated by the enemy was in use throughout "and later became 'Interval Signal No: 7' on BBC short-wave broadcasts.

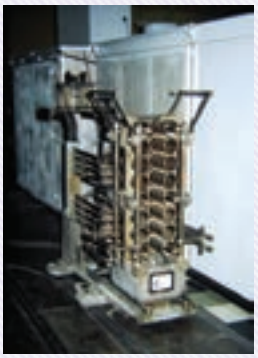
Crash-starting did away with the interval signals in an attempt to get the 'What, Why, Who, Where and How' out in the first few seconds of the broadcast without giving the Soviets (or other countries who didn't like what the BBC broadcast) any clue as to which frequency to jam. A broadcast could be dropped on a 'crash finish' from Woofferton (say) and picked up within a second on a Skelton transmitter. By doing so the same target audience would be reached as the propagation conditions grew past their best for Woofferton but peaked for Skelton. Later on 'crash starts' were used to allow different broadcasters their air-time without overlapping (and so interfering) transmissions.

By 198 th e 39 masts supported 31 aerials at Skelton A and 35 aerials at Skelton B.

All the BBC HF transmitters, or 'senders', were allocated a unique number. The Marconi transmitters at OSE8 (later Skelton A) were originally numbered 61, 62, 63, 64, 65 and 66 and the ST&C transmitters at OSE9 (later Skelton B) were 71, 72, 73, 74, 75 and 76. When the 'new' transmitters were installed at Skelton A in 1967/68 they were re-designated Senders 51 (ex-Lisnagarvey), 52, 53, 54, 55, and 56. Sender 61 remained and when the ex-Rampisham transmitters were installed at Skelton A in 1984 they were given the numbers 57 (ex-Rampisham No: 39), 58, 59 and 60. It's easy to draw parallels with train-spotting here.

Sender 61, Marconi 100kW SWB18, 1980s and SWB tuning truck, 1980s. Photos copyright Russell W. Barnes

Switching the transmitter output to the appropriate aerial was originally done on a switching frame, one for each building, about 150 feet in diameter, with an eight-sided tower in the centre, 40 feet high with a switch level for each transmitter. At OSE9 the sender 'A' channel went to the automatic switching tower in the centre and the 'B' channel went to the outer surrounding frame, to manual bifurcation switches. Further switching (slewing and reversal) was done manually by a Technical Assistant (Switching), riding a bicycle to the appropriate aerial amongst 750 Acres of land, wielding a long hooked ash switching pole, sometimes in utter darkness (miners' cap-lamps and helmets to mount them on were provided in later years) and switching took place after an instruction by field-telephone suggested it was safe and correct to do so. It was not unknown for the wrong feeder to be switched, and the subsequent arcs and demodulated corona booming programme around the aerial feed are not readily forgotten...



Sender 61, Marconi SWB tuning truck, 1980s. Photos copyright Russell W. Barnes

The requirement for manual aerial switching at Skelton ceased on 25th March 198 , TAs (Switching) were offered redundancy or a transfer to Day Maintenance duties. Manual switching continued well past this date at Woofferton.

The rotary switching tower, long-since modified from its original 'G new W eel' mechanism, remained at Skelton B until the station closed, and the Skelton A switching tower was replaced with an enclosed feeder matrix system to meet the requirements of the new 250kW senders and new aerials and used BBC-designed switches driven by electrically-controlled compressed air. Feeders out to the aerials were open wire construction of 328 Ohms characteristic impedance and the driven elements were end-fed half-wave dipoles so the drive-point impedance matched the feeder impedance. During normal scheduled operation under command of the E DA Automatic Control System (more later), any transmitter at Skelton A could be connected to one of eight aerial arrays, and any aerial could be made a ilable to up to three transmitters. Total flexibility was pro v ded by manually reconfiguring the aerial control wiring i v a plug and socket terminations in the control bays, as necessary.

Skelton B (OSE9) aerial switching tower and open wire feeders. Copyright R. W. Barnes

Skelton B (OSE9) aerial switching tower and open wire feeders. Copyright R. W. Barnes

The aerial curtain arrays at Skelton A were mostly dual band arrays post-1970, tuned for 6 and 7MHz; 9 and 11MHz; 15 and 17MHz; 17 and 21MHz, but there were remaining single band arrays for 4MHz and 7MHz. The array would typically be two elements wide and four high, and slewable, meaning the angle of radiation could be 'pulled' fifteen degrees either side of fundamental bearing by introducing a switched phase-difference at the feeder groundwork (a 'slew loop'). Skelton B used mostly single-band arrays, though dual-band arrays were later added.

A typical aerial array designation would read HRRS 4/2/.6 meaning it was Horizontally polarised, Reflected, Reversible, Slewable, 4 horizontal radiating elements, 2 vertical radiating elements, 0.6 wavelengths between ground and the lowest feed point. Half an array curtain could be used, giving a wider 'footprint' but possibly spilling over the target area. 'Reversible' simply means feeding the reflector and terminating the driven elements to achieve a 180 degree change of radiated signal.

When both channels on the ST&C CS8s at Skelton B (OSE9) were used, twelve frequencies could be broadcast simultaneously: two from each common-modulated sender (as transmitters are historically referred to in short-wave parlance). The transmitter output of each RF channel in this case was 75kW, with 100kW available on single channel working.

Programme was originally delivered to site on GPO circuits and from May 1943, was routed to the shortwave transmitter sites though Aldenham in Hertfordshire. From 1939 a simple language colour-coding system was used for the programme networks. Colour-coded 'chains' were used until the 1990s (Green for BBC World Service and Brown for BBC Arabic service, typically) and many an evening shift was spent amending schedules by hand with scissors, glue and coloured pencils. As the old joke goes - the BBC transmitter engineer, home after a hard shift, greets his little child. '...And what did you do at school today, son?' 'Oh, I cut things out of paper, coloured them in and glued them into a book. What about you, daddy? 'Oh, much the same as you!'

When WWII ended, programme chains and studios were relocated to London: to Bush House in the Aldwych and Oxford Street. A small emergency studio was provided at OSE8 and OSE9, each consisting of a turntable desk, microphone and signalling circuits. The studios were operational into the 1960s as a radio contributor (and later, a BBC agricultural correspondent) who lived in West Cumberland, Alfred Hall, MBE, was diverted to Skelton when he was due to make a broadcast and couldn't get to Manchester studios on time.

The programme feeds, or 'chains' to Skelton were, by the 1970s, using a GPO 48kHz 'split carrier' frequency division multiplex circuit, sent up a co-axial tube and provided via diverse paths to mitigate against failure. This system was replaced in the early 1990s with a more modern version of the old discrete private wire music lines as BT had signalled its intention to cease supporting 48kHz group circuits by 1992. These copper circuits were, in turn, replaced by a short-lived fibre-optic network. In the mid-1990s BT circuits were done away with in favour of an 'in-house' satellite network feeding all BBC HF sites and known as the Global Distribution System. In the unlikely event of failure, DELs (Direct Exchange Lines) with restricted music bandwidth could be used to carry programme, and, later on, ISDN circuits were used as backup, offering full bandwidth of 5 kHz.

In the last few years before HF broadcasting ceased, BBC feeds were routed via this satellite network and other feeds were sent via Internet protocol. In the even more unlikely event of a total loss of circuits, a 'Revox' reel-to-reel recorder was on hand to broadcast an emergency tape consisting of a readily-identifiable BBC interval signal. 'Even more unlikely...' But it did happen! Not long into the 1990s an incident with an excavator off-site led to the disruption of both diverse programme feeds from Penrith and Carlisle and a BT SHF link vehicle was sent to Skelton to try to establish a connection with the Harraby microwave link station at Carlisle. The attempt failed and DELs and a 'split-band' circuit providing two feeds were used instead until the fault was repaired.

Although the electricity required came onto the site from the outside supply, an alternative supply was provided at the opposite end of each building to that which the mains entered, to offer diversity in the event of an air attack. OSE8 (Skelton A) had three 11kV 500kVA English Electric alternators driven by 750hp English Electric Willans engines and OSE9 (Skelton B) had three 11kV 500kVA BTH alternators driven by 750hp Mirrlees engines. The inter-building OSE8 – OSE9 11kV electricity link was routed away from the site in a circuitous fashion, again to mitigate damage caused by enemy air strikes. The diesel engines driving the alternators were compressed air start and were removed in the early 1980s.

In 1967/68, five of the wartime Marconi transmitters were scrapped at Skelton A, and replaced with six new, more powerful and efficient Marconi B6122 transmitters of 250kW output. A further four ex-Rampisham Marconi BD272 transmitters (very similar to the B6122) were installed between 1983 and 1984 in what was the old standby house where the generators were. Sender 57, the first to be installed, was tested to air in July 1983. The one remaining wartime-vintage Marconi SWB18 100kW transmitter soldiered on until 1987, and was replaced in 1988/9 with a Marconi BD272 from Daventry.

From construction in WWII to the 1950s, transmitter control was effected rather like a manual telephone exchange, with BPO (British Post Office) quarter-inch jacks and corded plugs, a master and slave clock system and engineers sitting at a desk where the appropriate array for the sender and the correct programme to be broadcast were selected and switched, nearly always at quarter-hour intervals on the salient hours.

By 1957 all programme switching was carried out using a Siemens Bros automatic switching unit which used uniselectors and a matrix into which small pins were inserted to tell the uniselectors to switch appropriately.

The high-tension and filament supplies were applied manually by the transmitter engineer sat at the transmitter control desk, which at one time was enclosed within a cubicle. The cubicles were later removed after discussion with the Union and BBC management regarding reduction of staffing levels (one person could operate two senders under the new arrangement), and transmitter staff worked at the control desks in the open sender hall. Valve filaments were fed from motor-generator sets in the crypt, rated 1500 Amperes at 30V d.c. and in 1975/76, the rotating machinery was removed from Skelton B and the ST&C CS8 transmitter valves were converted to a.c. filament working.

When the 'new' 250kW transmitters were installed at Skelton A the control of the transmitters, the programme and aerial switching, was automated using a Mullard 4,096 word 42 bit magnetic 'core-store' system, programmed using punched tape or manual inputting. This was replaced in 1982 with a BBC 'in-house' Designs Department control system known as 'ZELDA' and built on 'Zeus' (Zed Eighty Universal System) modules. ZELDA stood for Zeus Editor, Loader, Disc operating system and Assembler. It was addressed by assembly code inputted from a keyboard. Data was written twice a year to an eight-inch floppy disc kept in one half of a dual drive in accordance with the summer and winter broadcasting schedules (March and October) and stored in volatile RAM to execute the appropriate sender on and off times, programme selection and aerial and bearing details, dependent on a series of 'day codes'. Control system data was stored in EPROMS.

ZELDA could support other applications and the system at Skelton featured a version of the popular game of Space Invaders!

This data existed in three places: a main supervisor, a backup supervisor and the sender controller. A polling system ensured that the data in the sender controller agreed with that in the supervisor's. If a schedule disagreement had been detected twice, a correction would be attempted. Manual intervention via the keyboard allowed instantaneous control, with further over-ride provision at the sender and array interface panels on the computer system. A network of VDUs was provided throughout the stations displaying present and 'next action' operations on one screen and alarms on another.

Automatic monitoring of the sender outputs and comparison with the inputs was provided, and any difference would sound an alarm and provide an indication appropriate to the fault on the VDU network. Alarms were prioritised and included fire alarms, compressed air failure (for the aerial switching), carrier fail, programme failure and non-urgent alarms requiring attention as soon as practicable. Included in the new 'Apparatus Rooms' where the ACS was housed were HCD rubidium master oscillators and back-up crystal oven oscillators, from which a highly stable 1MHz source was fed to the sender frequency synthesizers from which operational broadcast frequencies were derived. Synchronised inter-site transmitter working then became available proposition, with two transmitter sites targeting the same area.

The ZELDA automatic control system was disciplined from the 60kHz MSF transmitter at Rugby. This 60kHz time-transmitter is now at Anthorn and is provided by Babcock and the National Physical Laboratory, but that's another story...

On 24th March 1990, the six STC heavily-modified wartime-vintage transmitters at Skelton B were de-commissioned, with the last transmission being ceremoniously closed by Mrs Olive Shallcross who, as Olive Hodson, had worked on the transmitters at Skelton during WWII where she met her husband, Jack Shallcross, the Senior Maintenance Engineer on her shift. Skelton B was replaced with four 300 kilowatt fully automatic Marconi B6126 transmitters of high efficiency design in a new building several hundred metres away and hereafter referred to as Skelton C.
A further two ex-Daventry 300 kilowatt B6126 transmitters were added not long afterwards.
On 11th May 1990, Skelton C was officially opened by (Sir) John Tusa, then Managing Director of the BBC World Service. The Skelton B building was demolished in 1991.

The B6126 transmitters installed at Skelton C used PWM (Pulse-Width Modulation): a single TH555 hypervapotron valve acting as a switch at 60kHz is driven by a variable mark-space waveform where the excursion between maximum space minimum mark to maximum mark minimum space corresponds to no modulation to 100% modulation respectively. This switching waveform is smoothed out with the resulting d.c. output swinging between about 900V to 26kV dependent on the level of modulation. This voltage is applied to the anode of a TH537 hypervapotron valve in class 'C' single-ended configuration with 11.4kV equating to 50:50 mark-space ratio, or plain unmodulated carrier.

