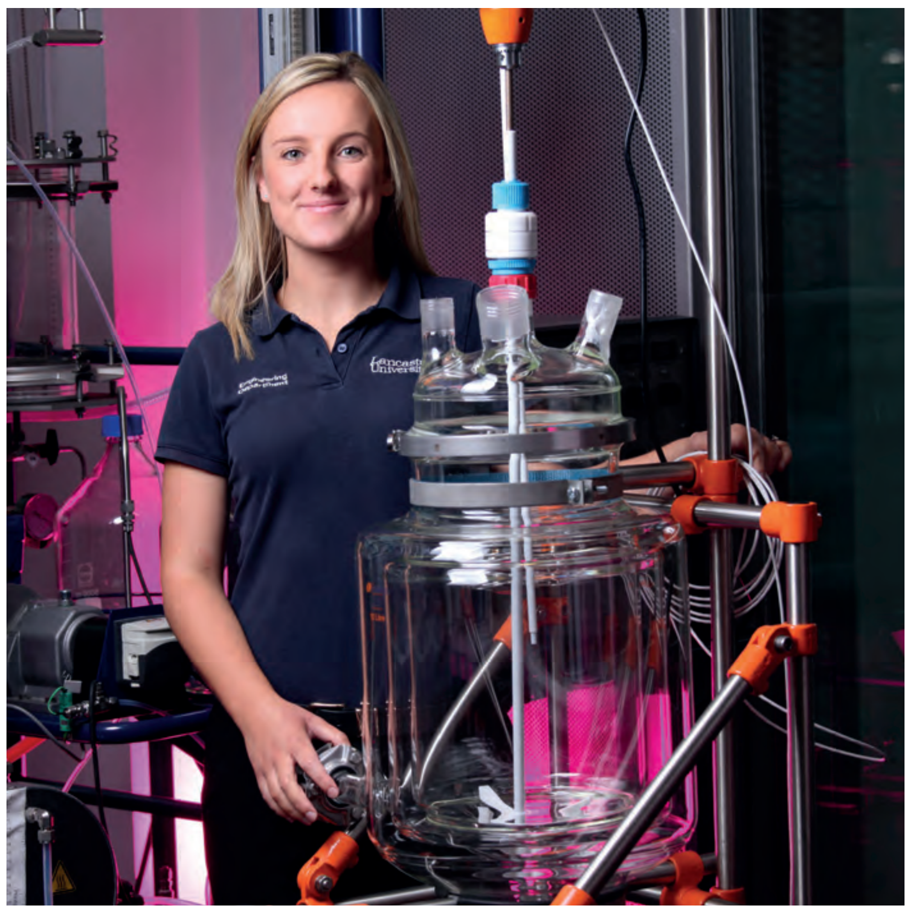
Earth sciences Biomedical Materials Criminology Physical sciences Interdisciplinary Engineering Applied science Marine biology Food Technology Graphic design Chemistry Forensics Software Textiles Technology



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The Official Journal of the Institute of Science & Technology

The Professional Body for Specialist, Technical and Managerial Staff

ISSN 2040-1868

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The Institute of Science & Technology

The Professional Body for Technical, Specialist, and Managerial Staff

Earth sciences Biomedical Materials Criminology Physical sciences Interdisciplinary Engineering Applied science Marine biology Food Technology Graphic design Chemistry Forensics Software Textiles Technology

The Journal

Spring/Summer 2019

Contents

Cover images credit: Technicians Make it Happen For more information go to: technicians.org.uk

The Journal

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Editor's welcome

Welcome to the 2019 spring/summer edition of the IST Journal.

Ian Moulson FIScT IST Vice President

Thanks go to our contributing authors.
In this edition we feature an array of excellent articles, for example a really interesting one