A system of amplitude-modulated companding with 6db compression ensures that the peak envelope of the fully modulated carrier does not exceed the peak envelope of unmodulated carrier.

The transmitter efficiencies made thus are transparent to the listener, whose receiver's automatic gain control negates the effect of AMC and renders it as it would a traditionally-modulated AM signal where the power at the peak of the envelope is four times carrier power. Transmitter efficiency at Skelton C would be typically 72% because of this: 6% more than the manufacturer's spec on 'traditional' AM. An option known as 'Enhanced' carrier was also available, increasing the effective transmitter carrier power to 450kW, and reducing when modulated. Until the collapse of the Berlin Wall in 1989 and the outbreak of 'perestroika' that preceded it, the BBC was in the second phase of the Cold War and was engaged in a radio 'power race' deemed necessary to transcend political boundaries. Enhanced mode offered the presence on the HF bands, should it be needed.

At Skelton C the 300kW transmitters had a 50 Ohm unbalanced output made from nine-inch rigid co-axial feeder and were fed to Marconi-designed wide-band aerial arrays via a co-axial switching matrix and semi-rigid nine-inch co-ax blown at positive pressure with dry air. The initial capital outlay of this system was expensive compared to the older open-wire feeders, but faults were extremely rare, whereas open-wire feeders would flash over when they sagged together in the summer heat and required greater maintenance and adjustments. Any sender could be connected to any aerial and a test-load was provided, consisting of a pumped column of sodium carbonate and de-ionised water solution. Skelton C aerials could be slewed at fixed bearings up to 30 degrees either side of fundamental. The 50-Ohm unbalanced feeder extended into the aerial field and was matched to the half-wave end-fed dipoles via a balun at the base of the array. Although these arrays were 'wide-band' (typically 6 – 12MHz; 9 – 15MHz; 9 – 18MHz and 11 – 21MHz) they were less efficient than the older arrays at Skelton A, though this was mitigated by being driven at higher power. The other advantage being that fewer arrays were needed and took up less land.

The Marconi B6126 transmitters were extensively controlled by CMOS technology and were frequency-agile, tuning automatically within the HF bandplans and reducing the need for engineering staff attendance to that purely of maintenance and fault repairs, as opposed to the 1960s B6122 and BD272 transmitters at Skelton A which used the same P8000 relay technology found in contemporary automatic telephone exchanges, and which not only required extensive maintenance to work correctly, but which had to be band-changed and tuned manually, with different sets of inductors clamped in by hand and the vacuum capacitors forming the tuning stages set to position from pre-written settings cards.

Three engineers could band-change a transmitter in minutes – one minute if challenged - although it was necessary to wear long leather gauntlets to change the coils, especially if the sender had been allowed to drift off-tune, causing the increased energy consumption of a non-resonant condition to create excessive heat. It was not unusual for transmitter engineers to be dressed in tee-shirts, shorts and open sandals during the hot summer months. Despite this sartorial casualness, the only injuries inflicted were the odd very minor burn from a carelessly-caught tuning coil. Aerosol tins of 'Burn-Eze' were readily available in the sender hall.

Solid-state rectification and a fast-acting ignitron crowbar valve protection device were used on the Skelton C transmitters to cut off the high-voltage a.c. by means of vacuum contactors and dump the 26kV stored in the reservoir capacitors down to earth via a chain of silicon carbide 'Polo Mint' resistors prior to being shorted out by a further vacuum contactor when sufficient energy had been discharged. Spectacular firework effects occurred very occasionally when the insulated bar supporting the resistors caught fire! As there were no oil-filled components in the HV enclosures of the B6126s, there was no protection other than portable extinguishers.

The BD272 transmitters (as well as the B6122 transmitters: a Marconi variant of the BD272) were equipped with fast-acting polarised Carpenter relays and thyratron valves to effect a rapid removal of supply as a result of a HT overload. High-level modulation was employed on the 250kW sets, as on the earlier SW 18 and CS8 transmitters, with the output load of the push-pull class B modulating amplifier being the primary winding of an oil-filled modulation transformer.

The secondary winding was in the HT circuit of the class C push-pull modulated amplifier. Vapour-phase cooling was employed on the BD272 (B6122) transmitter valves, with two 125kW BY1144L triode valves in both modulating amplifier (audio) and modulated amplifier (RF). Grounded-grid configuration was used with 10% of the output power being furnished by two BY1161 triode valves in the penultimate RF stage. The modulator final valves were driven via four cathode-follower valves to reduce distortion as the impedance changed when the output stage was driven into grid current.

An oil-filled smoothing reactor, modulation transformer, chokes and rectifier transformers were located in a room behind each transmitter, protected at Skelton A by a CO_2 fire-drench extinguisher system supplied by the Walter Kidde Company.

Some fire extinguishers consisted of a portable trolley upon which was mounted two cylinders of CO_2 and a discharge horn. The original fire protection system installed in 1943 consisted of manuallyop erated methyl-bromide extinguishers with floorm ounted systems in the sender hall sections, the HV switch room, the LV switch rooms and the diesel houses. Methyl-bromide remained in use at Skelton B until the early – mid 1970s.

In 2007 the last-to-be-installed ex-Daventry Marconi BD272 at Skelton A was replaced with a RIZ Croatian-built 300kW DRM (Digital Radio Mondiale) and analogue AM capable transmitter: the shape of things to come... Skelton A joined in the future of short-wave broadcasting, sending out digital and analogue transmissions from a fully automated frequency-agile computer controlled (Windows XP) state-of-the-art 80% efficient transmitter: its single RF output valve being driven by a solid-state driver stage and the valve HT being modulated by a pseudo-randomly switched set of modules using the 'step-stair' technique to build up an audio waveform, smooth the output, and apply it to the anode of the final valve.

The digital signal broadcast was near-FM quality and the robustness of the signal could be varied to meet the challenges presented by the varying conditions of the HF bands. The programme input to Sender 61 was digital in its entirety from studio to transmitter. A full description of DRM quantising levels, orthogonal frequency-division multiplex and robustness modes can be found online.

Similar transmitters were installed at Woofferton around the same time, but in 2012 a decision was made to dismantle and move Skelton's Sender 61 to the BBC Kranji site in Singapore after the end of the 2013 winter schedule. In May 2013, this move took place.

Skelton continued to broadcast to Europe, the Middle East, parts of Asia, Africa and the Americas throughout and after the 'Cold War', and it is likely that Skelton's voice to the world kept Beirut hostages John McCarthy, Terry Waite and Brian Keenan informed of events twenty-eight years ago. Over thirty different languages have modulated the signals from Cumbria's voice to the world and the typical daily output of 1981 was made up of Bulgarian, Czech, Finnish, French, German, Greek, Hungarian, Polish, Romanian, Russian, Serbo-Croat, Slovak, Slovene, Spanish for both Europe and S. America, Turkish, Arabic and, of course, English.

In the late 1980s, following the collapse of the Berlin Wall and the end of the 'Cold War' the world theatre started to change, and high-power short-wave transmissions with their subsequent expensive running costs were being superseded by local VHF radio and satellite broadcasts in the developed world. Short-wave was just one of several vehicles by which the BBC could be heard abroad.

Short-wave broadcasting still had a role to play in the developing world, in particular Africa and India, where educational and current affairs programmes were concentrated, and where short-wave could be received on very basic, universally aa ilable receivers costing nothing more than a few dollars.

Knowledge and entertainment are promulgated in the peaceable world of today largely via satellite and the Internet, and the role of powerful short-wave transmitters such as those at Skelton is diminishing as broadcasters face an ever-increasing strain on their budgets.

The Skelton Transmitting Station, once the voice of freedom in a world of turmoil, was sold off by the British Broadcasting Corporation in 1997 to become Merlin Communications International, although was still contracted to broadcast BBC programmes. Alongside the BBC, reciprocal transmissions from the likes of Vietnam, Canada and Korea were broadcast from this remote Cumbrian location, alongside independent broadcasters such as Family Radio.

On the evening of 30th October 2011, a small ceremony took place in front of Sender 54 at Skelton A when it was switched off for the last time at the close of the summer schedule at 23:15 GM T. This was the last of the B6122 / BD272 senders to radiate scheduled programme, although a very short 'test' transmission was broadcast at the 70th Anniversary party on 26th April 2013 when Senders 51 and 52 were powered, much to the pleasure of a small knot of long-retired staff. The last HF (shortwave) broadcast from Skelton (Skelton 'C') went out on 31st March 2013, at the end of the winter schedule.

In 2001, Merlin Communications was subsumed into Vosper Thorneycroft, later VT G oup, and in August 2010, VT G oup were bought out by Babcock International, who currently run the Skelton Transmitting Station and who, by building on the collective skills of the Skelton staff, are taking it forward to meet the technological challenges of the 21st Century.

Continued...

Skelton Transmitting Station: A Time-Line.

- **November 1942:** First Engineer-in-Charge on site, S. A. Williams, ex-Start Point.
- **January 1943:** Work begins on installing transmitters.
- **March 1943:** Transmitters tested on-air.
- **25th April 1943:** First transmitters at Skelton A in service.
- **November 1943:** All transmitters at Skelton A and Skelton B in service.
- **26th March 1946:** BBC Russian Service started.
- **1949:** 36 languages being broadcast.
- **1951:** One hundred and sixty staff employed at Skelton, with typically seventeen staff on shift.
- **1958:** Salary for a Technical Assistant was £855 per annum (max).
- **1964:** Salary for a Technical Assistant was £1,148 per annum (max).
- **1967:** Salary for a Technical Assistant was £1,400 per annum (max).
- **1967/68:** Installation of six 250kW Marconi B6122 transmitters at Skelton A (OSE).
- **1981:** 85 staff working at Skelton.
- **1984:** Four more Marconi BD272 HF transmitters (ex-Rampisham) installed in Skelton A.
- **1985:** BBC Domestic engineering staff and HF engineering staff integrated. Eight staff on shift at Skelton.
- **1985:** Typically 2520 transmission hours broadcast weekly from Skelton.
- **1988/9:** The last Wartime Marconi SWB8 transmitter (Sender 61) replaced with a Marconi 250kW BD272 transmitter.
- **24th March 1990:** Last transmission broadcast from Sk'B'.
- **1990s:** Five staff on shift at Skelton.
- 11th May 1990: Official opening of Sk'C' by John Tusa, Head of BBC WS.
- **1991:** Skelton B demolished.
- **1st April 1997:** BBC Transmitter Group privatised. Overseas broadcasting staff and management formed a 'buyout' consortium and became known as Merlin Communications International.
- **2000s:** Three staff on shift plus 'standby' call-out engineer.
- **2001:** Merlin Communications International taken over by Vosper Thorneycroft and became known as VT Communications.
- **20th February 2008:** Cessation of BBC analogue European BBC World Service shortwave broadcasts from Skelton.
- **2009:** Typically 376.75 transmission hours broadcast weekly from Skelton.
- **2010:** VT Communications bought out by Babcock.
- **30 October 2011:** Last HF transmission from the B6122 / BD272 transmitters at Skelton A.
- **31st March 2013:** Last HF transmission went out from Skelton C.
- **2014:** 30 staff working at Skelton.

Author

Russell W. Barnes I.Eng., MIET is a Senior Transmitting Engineer at the Skelton Transmitting Station and has been employed in broadcasting since 1988, starting work at the BBC Kirk o' Shotts television and radio transmitter in Central Scotland in July of that year and arriving at Skelton in November 1988 after qualifying as a BBC Engineer at TED Wood Norton. Attachments to transmitting stations at Hannington, Forfar, Rampisham (twice) and Masirah Island, Oman were undertaken between '88 and '91. A native of Workington, Cumbria, he now lives near Penrith and is married with two grown-up daughters. His interests (other than work) include amateur radio, photography, studying WW I defence infrastructure, local history and wrestling with the accordion. Oh, and playing in a brass band.

Electro-reduction of titanium dioxide to titanium

Charles Osarinmwian

Titanium was first discovered by William Gregor in 1791 and is found in igneous rocks where it forms components of acidic and basic magmas. The most useful mineral for its extraction is rutile; although rarer than ilmenite its titanium dioxide content is higher. Although titanium and its alloys exhibit outstanding structural efficiency, biocompatibility and corrosion resistance[1,2], titanium production by the pyro-metallurgical Kroll process or electro-deposition from ionic solutions is complex, environmentally unfriendly and cost ineffective. Herein the direct electro-reduction of titanium dioxide to titanium in molten calcium chloride by both experiment and numerical simulation is reported. Details of the experimental method and model development can be found in my previous work[3,4]. The work reported here was motivated by the paradigm shift in extractive metallurgy[5] and next generation titanium production in rotationally symmetric electrochemical reactors[4].

Figure 1 shows the interior of a sectioned titanium oxide cathode that was non-destructively visualized in 3D by stacking a series of individual 2D X-ray images using X-ray computed tomography. Tomography detectors measured the attenuation of X-ray intensity as a function of X-ray energy, path length of the electron beam and the linear attenuation coefficient through the cathode according to Beer's law. The grey contrast in the cathode image corresponds to lighter semiconducting phases in the interior and darker impurity phases at the surface. The calcium, oxygen and titanium elemental profiles suggest a perovskite $CaTiO_3$ phase at the titanium/core/melt three-phase interline (3PI) as well as Magnéli Ti_nO_{2n-1} and $CaTiO_3$ phases in central regions of the oxide cathode (Figure 2)[3]. The titanium profile was complemented by a sharp fall in oxygen profile by O^{2-} ion diffusion out of pores. It is important to note that a Cabrera and Mott-type transport mechanism could be responsible for the appearance of the initial titanium layer.

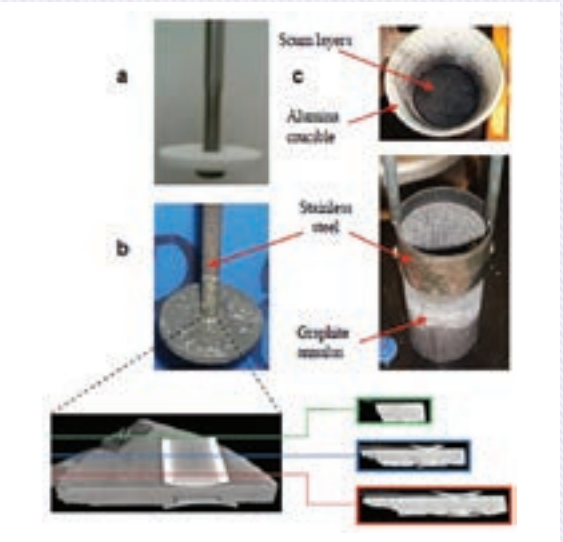


Figure 1: Electrochemical reactor components. a, *Porous titanium dioxide cathode precursor. b, Porous titanium oxide cathode. c, Components post electro-reduction.*

The dense floret patches in Figure 3a can be described as an asymptotic, selfsim ilar Ostwald ripening regime of supersaturated floret patches with a narrow size distribution. Assuming isotropic surface energy, the driv n g force for mass transfer from regions of high to low cura ture occurs according to the cura ture dependence of the chemical potential[6]. This results in the disappearance of surfaces possessing high cura ture and thus a lowering of interfacial free energy by mass transfer from the smaller to the larger patches of the distribution; the total patch number diminishes while average patch size increases.

The Lifshitz-Slyozov encounter modified theory could prov de a reasonably accurate approximation of this behaviour when perturbations in the Lifshitz-Slyozov-Wagner theory are small[7]. As time progresses, the lowering of the free energy barrier to nucleation leads to spinodal decomposition[4].

The evolution of Kirkendall porosity during the generation of titanium from the penetration of the 3PI (Figure 3b and 4) can be understood by considering mass transfer across the 3PI. The excess vacancy concentration needed to grow Kirkendall pores can be described by the Gibbs-Thomson relation

where vacancies condense at voids containing the volume equivalent to many vacant lattice sites if an excess vacancy concentration of at least twice the equilibrium vacancy concentration[8]. Further, the contraction of the cathode in a direction perpendicular to the 3PI could be achieved by the annihilation of vacancies predominantly at edge dislocations whose Burgers' vectors are perpendicular to the 3PI. Such a contraction would be one dimensional and could not tend to establish any tensile stress since relaxation is permitted in this direction. The development of Kirkendall porosity behind the 3PI (Figure 4b) occurs when an appropriate supersaturation of vacancies is supplemented by a subnormal concentration of interstitial oxygen atoms.

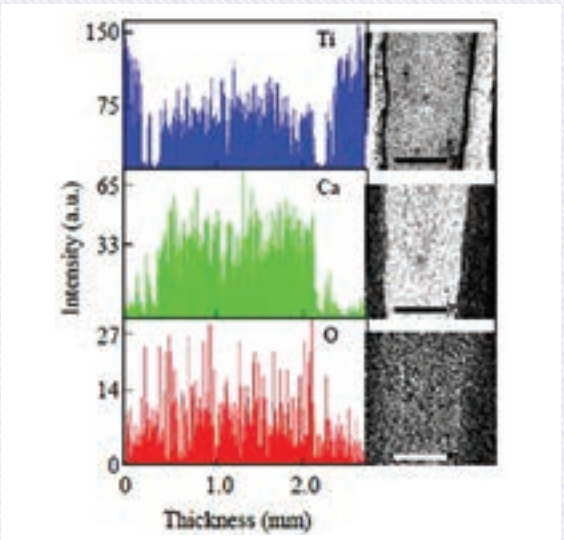


Figure 2: Titanium oxide cathode. XRMS elemental linescan and electron map (viewed in BSE) of titanium, calcium and oxygen elemental profiles.

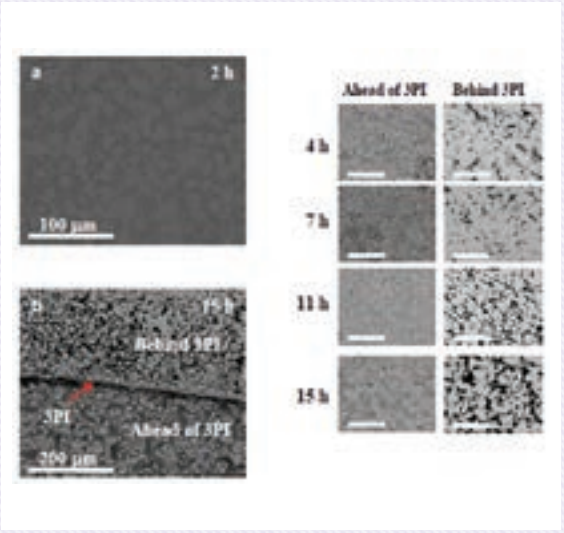


Figure 3: Cathodic mass transfer. a, Ostwald ripening. b, Kirkendall effect. Scale bars: 50 μm.

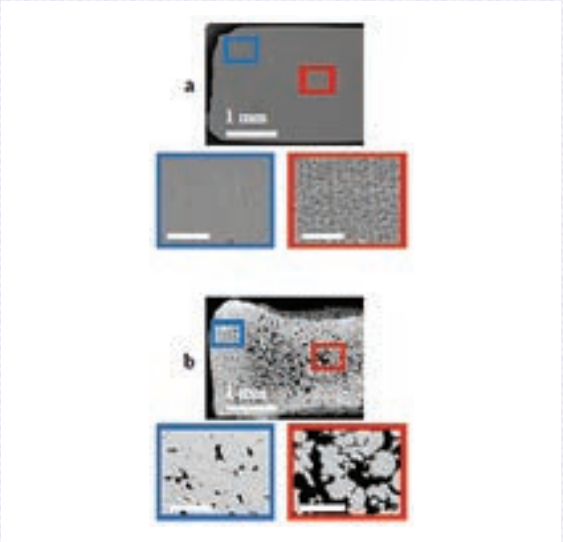


Figure 4: Cathode microstructure. a, Titanium dioxide cathode precursor. b, Vacancy condensation in a titanium cathode. Scale bars: 50 μm.

Understanding the nature of the Ti/TiO_2/melt 3PI (i.e. a renormalization of 1D interlines into a quasi-2D interface) is important for modelling the electro-reduction of titanium dioxide to titanium. The 3PI can be described as a localized system in a statistical continuum limit where very short wavelength fluctuations in a field are as important as fluctuations at a fixed wavelength. Therefore, the effective interaction (or Hamiltonian) that describes the length (or energy) scales of fluctuations at each 1D interline is very similar; the number of independent variables at each 1D interline is fixed and finite. The continuum limit arises on a macroscopic length scale in which independent field variables are defined by a continuum. The application of quantum shuffle diagrams[9] indicates many ways of distributing energy at 1D interlines and that a classical continuum limit is nonsense because of the violation of the second law of thermodynamics leading to zero entropy according to the Boltzmann equation.

Ti/TiO_2/melt 3PI movement using the arbitrary Lagrangian-Eulerian method renders the orientation of a tangent plane to a function at a given point within the cathode that represents the best linear approximation to a differentiable function near that point (i.e. Jacobian matrix) impossible. This has a detrimental effect on the local stability of the time-dependent evolution of nonlinear dynamical phenomena governed by partial differential equations (i.e. Stiffness matrix)[10] and thus severe numerical instability (Figure 5)[4]. In the Lagrangian method the position and physical properties of the 3PI are described in terms of reference coordinates at time = zero whereas the Eulerian method is

restricted to the configuration achieved after 3PI movement and therefore describes a fixed 3PI in space at time > zero. The contracting 3PI length in figure 5 is consistent with a fall in experimental current beyond surface metallization[4].

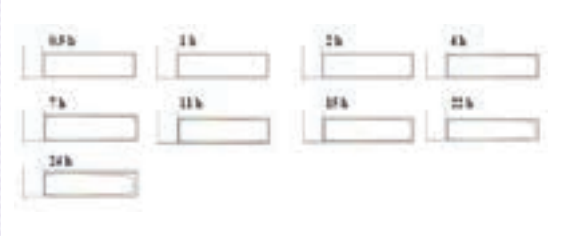


Figure 5: Penetrating 3PI against a flat horizontal anode. The rate of electro-reduction is slower than that observed against an annulus anode4.

In future, the diffusion and nucleation mechanisms during the electror eduction of G oup III-X and rare earth oxides with complimentary numerical models based on meshless methods should be investigated[4]. Further, injecting current into an electrochemical reactor from a current source and then measuring the voltage between electrodes could generate in-situ electrical conductiv ty distribution maps (i.e. electrical impedance tomography)[11,12]. Depending on the arrangement of current injecting and receiving electrodes, most of the current could be constrained through the cathode. This could be used to validate numerical models as well as monitoring reaction progress by probing potential distribution. It is important to note that the difficulty of quantifying the reliability of images and data error caused by poor electrode location characterized by the sensitivity in voltage to both the current source and receiver positions, and the contact of electrodes with the molten salt, need to be addressed.

Author

Charles Osarinmwian, MIScT, RSci, is in the School of Chemical E gineering and Analytical Science, The b iversity of Manchester, O ford Road, Manchester M13 9PL, b ited Kingdom.
Email: charles.osarinmwian@manchester.ac.uk

References
1. H.M. Flower, Nature 407 (2000) 305.
2. M.A. Tarselli, Nature Chem. 5 (2013) 546.
3. C. Osarinmwian, E.P.L. Roberts, I.M. Mellor, Chem. Phys. Lett. 621 (2015) 184.
4. C. Osarinmwian, I.M. Mellor, E.P.L. Roberts, Electrochim. Acta 164 (2015) 48.
5. G.Z. Chen, D.J. Fray, T.W. Farthing, Nature 407 (2000) 361.
6. P.W. Voorhees, J. Stat. Phys. 38 (1985) 231.
7. C.K.L. Davies, P. Nash, R.N. Steven, Acta Metallurgica 28 (1979) 179.
8. F. Seitz, Acta Metallurgica 1 (1953) 355.
9. C. Osarinmwian, (arxiv 1310.2065, 2013).
10. W.B.J. Zimmerman, (World Scientific, Singapore, 2006).
11. C. Osarinmwian, (arxiv 1312.2258, 2013).
12. C. Osarinmwian, (EngD Thesis, The University of Manchester, 2012).

UK climate instruments take a ride on NASA's Global Hawk

NASA's Global Hawk, a remoteeon trolled airplane that can fly for up to 30 hours at altitudes up to 65,000 feet.

Two cutting-edge science instruments developed by UK researchers took to the skies aboard NASA's Global Hawk research aircraft for the first time in March 2015.

The two instruments are the first from the UK to take advantage of the Global Hawk's capabilities. They were developed as part of the four year collaboration between the NERC's Coordinated Airborne Studies in the Tropics (CAST) project and NASA's Airborne Tropical Tropopause Experiment (ATTREX).

The uninhabited aircraft, based at NASA's Armstrong Flight Research Centre, California, can fly at twice the height of Mount Everest and double the altitude of a commercial jet for more than a day at a time, travelling the equivalent of half of Earth's circumference in a single flight in an atmosphere where the air pressure is less than a tenth of that at sea level.

The aircraft is flying above the equatorial regions of the Pacific Ocean at an altitude of 20km, where the lowest layer of the atmosphere, the troposphere, meets the stratosphere above. Scientists believe this area, known as the tropopause, plays a critical role in Earth's climate.

The first of the instruments, GHOST (Greenhouse Observations of the Stratosphere and Troposphere), was developed by the Science & Technology Facilities Council's (STFC) UK Astronomy Technology Centre (UKATC) in Edinburgh, in a joint effort with the universities of Edinburgh and Leicester.

Sitting in the belly of the Global Hawk, GHOST behaves like a suborbital satellite instrument, measuring greenhouse gases such as carbon dioxide and methane across large regions but in fine detail. This will allow scientists to produce precise maps of where greenhouse gases are being released and taken up at the Earth's surface - vital information for international climate negotiations.

The second instrument, AIITS (the Aerosol Ice Interface Transition Spectrometer), measures particles like dust, water droplets and ice crystals. The transport of particles and pollutants between the troposphere and stratosphere plays a crucial role in the climate system and the health of the ozone layer. AIITS was jointly developed by the universities of Hertfordshire and Manchester.

The two UK pieces of kit were joined on board by instruments from the ATTREX project. These will focus on the transport of water vapour and other trace gases into the stratosphere. Studies show that even slight changes in the amount of water vapour in the stratosphere can warm temperatures by absorbing heat rising from the surface.

"These are important issues for climate science. The chance to fly two new UK instruments on the Global Hawk is very exciting. We are flying at temperatures below -80C in the equatorial East Pacific to investigate how thin cirrus clouds form. We then track back below the new NASA OCO-2 satellite to provide more detailed measurements where the satellite measures." - Dr Neil Harris, University of Cambridge, science lead for the NERC CAST project

"These incredibly sensitive instruments, that were originally developed to meet major astronomical challenges by dealing with very low levels of light, are now being used to instead accurately measure the incredibly tiny fluctuations in the levels of greenhouse gases. This new information will allow us to better understand these changes and the data collected will be used to evaluate and improve global models used to predict future climate change." - Andy Vick, innovations manager at STFC's UKATC facility and the lead investigator for the GHOST project, celebrated the successful first flight of GHOST

Image credit: NASA Photo by Carla Thomas

Cities and water – looking to the future

Nagoya West Medical Center (Japan) rooftop garden by AMYOKO - Wikimedia Commons

NERC expertise has made a key contribution to a new report on how the cities of the future can deal with the challenges around managing water in a changing environment - challenges that include providing clean water, dealing with wastewater and controlling flood risk.

The report, "Future visions for water and cities: a thought piece", examines five different visions for how water could be managed in future cities, and explores the research breakthroughs and technological innovations we will need to get to each of them. It is published by the Government Office for Science (Science) and was produced by the UK Water Partnership, which is a collaboration between the water industry, policymakers and researchers.

"The Foresight Future of Cities project is considering the broad range of issues, which have a significant influence on the long-term development of the UK's cities. The impact of water and its sustainable management play a critical role in this future. The UK Water Partnership has made a valuable contribution to the debate by its presentation of a set of interesting alternative visions for the supply and use of water in our cities, for which the expertise created by NERC's investment in environmental science played a vital part." - Sir Mark Walport, Government Chief Scientific Adviser and head of GO-Science

The report investigates ideas that include growing food in and on buildings to create 'garden cityscapes'; designing buildings on stilts to flood-proof cities; using the internet and smart appliances to improve water management; harnessing the deep geology beneath urban areas to deliver drainage, water, heating and cooling; and using utility-run programmes to make communities' water use more sustainable.

This is a highly topical area and one in which NERC is showing thought leadership, working alongside many different stakeholders including government, NGOs and industry. Environmental change is expected to reduce the availability of clean water in many areas, and extreme weather is expected to increase - the cities of the future are likely to face more droughts and greater risk of flooding. To deal with such challenges, innovative thinking will be essential.

"Environmental science will be crucial in enabling cities to meet the challenges they face around water in the coming decades. NERC is pleased to have supported this report, which shows how the researchers we fund are helping lead the debate in this area." - Duncan Wingham, chief executive of NERC

An RCUK event held on 30 June attracted around 200 people from across industry, government and the research community, to discuss challenges for water in cities of the future, focusing on the visions set out in the report. A new video highlights some of the key themes from the event.

"Over recent years the different parts of the UK water sector have tended to operate in isolation, with the biggest gap being around the take up of academic research by the water industry. That's why I applaud the work that NERC has put into initiatives like the UK Water Partnership. NERC is helping to break down barriers, and this ultimately has to benefit UK plc." - Peter Drake, chief executive of the Water Industry Forum, an industry group that supports the UK Water Partnership

Among the report's authors are NERC's Faith Culshaw, coordinator for the UK Water Partnership's Research and Innovation group, Stephanie Bricker of the British Geological Survey and Mike Acreman and Graham Leeks of the Centre for Ecology & Hydrology.

Research aims to improve access to music for people using hearing aids

1820 portrait of Ludwig van Beethoven aged 49 when composing the Missa Sole. Around 1814 however, by the age of 44, Beethoven was almost totally deaf.

Beethoven composed some of his most famous works after he became profoundly deaf.

More recently, musicians such as Ozzy Osbourne, Brian Wilson and Phil Collins have encountered problems with their hearing. Tinnitus affects many more, from Eric Clapton and Neil Young to will.i.am.

Now a collaborative project between the University of Leeds and Sheffield Teaching Hospitals NHS Foundation Trust is bringing together music psychologist Dr Alinka Greasley and Dr Harriet Crook, Lead Clinical Scientist for Complex Hearing Loss, to investigate how music listening experiences are affected by deafness, hearing impairments and the use of hearing aids.

The project, Hearing Aids for Music, will look at how people use hearing aids in musical situations, from listening to music at home to going to a symphony or rock concert.

Dr Greasley, from the University's School of Music, pointed out that you don't need to have lived a rock 'n' roll lifestyle to have a hearing impairment.

"As a population we're tending to live longer, and many people's hearing naturally declines as we get older," she said. "Action on Hearing Loss reports that there are 10 million people with hearing impairments in the UK – two million of them wear hearing aids – and these numbers are rising."

"Music is an important part of people's lives and can have powerful physical, social, and emotional effects on individuals, including those with all levels of hearing impairment – even the profoundly deaf. The purpose of hearing aids is to amplify speech, and evidence suggests that many hearing aid users experience problems when listening to music, such as acoustic feedback, distortion and reduced tone quality."

"Exploring these issues systematically, through a combination of in-depth interviewing and a large- scale national survey, will allow us to understand these problems and identify areas for improving the perception of music using hearing aid technology."

As well as providing advice to hearing aid users, results will be used to help audiologists talk about music listening issues with patients in their clinics. The research may also benefit manufacturers of hearing aids by providing a basis for improved digital signal processing, helping users of the technology to access music.

"This is the first time hearing test data has been used alongside social psychological data to create a systematic exploration into how hearing aids affect music listening behaviours." "Improved access to music using hearing aids will benefit people of all ages, facilitating music education for deaf children and young people, music listening and performance in adulthood, and continued musical engagement into old age." Dr Crook, an expert in the neuroscience of music perception based at the Royal Hallamshire Hospital, Sheffield.

Despite the large numbers of those affected, very little is known about the music listening experiences and behaviour of people with hearing impairments because previous studies have assumed a typical level of hearing in participants.

"People tell us that modern digital hearing aids have proved a revelation because they reveal hitherto 'lost' sounds such as a humming fridge or boiling kettle, yet listening to music is still problematic." Dr Greasley

Pianist Danny Lane, himself profoundly deaf, is Artistic Director of West Yorkshire charity Music and the Deaf founded in 198 to help deaf people access music and performing arts.

"This research is very much needed. Music and the Deaf often receive emails from musicians or parents of musical children who are frustrated with their hearing aids." "Music forms a very important part of their lives – anything that might help improve their enjoyment of it, whether as listeners or performers, is to be welcomed."- Danny Lane

Dr Greasley is conducting interviews with hearing aid users and will also lead a large-scale national online survey.

Dr Robert Fulford, a Post-doctoral Research Fellow at the University, is also working on the three year project, which has been awarded funding worth £247,295 from the Arts and Humanities Research Council.

Drs Greasley, Crook and Fulford are joined by an advisory panel consisting of experts in auditory processing, digital signal processing, hearing aid fitting, hearing therapy and deaf education.

Their findings will benefit hearing aid users and people with all levels of deafness, both in the UK and internationally, through open access content on the project website and forum.

Rail consortium shows how to cut costs and reduce delays

Pictures courtesy University of Southampton

Practical measures to aid landslip prevention and enhance track stability are among the improvements pinpointed by recent research that will mean rail passengers face fewer speed restrictions, delays and cancellations in future - and will help the UK rail industry achieve multi-million pound savings.

A whole range of potential improvements to how railway track is designed, built and maintained has been highlighted by "Railway Track for the 21st Century", a £3.1 million, five year research programme funded by the Engineering and Physical Sciences Research Council (EPSRC). It has been undertaken by a consortium led by the University of Southampton, and also the University of Birmingham, the University of Nottingham as well as a range of industry partners, who have provided additional financial support.

Pictures courtesy University of Southampton

Using innovative computer models and on-train and trackside measurement techniques to reveal in unprecedented detail the forces and pressures that railway track is subjected to, key outcomes and findings include the following:

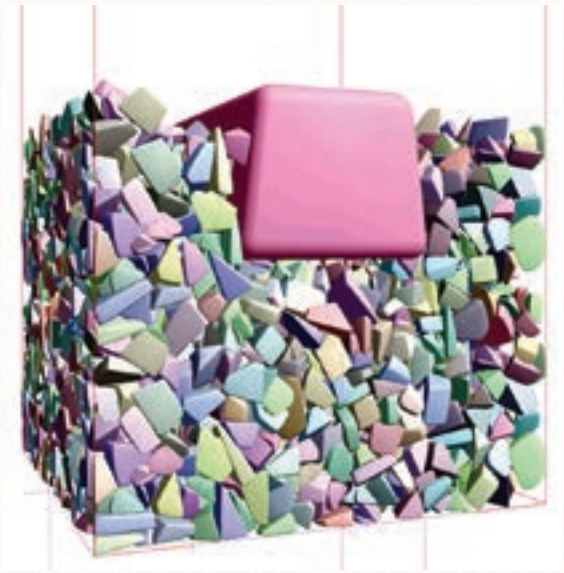
- Savings of £500,000 a year have already been realised through more effective management of line side vegetation. Seasonal track movement on clay embankments can be addressed by using vegetation to manage water content and hence reduce shrink-swell problems in the clay, as well as improving track stability during wet periods.

- Better risk assessment of earthworks has led to improved adverse weather management, delivering an estimated 14 per cent reduction in the risk of trains running into landslides during high-rainfall periods.

- The risk of landslips can be further reduced by piles driven into the earth to stabilise slopes forming part of cuttings and embankments. Annual savings estimated at between £3 million and £20 million are expected from improved design arising from the research, as well as big reductions in the time taken for the works.

- Maintenance requirements can also be reduced by including a wider range of grain size in the ballast supporting the track, by inserting flexible pads under sleepers, or by reducing the ballast shoulder slope, all of which can reduce the stresses that the track system experiences.

"Trains have changed hugely over the last few decades, but the track and earthworks they run on are substantially the same as a century ago. Increases in the speed and weight of trains are putting our rail infrastructure under growing pressure, while increases in service frequency are reducing maintenance windows. The changes we've explored offer ways to help maintain and upgrade the infrastructure for the 21st century."
- Professor William Powrie of Southampton University, who has led the research



Pictures courtesy University of Southampton

The slope stabilisation project in London has saved £1.5 million in costs and achieved a four month shortening in timescale through utilising procedures devised by the research programme.

"This is an excellent example of how research aligned to government transport policy produces significant benefits, in this case for the railways and passengers." Kedar Pandya, Head of Engineering at EPSRC (Engineering and Physical Sciences Research Council)

Now several of the most promising ideas generated by the programme are being taken further forward by the £2 million, five year follow-on initiative 'Track to the Future' primarily funded by EPSRC (Engineering and Physical Sciences Research Council) and being undertaken by the same consortium, which Huddersfield University has now also joined.

"Our work has shed more light on the many complex factors and mechanisms that determine how railway track behaves. Our conclusions are equally applicable to the UK's existing rail network and to the high-speed railways of tomorrow." - Professor Powrie

The five year EPSRC (Engineering and Physical Sciences Research Council)-funded research programme 'Railway Track for the 21st Century' began in June 2010.

Industrial partners include: Network Rail, London Underground, Tata Steel, Balfour Beatty, Pandrol Track Systems, the Rail Safety & Standards Board (RSSB), the Rail Industry Association (RIA) and the Association of Train Operating Companies (ATOC).

The UK's rail network includes over 18,000km of embankments and cuttings where slope stability is a critical operational requirement.

Space science laboratory offers £27.7m boost to UK's space industry

Minister for Universities and Science Jo Johnson speaking at the inauguration of R100 (Credit: STFC)

July 2015 marked a giant leap for the UK space industry as 2 major new space facilities opened at the UK Space Gateway in Oxfordshire, including the new STFC RAL Space integration and test facility "R100".

"With the heritage of the Rutherford Appleton Laboratory it would be hard to find another facility that has done more to establish the credentials of UK space science. We set the standard for space science technology and British ingenuity is helping mankind look back at the formation of our universe to see the first stars and galaxies, and nothing could be more exciting or thrilling than that. And space science is of course not just an end in itself, but as one of our 8 great technologies satellite technology underpins so many of our key industrial sectors.

This new facility means the UK now has one of the best testing facilities anywhere in the world, and I'm delighted to be part of the opening of the R100 Development and Test Facility today"
- Jo Johnson, the Minister for Universities and Science speaking at the inauguration event

"Our new integration and test facility provides capability for the needs of the next generation of spacecraft and instruments, and will contribute to the growing community of space focussed businesses, capabilities and skills located at the Harwell Campus space Gateway.

Our R100 building is a major expansion of our test facilities; including two new 5m diameter Space Test Chambers along with a vibration facility, clean rooms and AIV (Assembly, Integration and Verification) control room. With Phase 2 of the project currently expected to be completed by June 2017 these are incredibly exciting times to be working at RAL Space." - Dr Chris Mutlow, Director of RAL Space

The first instrument to arrive for calibration in Phase 1 of this new state of the art facility will be the ESA Sentinel 4 UVN (Ultra-violet/Visible/Near-infrared) instrument, which is destined for geo-stationary orbit, forms part of Copernicus, the European Earth observation programme.

July also saw the opening of the new ECSAT building – the European Space Agency's (ESA) home in the UK. ESA's UK facility has been developing steadily since 2008, following the UK government's decision to increase its contribution to ESA and the new building will host 120+ jobs, including teams in telecommunications and integrated applications. Special emphasis will be put on the development of new markets for satellite-based services and applications. The building will also house the Earth Observation Climate Office, Science and Exploration teams and Technology and Quality Management teams supporting ESA research and development programmes in the UK, focusing on 'game-changing' technologies and capabilities.

Major European mouse study reveals the role of genes in disease

The functions of around 150 genes have been discovered by scientists across Europe in a major initiative to try to understand the part they play in disease and biology.

Since mice share 90 per cent of their genes with humans they are one of the best organisms to help us understand human genetics. The E ropean Mouse Disease Clinic (M D IC)* brought together scientists from across E rope to investigate the functions of 320 genes in mice. O er half of these genes had no prev ously known function, and the remaining genes were poorly understood.

Over 80 per cent of the mouse lines assessed had a characteristic that provided a clue to what the missing gene's role might be. If the mouse fails a hearing test, for example, it suggests the missing gene might have a role in hearing. In total, they carried out over 150 different tests on each mouse line. The researchers classified 94 genes linked to disease into three categories: bone and skeleton, metabolism, and neurological and behavioural disorders.

O e of the genes discovered, E mod1, belongs to a large group of genes active in the brain for which there was no information about its function. This work revealed that mice with a faulty E mod1 gene had lower blood glucose levels and lower body weight. It also revealed that this gene was involved in gait and the animals had a lower grip strength.

In order to study gene function, the EUMODIC consortium produced mouse lines which each had a single gene removed. These mouse lines were then analysed in mouse clinics, where each mouse was assessed by a series of tests and investigations, allowing the researchers to establish the functions of the missing genes.

EUMODIC was the first step towards the creation of a database of mouse gene functions, a vision now being realised by the International Mouse Phenotyping Consortium (IMPC). The IMPC incorporates 18 centres from across the globe with the aim over the next ten years of uncovering the functions of all 20,000 genes in the mouse genome. IMPC builds on the groundwork and achievements of EUMODIC in establishing the procedures and processes to identify and catalogue the functions of genes.

"EUMODIC leaves a powerful legacy that will live on in the IMPC and the data and resources it has provided for scientists. EUMODIC and IMPC will be truly transformative for medical research by revealing the roles that different genes play in disease." - Professor Steve Brown, Director of the MRC Mammalian G netics Unit at Harwell and the coordinator of the E MODIC consortium

"The standardised practices that have been developed through this research allow multiple centres to work in concert to generate robust, reproducible data. In the long term, this streamlined approach and the availability of the data from these studies will significantly reduce the number of animals used in research." - Dr David Adams, Experimental Cancer Genetics Group Leader at the Wellcome Trust Sanger Institute, a major contributor to the EUDOMIC consortium

This was the first time such a project has been attempted on this scale with multiple centres cooperating together from different countries. The consortium had to establish new standardised procedures to generate and assess the mouse lines and a central E ropean database to store all the data. The aim of the project was to understand more about genes we currently know very little about, and open up new avenues for research into the genetics of human disease. All the findings have been made publically av ilable, allowing other scientists to use them in their own research.

** EUMODIC, was established in 2007, and was the first genetics project of its kind bringing together mouse genetics centres from across Europe to work together to study the role of hundreds of genes. It revealed the traits of over 300 genes and set standards and procedures for a larger international effort to investigate the functions of all 20,000 genes in the mouse.*

Molecular trick alters rules of attraction for non-magnetic metals

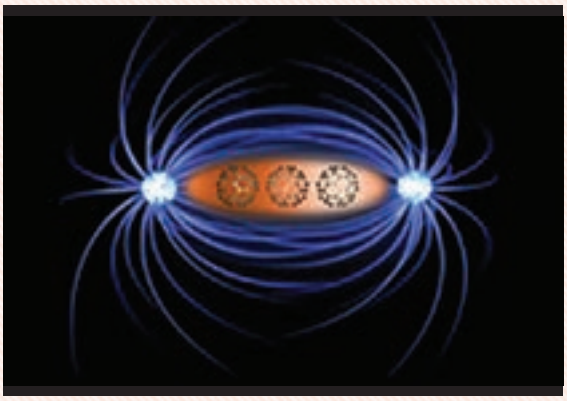


Image courtesy University of Leeds

Scientists have demonstrated for the first time how to generate magnetism in metals that arent n aturally magnetic, which could end our reliance on some rare and toxic elements currently used.

In a study led by the bI iversity of Leeds and published in the journal *Nature*, researchers detail a way of altering the quantum interactions of matter in order to "fiddle the numbers" in a mathematical equation that determines whether elements are magnetic, called the Stoner Criterion.

"Being able to generate magnetism in materials that are not naturally magnetic opens new paths to devices that use abundant and hazardless elements, such as carbon and copper." -C ol- ead author Fatma Al MaM ari, from the School of Physics &A stronomy at the University of Leeds

Magnets are used in many industrial and technological applications, including power generation in wind turbines, memory storage in hard disks and in medical imaging.

"Future technologies, such as quantum computers, will require a new breed of magnets with additional properties to increase storage and processing capabilities. Our research is a step towards creating such 'magnetic metamaterials' that can fulfil this need". - Al Ma'Mari

Yet, despite their widespread use, at room temperature only three elements are ferromagnetic - meaning they have high susceptibility to becoming and remaining magnetic in the absence of a field, as opposed to paramagnetic substances, which are only weakly attracted to the poles of a magnet and do not retain any magnetism on their own. These ferromagnetic elements are the metals iron, cobalt and nickel.

"Having such a small variety of magnetic materials limits our ability to tailor magnetic systems to the needs of applications without using very rare or toxic materials. Having to build devices with only the three magnetic metals naturally available to us is rather like trying to build a skyscraper using only wrought iron. Why not add a little carbon and make steel?" - Co-lead author Tim Moorsom, also from the University's School of Physics & Astronomy

The condition that determines whether a substance is ferromagnetic is called the Stoner Criterion.

It explains why iron is ferromagnetic while manganese is not, even though the elements are found sideb ysid e in the periodic table.

The Stoner Criterion was formulated by Professor Edmund Clifton Stoner, a theoretical physicist who worked at the bI iversity of Leeds from the 1930s until the 1960s. At its heart, it analyses the distribution of electrons in an atom and the strength of the interaction between them.

It states that for an element to be ferromagnetic, when you multiply the number of different states that electrons are allowed to occupy in orbitals around the nucleus of an atom - called the Density of States (DOS) - by something called the "exchange interaction", the result must be greater than one.

The exchange interaction refers to the magnetic interaction between electrons within an atom, which is determined by the orientation of each electron's magnetic "spin" - a quantum mechanical property to describe the intrinsic angular momentum carried by elementary particles, with only two options, either "up" or "down".

In the new study, the researchers have shown how to change the exchange interaction and DOS in non-magnetic materials by remoiv ng some electrons using an interface coated with a thin layer of the carbon molecule C_{60}, which is also called a "buckyball".

The movement of electrons between the metal and the molecules allows the non-magnetic material to overcome the Stoner Criterion.

"We and other researchers had noticed that creating a molecular interface changed how magnets behave. For us, the next step was to test if molecules could also be used to bring magnetic ordering into non-magnetic metals." - Dr Oscar Cespedes, principal investigator of the project, also from the University's School of Physics & Astronomy

The researchers say that the study has successfully demonstrated the technique, but that further work is needed to make these synthetic magnets stronger.

"Currently, you wouldn't be able to stick one of these magnets to your fridge. But we are confident that applying the technique to the right combination of elements will yield a new form of designer magnets for current and future technologies". - Dr Cespedes

The research paper, "Beating the Stoner Criterion Using Molecular Interfaces", is published in the journal *Nature*.

“Selfish” bacteria link IBD and gut micro biota changes

The discovery of unusual foraging activity in bacteria species populating our gut may explain how conditions like Inflammatory Bowel Disease (IBD) link to changes in the populations of bacteria in our gut.

IBD affects 1 in every 250 people in the UK, but its causes are unknown. Studies have shown that IBD patients have a different profile of gut microbes, which is called dysbiosis.

All of us have trillions of beneficial bacteria in our gut, but the combination of different species, known as the microbiome, varies. A crucial question has been whether IBD causes our microbiome to change, or whether an imbalanced microbiome could be triggering IBD. The question is, exactly how does one affect the other? We need to study these interactions to define new targets for therapeutics.

Nathalie Juge and colleagues at the Institute of Food Research (IFR) have been trying to answer these questions by looking at the environment in which gut bacteria grow mucus. IFR is strategically supported by the Biotechnology and Biological Sciences Research Council.

Mucus covers the lining of our gut and provides an ideal environment for gut bacteria to grow by providing them with a rich source of sugars. However not all bacteria can consume mucus, and it has been shown recently that IBD patients had a higher proportion of specific mucus-degrading bacteria called *Ruminococcus gnavus*, common gut bacteria found in most individuals.

Mucus is made up of long molecules, called mucins, which consist of protein chains, coated with sugars, and usually capped with sialic acid, a sugar residue widely distributed in animal tissues. To use mucins, bacteria first have to remove the sialic acid.

Once this is done, the sialic acid becomes available as a nutrient source for the whole of the bacterial community in the mucosal environment.

This means mucin-degrading bacteria have an important role in the whole bacterial community, so the researchers set out to work out what makes them effective.

Previously, the researchers found that *R. gnavus’s* ability to degrade mucins depended on the type of strain they were working with. So they then compared the genome sequences of these strains to identify which genes were behind the mucus-degrading abilities.

In a follow-up study, published in the journal *Nature Communications*, they found a surprising result. The cleavage enzyme allowing *R. gnavus* strains to grow on mucins, instead of releasing free sialic acid, chemically modifies it upon cleavage, providing these bacteria with a preferential source of nutrient.

This suggests a “selfish” behaviour where instead of sharing free sialic acid with other bacteria, *R. gnavus* mucin-degrader strains can use the modified sialic acid themselves.

This unusual activity hadn’t been seen in any other gut bacteria before. But having identified the enzyme, a bioinformatics screen found it in 11% of other bacteria. And the enzyme is also enriched in IBD patients, which agrees with previous studies showing an increased proportion of *R. gnavus* in IBD patients.

“We think that this enzyme may help the bacteria to adapt to changes occurring in IBD patients’ mucosal environment and give these bacteria a competitive nutritional advantage over others”. - Dr Juge

The researchers now need to determine the impact of these findings in a complex microbial community, but this study points the way beyond correlations between IBD and changes in the microbiota. Whilst it will be a while before this information could be used to develop new therapies, it could be developed into a better biomarker for IBD.

Image credit: by Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine.

Large-scale trial will assess effectiveness of teaching mindfulness in UK schools

Researchers from the MRC Cognition and Brain Sciences b it will be part of a major Wellcome Trust study to assess whether mindfulness training for teenagers can improve their mental health.

The threep art study includes the first large randomised control trial of mindfulness training compared with 'teaching as usual'. It will involve nearly six thousand students aged 11 to 14. Other parts of the study are a programme of experimental research to establish whether and how mindfulness improves the mental resilience of teenagers, and an ea luation of the most effective way to train teachers to deliver mindfulness classes to students.

The £6. 4 million research programme will also be carried out with teams at the b iversity of Oxford and U L (b iversity College London)in collaboration with the b iversity of E eter, over seven years.

Teenage years are a vulnerable time in terms of onset of mental illness, with over 75% of mental disorders beginning before the age of 24 and half by the age of 15. This programme of research is based on the theory that, just as physical training is associated with improved physical health, psychological resilience training is associated with better mental health outcomes. By promoting good mental health and intervening early, i.e. in crucial teenage years, researchers are seeking to understand whether they can build young people's resilience and help to prevent mental illness developing.

Mindfulness training is a very popular technique that has been found to be very effective in preventing depression and promoting mental health in adults. This programme of research seeks to answer whether mindfulness reduces the incidence of depression and associated mental disorders in teenagers by improving their ability to employ problem solving skills in the face of emotional distress, intrusive thoughts or behavioural impulses. This ability is known by researchers as 'executive control'.

The study has recruited 76 mainstream schools: 38 schools will train 11-14 year old students in mindfulness and 38 schools will act as a 'control', teaching standard personal, health and social education lessons. Mindfulness training, which takes place over 10 lessons within a school term, will be offered to all students as part of their normal school curriculum. The trial is expected to begin in late 2016 and will run for 5 years, including a follow-up period of 2 years for each student.

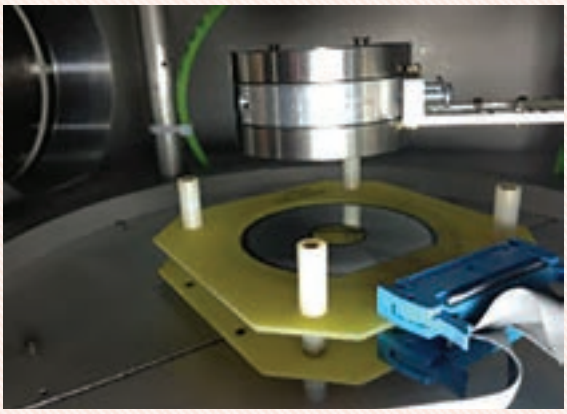
Mindfulness training is designed to be of benefit across a spectrum of mental health vulnerability, from those at high risk, to those that are low risk and/or flourishing – as you might see across any typical classroom. The goal is to ea luate mindfulness training across the whole population, and researchers want to assess both mental health problems and positive mental health. Key outcomes researchers will be looking for are: risk of depression, social and behavioural skills, and well-being.

Researchers are also looking at secondary outcomes of mindfulness training including peer relationships, anxiety, student attainment, and teacher well-being.

Researchers at the MRC Cognition and Brain Sciences Unit, with UCL, are testing exactly how mindfulness affects wellbeing and whether mindfulness training is more beneficial at some stages of adolescence than others.

Image credit: Wellcome Trust

York scientists unlock secrets of stars through aluminium



The gas cell target and silicon detector array inside the TUDA scattering chamber at TRIUMF (credit: Jessica Tomlinson)

Physicists at the Uiversity of York have revealed a new understanding of nucleosynthesis in stars, proiding insight into the role massive stars play in the evolution of the Milky Way and the origins of the Solar System.

Radioactive aluminium (aluminium-26 or Al26) is an element that emits gamma radiation through its decay enabling astronomers to image its location in our galaxy. Studying how Al26 is created in massive stars, scientists have distinguished between previously conflicting assumptions about its rate of production by nuclear fusion.

Measuring the fusion of helium and sodium at two separate particle accelerators in Canada and Denmark, the rate of production of Al26 was determined to within a factor of two. An improvement on previous experiments where there was disagreement of around a factor of 100 between measurements, this outcome removes dispute about the effect of sodium fusion on the rate of aluminium production.

Al26 is known for its relatively short lifespan (in astrophysical terms), decaying in around 1 million years, compared with the lifetime of massive stars of about 19 million years.

This means we are now able to better understand gamma radiation maps of the galaxy, observed by space telescopes such as INTEGRAL and COMPTEL, and deduce a more accurate picture of recent activities of massive stars in the galaxy.

Evidence of Al26 decay observed in meteorites and pre-solar grains also suggests that material from massive stars contaminated the gas cloud from which the Solar System formed, providing insight into its early existence.

"This research highlights clear and unambiguous evidence from gamma-ray observations of the galaxy that nucleosynthesis is happening in stars. By pinning down the production rate of radioactive aluminium, we will be able to interpret and understand these observations. Now we better understand the processes within stars that drive aluminium production, we pave the way for more detailed and thorough research into how massive stars affect our galaxy and the origins of our Solar System." - Dr Alison Laird, Reader in the University of York's Department of Physics and lead author on one of the two research papers.

"These two experiments, completely independent of each other at a technical level and using opposite methodology, provide the most definitive research we have to date of radioactive aluminium production. Through this, we can now much better understand where and how aluminium-26 is produced in stars, and can simulate in the lab how stars work. By observing aluminium decay through gamma-radiation maps, we are now able to build a more accurate picture of the conditions when our Solar System formed." - Dr Christian Diget, Lecturer in Nuclear Astrophysics in York's Department of Physics and a lead researcher on the second research paper.

From the Archives

Alan Gall, IST Archivist

Sanatogen nerve tonic and its role in the history of the laboratory supply industry

Introduction

Compton Mackenzie is known for the novel *Whisky Galore*, released as a film in 1949. He is also notable for being prosecuted under the Official Secrets Act after some sensitive revelations in his book *Greek Memories*, and for being an enthusiastic promoter of a nerve tonic called Sanatogen.

This product existed before World War One but its German ownership in the UK ceased when the business was confiscated and put up for tender. Its new owners promised to remove links with the past by renaming the tonic. This never happened. A number of firms, eager to take advantage of the uncertainty surrounding the future of Sanatogen, offered "superior" products with copycat names like Sanaphos and Sanagen. It was open season on anything connected with "the enemy".

Both German and English owners promoted Santogen shamelessly, with the typically exaggerated claims of the day. In its original form, it was not supplied as an alcoholic drink - later came the formulation with fortified wine. On changing to British ownership, the name of the company became Genatosan. As a subsidiary of the Anglo-Continental Guano Works Ltd, it joined Fisons and gave birth to the Loughborough Glass Company Ltd, the foundation stone of the major laboratory supplier Fisons Scientific Apparatus Ltd.

A. Wülfing & Company

Bauer & Co of Berlin first used the registered trademark Sanatogen in October 1897, its creation due to the work of Albert Busch and Felix Bauer.

Serious sales promotion in this country began in 1903 when A. Wülfing & Company, trading as the Sanatogen Company, rented part of a warehouse at 83 Upper Thames Street, London. Dr Albert Busch and Johann Abraham Wülfing were partners in this concern.

An early advertisement made the immodest claim: "... greatest invention of modern medical science" and "Doctors have proved it the most rapid cure for Rickets in children."[1] As time went on, some very eminent people lent their support.

One of the earliest advertisements for Sanatogen in England (Illustrated London News, 24 October 1903)

Lloyd George introduced the Patents and Designs Act of 1907. One of the provisions was to enable cancellation of a patent if the article (or process) in question failed to be manufactured to an adequate degree in the UK. Since Sanatogen supplies came from a factory near Hanover, and Wülfing wished to protect its patent rights, finding a suitable site became a priority. Milk is required in large quantities for Sanatogen and a willing local workforce always helps. Cornwall provided both, with its dairy herds and general lack of industrial employment opportunities.

The Consolidated Tin Smelting Company had a works at Chyandour and one at Stable Hobba, both near Penzance. Consolidated Tin moved smelting to Chyandour, closing down their operations at Stable Hobba. A.Wülfing & Co took up the lease. There were complaints of smells from the new plant but the local press and authorities were too well disposed towards the company to make much of a fuss.

The main components of Sanatogen powder were identified at the Connecticut Agricultural Experimental Station in 1912. After discounting the 10% water content, the balance consisted of 90% casein and 5% sodium glycerophosphate. Also there were unspecified compounds of phosphorus, nitrogen and sulphur making up the remainder.[2]

A severe fire at 8 þ per Thames Street in September 1908 dislodged the thirteen firms occupying the six-floored warehouse.[3] The Sanatogen Company quickly found a new home at 12 Chenies Street, off the Tottenham Court Road. Advertising continued with outlandish statements like: "And over 16000 doctors have written voluntary letters, commending Sanatogen because of the excellent results which they have obtained from it in cases of Nervous Exhaustion, Brain-fag, Sleeplessness, Depression, Impaired Digestion, and various wasting diseases."[4]

Such were the business methods employed that even the government took notice. Later, in a House of Commons debate on 6 June 1921, Gershom Stewart, MP for Wirral, said:

If you ever saw any particularly blatant advertisement by a British company you might be sure there was something German about it. They went in for fancy names for their articles. An article called Sanatogen, used by a great many people, was made by a German firm called Wülfing Company. The whole of their system of shamming was induced by cupidity and deceit.[5]

When war broke out in 1914, A. Wülfing & Company was quick to issue a statement to the press: "... Mr Wülfing, the proprietor of the business, is over 60 years of age and is incapable of fighting with the German forces ..." More important was the suspicion that Wülfing's money might be supporting the German war machine.

The Sanatogen factory at Stable Hobba. This appeared in a number of newspapers during 1915 with a declaration to appease the British public: "There are not, and have never been, any but British workmen in this factory since it was established seven years ago."

German employees of A. Wülfing & Company were allowed by the authorities to continue with their work for some time. However, other members of the staff were plotting a coup and at least one rival business started a campaign to have the general manager Max Müller removed. The Alien Internment Committee had originally allowed Herr Müller to remain in his post as he was indispensable to the running of the company and it was in the interest of the country that he continued to do so.[6] A petition organised by Albert Warren Scales, briefly joint manager with Müller, suggested that it was a mistake to exempt Muller from internment and that the petitioners should be allowed to take over. Having discovered the plot, Müller sacked Scales and those involved, on the basis of disloyalty. Scales then sued for wrongful dismissal, probably hoping to capitalise on prevailing anti-German sentiments,

The court case went badly for Scales. After hearing from the advertisement writer Eric Hudson that Scales had said "Why should we go on making money for these German swine when we could be making it for ourselves", the jury found for A. Wülfing. Meanwhile, there was a concerted effort by the British Milk Products Co Ltd, makers of Sanaphos, to exert influence.

No sooner had war broken out than Sanaphos appeared on the market. Advertisements went straight for the jugular: "The extravagant price at which "Sanatogen" was sold not only enriched its German owner, but prevented its use amongst those who cannot afford such prices." British Milk Products Co Ltd went further to step up the pressure. They provided lists of doctors who now found that Sanatogen was an inferior product, and the company started what they called "The Sanaphos Petition" – asking the government to forbid trading by German-owned firms. Another contender in the nerve tonic market, Sanagen, billed itself as the British super-Sanatogen.[7]

The Wülfing company mounted a defence: "Never forget that Sanatogen is a food not a medicine or "secret remedy". It increases nerve-energy by feeding the nerves – not by goading them with drugs or stimulants."[8]

Eventually, the papers reported with obvious satisfaction that 38 year-old Max Müller had been arrested and sent to an internment camp based at Alexandra Palace.[9] Then followed the disposal of the business, as a going concern.

Genatosan

Another of the products originated by Wülfing & Company, Formamint was a throat lozenge with antiseptic properties (Image credit: Welcome Library, London)

A person claiming to have benefited from regular doses of Sanatogen, and no doubt someone with an eye for a profitable venture, set about contacting prospective investors to support a bid for Wülfing.[10] This led to a successful tender of £6000, ten percent payable as a deposit. The Board of Trade gave its official authorisation for the transfer from state ownership on 16 February 1917, the date that Genatosan Ltd came into being. Observant readers will note that Genatosan is an anagram of Sanatogen.

Amongst the "movers and shakers" behind Genatosan were The Right Honourable David Alfred Baron Rhondda, Archibald Mitchelson and James Gilmer Berry. They were also directors of The Anglo-Continental Guano Works Ltd.[11]

Baron Rhondda, born David Alfred Thomas, served as Minister of Food Control toward the end of the First World War and survived the sinking of the ship Lusitania. James Gomer Berry owned *The Sunday Times* with his brother William, and Mitchelson was a stockbroker holding 17 other directorships.

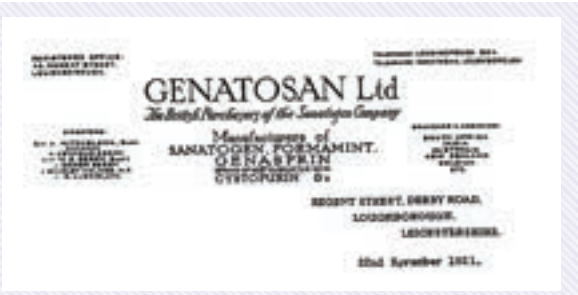
Von Nolendorff & Co ran a fertiliser and acid factory near the River Thames, where they treated Peruvian guano with sulphuric acid to produce what was known as "dissolved guano". The principals were Albertus von Nolendorff and Adolphus Horny. In 1888 the Anglo-Continental Guano Works was formed as a subsidiary of Von Nolendorff & Co to operate the factories at London, Hamburg, Antwerp and Emmerich am Rhein. Von Nolendorff decided to retire in 1888 so that he could concentrate on his Hamburg business, leaving Horny with the benefit of a substantial loan to continue the London fertiliser works.[12] Lord Rhondda and his investors acquired Anglo-Continental from the Public Trustee in 1916, and Genatosan became a subsidiary in due course.

When the First World War ended, there were opportunities to increase sales abroad of Sanatogen and the other "health" products: Albulactin (a food for infants), Formamint, Cystopurin and Genasprin. These were all inherited from Wülfing, apart from Genatosan's brand of asprin, Genasprin. An advertisement in *The Practitioner*, a journal read by Drs, describes Genasprin as "The faultless brand of asprin, guaranteed absolutely free from irritant toxic acids, talc, and all harmful impurities and adulterants." Formamint - "The trustworthy mouth and throat disinfectant in tablet form, releasing nascent formaldehyde" and Cystopurin – "A distinct advance on other urinary antiseptics of this type, owing to the presence of undecomposed hexamethylene tetramine."[13]

One of the legacies of German ownership was a network of branches and agencies abroad, kept in existence throughout the war so that trade could be taken up more readily when the time came. These were in Australia, Canada, China, Egypt, India, Japan, South Africa, South America, and New Zealand; a testimony to the previous success of the Wülfing company.

General manager William George Asquith expressed the company's ambition to expand the product range by moving into fine chemical production and to extend the existing facilities for the manufacture of containers. These plans required more space than was available at Stable Hobba and by 1919 the board had investigated possible sites. By 1921, suitable premises on Regent Street, Loughborough, had been found.

From the start of Genatosan's formation onwards, Compton Mackenzie endorsed Sanatogen.


GENATOSAN Ltd

The heading of a letter written shortly after Genatosan moved to the new address

He even managed to mention the tonic in one of his novels: "A curious thing really that Philip should be prepared to choke himself over a cup of badly mixed Sanatogen rather than wound a young woman's feelings..."[14] When it came to writing a promotional booklet about the company's history and activities, who better to do it than the famous author himself?

According to Mackenzie, Sanatogen took six days to make from start to finish. First, acidification of skimmed milk precipitated casein (milk protein) which, after removal by filtration, was pressed to remove water. There were then two washes, one with alcohol, the next with ether. At this point came the addition of sodium glycerophosphate, followed by drying, grinding and packing. The German origin of the formulation is not mentioned.

Sanatogen also appeared in shops mixed with chocolate. The blend with British fortified wine didn't come onto the market until 1938 manufactured under licence by Whiteways.

Fisons

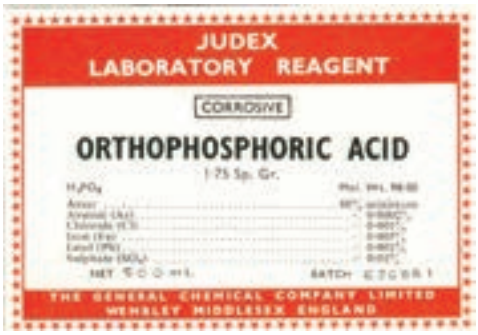
James Fison began as a village baker at Barningham, Suffolk. From this beginning, via the merger of James Fison & Sons with Edward Packard & Co in 1919, and a further major amalgamation with two other East Anglian companies[15] Fisons built up a respectable presence in the fertiliser market. By acquiring a majority stake in the Anglo-Continental Guano Works Ltd in 1937, the size of Fisons effectively doubled.

The acquisition of Genatosan, as a subsidiary of Anglo-Continental, ultimately led to Fisons establishing a pharmaceutical division, and a scientific supply business that, for a time, ranked number three in the world. It started During the Second World War with a single glassblower, Colin Clegg, who was brought in to help remedy the shortage of glass apparatus required for Genatosan's new research labs. This service expanded with the formation of the Loughborough Glass Company Ltd, incorporated on 19 December 1946 and renamed as Fisons Scientific Apparatus Ltd in 1962. Laboratory chemicals were added to the range when Fisons bought the General Chemical Company Ltd in 1963.

Bengers Ltd
Corby Basic Slag Ltd
Fisons Chemicals (Export Ltd)
Fisons Milk Products Ltd
Fisons Pest Control Ltd
Genatosan Ltd
Loughborough Glass Co Ltd
Nitrogen Fertilisers Ltd
Whiffen & Sons Ltd

Fisons' principal subsidiaries in 1958

A spin-off from Genatosan Ltd, dedicated premises for the Loughborough Glass Company Ltd, June 1960 (Loughborough Glass Co Ltd catalogue, 1960)



The acquisition of the General Chemical Company gave Fisons better coverage of the laboratory supply market, although the range of reagents was drastically pruned in 1964

Fisons went on to acquire A. Gallenkamp & Co Ltd in 1977, which had already merged with another major laboratory supplier, Griffin & George Ltd. Following the sale of Fison's loss-making fertiliser division to Norsk Hydro in 1982, it was a rapid downhill slide. What hadn't already been disposed of was dispersed after Fisons plc fell to a takeover by RPR Acquisition Corp on behalf of Rhône Poulenc Rorer during 1995.

The name of Fisons is fading from memory but Sanatogen lives on. The 15% abv tonic wine, readily available in supermarkets, is now under the control of Accolade Wines, and Sanatogen based products are part of a supplements range from Bayer AG.

Acknowledgements

Thanks to the staff and volunteers at the local studies section of Loughborough Library, including: Brian Bentley, Christine Harris, Carol Neath and Kathy Philips.

Thanks also to Professor Michael Moss for a copy of his Fisons manuscript.

Bibliography of main sources

Companies House archive CD for Genatosan Ltd, company number 00146033.

ANON, *Development of the Organisation: Fisons Pharmaceuticals* (Local Studies Library, Loughborough, ref 661 L/BORO, c 1987).
DAVIS, Andy, *R&D Charnwood a Site History* (AstraZenica, nd).
MACKENZIE, Compton, *Genatosan* (Genatosan Ltd, 1950s).
MOSS, Michael S., *Fertilizers to Pharmaceuticals, Fisons: The Biography of a Company 1720-1986* (unpublished manuscript, copy at Ipswich Public Record Office).

Further details about Fisons Scientific Apparatus Ltd can be found in:
Alan Gall, "A History of the Pyrex Wholesalers: Part Eighteen – Fisons Scientific Apparatus Ltd, Loughborough", *British Society of Scientific Glassblowers Journal*, 52/2 (April 2014), 71-79.
Alan Gall,"A History of the Pyrex Wholesalers: Part Eighteen – Fisons Scientific Apparatus Ltd - the Story Concluded", *British Society of Scientific Glassblowers Journal*, 52/3 (July 2014), 112-120.

References

[1] *Sheffield Daily Telegraph*, 21 April 1904.
[2] The analysis of Sanatogen is referred to in John P. Street, "The Feeding of Sanatogen Compared with Commercial Casein with Respect to Maintenance and Growth", *Journal of the American Medical Society*, 63/21 (1914).
[3] *Stamford Mercury*, 18 September 1908
[4] Advertisement in *The Observer*, 6 October 1912.
[5] House of Commons Debates (Hansard), 6 June 1921, vol 142, col 1553.
[6] "German Sued", *Chemist & Druggist*, 1 April 1916.
[7] Advertisement, *Daily Record*, 15 June 1916.
[8] *Sheffield Evening Telegraph*, 16 February 1915.
[9] See, for example, *Bath Chronicle & Weekly Gazette*, 3 June 1916.
[10] *The Observer*, 17 December 1916.
[11] See Alan Gall, "Treasure Island: Riches From Guano", *IST Journal* (Summer 2013), 2931.
[12] *The Economist*, 7 July 18
[13] *The Practitioner*, July 1920.
[14] Compton Mackenzie, *Sylvia and Michael: The Later Adventures of Sylvia Scarlett* (London: Harper Brothers, 1919), 154.
[15] Packard & James Fison (Thetford)Ltd merged with Joseph Fison & Co and Prentice Brothers to form Fison, Packard & Prentice Ltd.

IST Organisation

IST Executive Board Members

President: Helen Sharman OBE, FRSC

Helen is the Operations Manager for the Chemistry Department at Imperial College. She started her career with a degree in chemistry from the University of Sheffield before working in industry for GEC and then Mars Confectionery, where she was part of the team that created the Mars Ice Cream. After applying for a job that was advertised as, “Astronaut wanted,” Helen trained at the Yuri Gagarin Cosmonaut Training Centre in Star City near Moscow, becoming the first British astronaut when she launched into space on board a Soyuz spacecraft on 18 May 1991. Helen became a science communicator after her space flight. More recently, she has started a new career in management, working at the National Physical Laboratory and at Kingston University London, before moving to Imperial College in the summer of 2015.

Chairman: Terry Croft MBE, FIScT

Terry is the Chairman of the IST and has a passion and commitment to the Technical Community. His work involves promoting the Professional Technician as a career choice. He brings a wealth of experience to the board through his involvement with the wider sector and as Director of the Catalyst Project, titled “Development of Career Pathways for Technicians across the Higher Education Sector.”

E: t.croft@istonline.org.uk

Honorary Secretary: Chris Smith MIScT

In 2010 Chris became a member of the Institute of Science and Technology and was co-opted onto the IST’s Executive as Deputy Marketing Officer. Chris was instrumental in rebranding the IST with a new logo and new-look journal. He continues to help manage the production of The Journal with the IST marketing team. Chris became an elected member of the Executive in May 2014 and serves as the IST Secretary.

E: c.p.smith@istonline.org.uk

Treasurer: Joan Ward FIScT

As Treasurer, Joan’s primarily role is to control expenditure on behalf of the Executive and be responsible for ensuring that satisfactory accounts of all monies received and expended are maintained. Further to this, Joan provides advice as to how annual financial performance might be improved, within the context of the IST being a not-for-profit organisation. She carries out any tasks agreed by the Executive to maximise overall financial wellbeing.

E: joanward@istonline.org.uk

Education Officer: Philippa Nobbs BA (hons), MCGI, CMIOSH, FIScT

As Education Officer, Philippa maintains knowledge of vocational training and qualifications for technical practitioners and participates in regional and national development programmes. She has a long history of involvement in the development and delivery of technician training and led the introduction of the IST’s service to employers to validate their in-house training schemes.

E: education@istonline.org.uk

Marketing Officer: Ian Moulson FIScT

As Marketing Officer, Ian looks at new and existing ways in which the IST markets itself to its members, prospective members, and the science and technology community. Ian is also the Editor of the IST's biannual publication 'The Journal' and is chair of its editorial panel, which oversees the quality of its articles and other content.

E: i.moulson@istonline.org.uk

Membership Development Officer: Kevin Oxley FIScT, CSci

As Membership Development Officer, Kevin develops strategies for membership engagement with the IST. His role further includes developing, managing and implementing a communication strategy for members. A key element of this is to identify opportunities to recruit new members and upgrade existing ones. Working alongside the Marketing Officer and PR Advisor, Kevin develops the implementation of recruitment and retention campaigns and promotes the benefits of membership to Higher Education institutions and industry.
E: k.m.oxley@istonline.org.uk

Registrar: Michelle Jackson BSc, PhD, FIScT, CSci

As Registrar, Michelle oversees the registration schemes run through the IST and contributes to the development of associated strategic and operational procedures.
E: michellejackson@istonline.org.uk

Fellowship & Overseas Secretary: Derek Sayers FIScT

As Fellowship & Overseas Secretary Derek coordinates the review of Fellowship applications, setting in place panels of other Fellows for peer review, and advises the Executive on the outcome of the reviews. He also maintains the documentation of those applications. Derek is point of contact for overseas inquiries for organisations wishing to work with the IST; he liaises with such organisations and reports back to the Executive.
E: dereksayers@istonline.org.uk

PR Advisor/Senior Assessor: Natalie Kennerley FIScT, CSci

As Public Relations Advisor, Natalie's role is to represent the IST at events, conferences, exhibitions, and open days. Planning PR campaigns, strategies, and writing and editing marketing material are all key aspects of this role. Natalie is a member of the IST Marketing Board. In her role as Senior Assessor, Natalie assesses applications for Registered Science Technician, Registered Scientist, and Chartered Scientist.
E: n.j.kennerley@istonline.org.uk

China Advisor/Representative: Geoffrey Howell MIScT, RSci

Geoffrey is a member of the IST Education Board and is one of the assessors for Professional Registration. His background is in technical training management, and he is now leading the first International HE technical training programme in China as part of an ongoing IST Project.
E: g.howell@istonline.org.uk

IST's Special Interest Groups

About our IST Special Interest Groups:

TMU, Technical Managers in Universities *(previously known as EMU, Engineering Managers in Universities)*, and **CHEM,** Chemistry Higher Education Managers *(previously known as UCLAS, University Chemistry Laboratory Administrators and Supervisors)* are two voluntary associations of technical managers and supervisors working within chemistry, technology, and engineering in support of a wide range of disciplines in universities throughout the United Kingdom. For both groups the broad term 'Technical Manager' encompasses a wide range of activities, employment categories and job titles in HEIs. But such a person will normally have some responsibility for managing technical resources such as a technical service, a facility, a workshop, or a laboratory that provides support to academic teaching and/or research. This technical support can be in and across any of the enormously diverse range of disciplines found in universities.

The aims of the TMU & CHEM Associations are:

- To foster a corporate and collegiate spirit across its membership
- To enable sharing of best practice
- To add to individual and corporate knowledge
- To broaden understanding of the profession
- To act as a focus for feeding legitimate and common concerns with respect to their support for teaching and research in Higher Education Institutions (HEIs) to the Institute of Science and Technology, of which TMU and CHEM are registered Special Interest Groups

For more information contact:
CHEM - Harry Adams, E: h.adams@sheffield.ac.uk
TMU – Geoff Howell, E: g.howell@sheffield.ac.uk
IST Office – Wendy Mason, E: office@istonline.org.uk

The Institute of Science & Technology

Leading Your Technical Team

The Leading Your Technical Team Programme Set
LYTT - Leading Your Technical Team
BYLS - Building on Your Leadership Skills

The Leading Your Technical Team programme set of **Leading Your Technical Team** and **Building on Your Leadership Skills** is geared toward delivering the fundamental and key skill elements for leading and managing people, particularly in a technical team.

The nature of technical support in many universities and higher education colleges is changing. Technicians have become both increasingly specialised and also high impact in terms of directly supporting teaching, research or infrastructure. Recent surveys have shown that high quality technical support is now seen as essential in delivering a high value student experience and quality research.

For many universities one of the key challenges is how to effectively channel, develop and manage their highly valuable technical resource. Increasingly, what has been highlighted when realigning and grouping together technical support is the need to prepare and train technicians to manage, and above all, lead technical teams. We have designed the Leading Your Technical Team programme set to meet this need.

Both LYTT and BYLS are delivered in the context of a higher education technical environment but they are not aimed at any specific job role or discipline. Our participants come from a very broad range of higher education institutions, and from a very diverse range of academic disciplines and departments or service sections. For example our recent courses have included people from institutions such as Glasgow Caledonian University, University of Leeds, University of Oxford, Canterbury College, University of Bristol, University College Cork, and Norwich University College of Arts to name but a few. Similarly our participants also have a wide variety of job roles. These ranging for example from Technician, Senior Technician, Laboratory Manager, IT Network Team Leader, Workshop Manager, Geological Facilities Manager, Textile Workshop Manager and Bio-repository Manager.

Leading Your Technical Team has a long and well respected history. It has been running for 30 years with more than 1,200 technicians having been through the programme over this time.
The programme content has continued to adapt and develop in line with changes in HE and it continues to be held in very high regard by HE senior managers and staff developers. Its high reputation is maintained through delivering a very high standard of technical management training via experienced HE managers, in a practical context with the reality of managing in a university technical environment.

How the programme works: Both programme follow a similar format, in that the learning is enhanced through informal and highly participative sessions that include active discussion, exchange of ideas and delegate group work. There is no role playing.

There are a strictly limited number of places and applicants are advised to apply early in order to secure a place.

Leading Your Technical Team

Specific programme goals

The programme introduces the fundamental building blocks of management and leadership specifically in the context of technical support in universities and higher education colleges. It provides an opportunity to look at the practical challenges of managing and supervising technical staff from both academic and service areas, as well as examining a range of essential management and leadership skills and techniques. The programme links practical leadership theories to dynamic team leading in context with the reality of managing in a technical university environment.

By the end of the programme participants will have:

- Identified the main management/leadership/supervisory skills required of them within their own working environment.
- Gained information on key issues, changes in higher education and current initiatives and developments which affect technical staff.
- Reflected upon the practices and processes affecting management and leadership in technical units, sections and departments.
- Practised a number of leadership and management skills and identified ways to develop these skills further.
- Had an opportunity to share with presenters and fellow participants from a wide number of universities and higher education colleges, their views, experiences, expertise etc.

Content

The programme will cover topics including:

- Key issues - roles and responsibilities.
- Management v leadership.
- Motivation and delegation - individuals and team.
- Communication skills & team briefing.
- Influencing skills and analysing your network.
- Managing and leading your team through change.
- People management issues & case studies.
- Positive team leadership

Who should attend

This programme is intended for chief/ principal/ senior technicians, laboratory/ workshop/unit managers, recently appointed departmental superintendents or senior colleagues from UK universities and colleges, who might now or in the future, have managerial or supervisory responsibilities and are interested in developing their fundamental management/leadership skills. The programme content will be delivered within the context of working in an university environment and will be applicable to support staff from academic and service areas. It is most important that participants are, wherever possible, residential and therefore available to attend the programme throughout.

Building on Your Leadership Skills

Specific programme goals

The programme builds on the fundamentals learned in Leading Your Technical Team and provides a further opportunity to look at the practical challenges of managing or supervising technical staff from both academic and service areas, as well as examining a range of essential management and leadership skills and techniques. The programme again links practical leadership theories to dynamic team leading in context with the reality of managing in a technical university environment. The programme content incorporates a range of topics that were suggested by attendees on Leading Your Technical Team as areas that they would most like to explore further, e.g. Managing Staff Performance, Dealing with Difficult People and Influencing Skills. Toward the end of the programme we begin to explore the topic of Leadership Intelligences, which introduces you to themes covered in greater depth in more advanced leadership programmes.

By the end of the programme participants will know how to:

- Lead and motivate by identifying the key skills and characteristics of successful leaders and to develop the key people management skills you need to ensure success.
- Improve performance through developing personal strategies for enhancing the effectiveness of your team by using flexibility across the leadership styles.
- Manage performance through developing your team's strengths by setting and reaching both personal and team objectives using delegation and leadership skills.
- Lead a team made up of different personalities and encourage mutual respect and cooperation from all team members and understand how to overcome barriers to communication.
- Work with difficult people through resolving conflict and dealing with difficult people and situations confidently and positively.
- Understand yourself, your influencing environment and your impact and to develop multidirectional influencing skills and an influencing strategy.

Content

The programme will cover topics including:

- Leadership & motivation - The differences of motivation, influence and manipulation.
- Managing performance – Where and when to improve team and/or individuals performance.
- Working with difficult people - How to take control & case studies.
- Influencing - Influencing teams & influencing individuals.
- Leadership intelligences - Personality based leadership, leadership and team performance.

Who should attend

This programme is particularly suited to people who have completed Leading Your Technical Team or those who have previously attended similar programmes and have a few years' experience in a technical managerial or supervisory role and want to further develop their management/leadership skills. The programme content will be delivered within the context of working in a university environment and will be applicable to support staff from academic and service areas. It is most important that participants are, wherever possible, residential and therefore available to attend the programme throughout.

Previous course feedback

Leading Your Technical Team

'I have learned more about the supervisory skills that I require in my job, how to develop these skills and especially in the way I communicate to other members of staff. I really enjoyed sharing views and experiences with fellow participants from other universities.'

'The course was run in a relaxed and informal manner, at the same time being really informative which led to an interesting and useful experience.'

'This course is well structured and presented. It thought me to look at my management technique and to focus my efforts on areas where I can succeed'

'Good course that hits a lot of the main areas and interesting areas regarding management and team leadership. It's motivational to the point that you return to work with more ideas and your own motivation to tackle day to day leadership.'

'For me the course was a positive experience and directly related to my day to day working life.'

'It was useful to find that many people are in the same position with the same worries and the programme provided useful information on dealing with many of our issues.

Building on Your Leadership Skills

'A Different way of looking at the way I respond to my team to improve all our performances. A way of understanding the individual members of my team. A chance to discuss with people from different institutions and areas of work how they deal with difficult members of their teams.'

'Felt I came away from the course feeling better about being a team leader and focusing on management issues.'

'A fun and informative way of helping me explore my leadership skills and how they affect my team.'

'The course was very informative and inspirational with lots of ideas and discussions throughout the sessions. A very useful programme delivered in a fun relaxed environment.'

'A very relaxed and informative course with like-minded delegates; the course was inclusive and challenged delegate with thought provoking ideas and concepts.'

'Interaction and problems experienced between people across the HE spectrum away from your place of work is of great value and should not be forgotten. In-house training is not necessarily the way forward.'

The Leading Your Technical Team Programme Set

LYTT - Leading Your Technical Team
BYLS - Building on Your Leadership Skills

2016 Pogramme Dates and Cost:

Leading Your Technical Team

Date: 11th &12th Febuary 2016

Times: Start 09.30 close at 16.00 Day Two
Venue: TBC, please contact Wendy
T: 0114 276 3197
E: office@istonline.org.uk

Building on Your Leadership Skills

Date: 10th &11th March 2016

Times: Start 09.30 close at 16.00 Day Two
Venue: TBC, please contact Wendy
T: 0114 276 3197
E: office@istonline.org.uk

Cost:

£500 IST Members - Residential fees are inclusive of all meals and one night's en suite accommodation
£570 (Non IST members) - Residential fees are inclusive of all meals and one night's en suite accommodation
Extra night accommodation £89

Additional dates, bespoke courses:

We would be happy to discuss running these courses at your host instituion or at a suitable venue, if a number of attendees from a single institution wish to undertake the courses. Please contact Wendy Mason.
T: 0114 276 3197
E: office@istonline.org.uk

Presenter profiles

Kevin Oxley

Kevin is the Programme Director for the LYTT & BYLS courses, which are now run through the Institute of Science & Technology (IST). He is the departmental manager of the Department of Infection & Immunity within the Medical School at the University of Sheffield. He began his career at Sheffield as a trainee Medical Laboratory Scientific Officer over 30 year ago and has subsequently experienced a series of diverse technical roles within the School. Over the last 10 years he has undertaken a range of senior managerial positions, leading technical and support staff teams, under various administrations and has been involved with small and large project teams across the University. As well as helping to redesign and co-deliver the LYTT & BYLS programmes from 2010 Kevin is also actively involved in both promoting and delivering staff development and training at Sheffield.

Lisa Woods

Lisa has significant experience managing large teams in both private and public sector organisations. After graduating from Loughborough University she worked for airport operator BAAplc in a variety of operational, change management and training roles across all the London airports. Whilst with BAA she also gained her MBA from the University of Surrey. In 2000 Lisa moved with her family to the USA where she undertook volunteer work which included the American Red Cross and the Small Business Administration in Texas. Lisa joined the University of Sheffield in 2005 and currently manages a team of 400+ staff in her role as Head of Campus Services.

Ian Moulson

Before his retirement in December 2013 Ian was the departmental manager of the Department of E ectronic and E ectrical E gineering at the University of Sheffield. He was at Sheffield for 40 years, beginning his career there as an electronics technician following a number of years in the electronics industry and an electrical engineering apprenticeship in the steel industry. Throughout his career Ian built up a wealth of experience in managing a diverse range of support staff teams. He has managed technical teams ranging in size from 2 to 40 people as well as small to medium sized administrative and managerial teams. For many years Ian has been actively involved in both promoting and delivering technical training at Sheffield and also more widely since 2002 through the Leading Your Technical Team programmes.

To book a place on either of these programmes please contact:

Wendy Mason,
LYTT & BYLS Programme Administrator

T: 0114 276 3197
E: office@istonline.org.uk

Promote your business with the IST

Advertising in the journal offers a cost-effective method of reaching the specialist technical community.

The Institute of Science & Technology's bi-annual Journal is a practically focused high quality publication, aimed at all levels of the technical and specialist community, who work in a wide and diverse number of areas. These areas range through industry, business, and education disciplines, from science labs and engineering facilities to recording studios and IT departments. Its main focus is the opportunity to keep our members, and also the very many other colleagues in the wider community of professional technicians who read it, informed.

The IST is an international organisation with members from across the UK and Europe, South America, Africa, Malaysia, and Australia.

We strive to help industry, business and education to maintain and grow the quality of their technical staff, and help them to keep up with constant advances in science and technology.

The Journal offers an ideal opportunity for suppliers of services to industry, business, and education disciplines to promote their products, develop new contacts, and reinforce existing relationships. Suppliers and manufacturers are much more likely to reach the people who are directly using their services and products through the IST and its Journal.

Advertisement opportunities 2015/16

1 insertion
Full page colour: £800 / mono £700
1/2 page colour: £600 / mono £500
1/4 page colour: £350 / mono £250
Double Page Spread = 2 x Full page rates

(Corporate Affiliates receive a discount of 10%)

Artwork needs to be CMYK and a 300dpi jpeg or a print ready PDF with the following dimensions (mm)

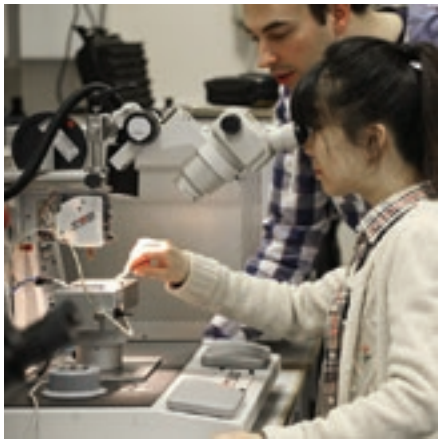
Full page
Artwork: 267 x 180
Trim: 297 x 210
Bleed: 303 x 216

1/2 page (Vertical)
Artwork: 267 x 75
Trim: 297 x 105
Bleed: 303 x 111

1/2 page (Horizontal)
Artwork: 118.5 x 180
Trim: 148.5 x 210
Bleed: 154.5 x 216

1/4 page
Artwork: 118.5 x 75
Trim: 148.5 x 105
Bleed: 154.5 x 111

Double page spread
Artwork: 267 x 390
Trim: 297 x 420
Bleed: 303 x 426



The Official Journal of The Institute of Science & Technology

The Professional Body for Specialist, Technical and Managerial Staff

ISSN 2040-1868

Kingfisher House, 90 Rockingham Street
Sheffield S1 4EB

T: 0114 276 3197 office@istonline.org.uk
F: 0114 272 6354 www.istonline.org.uk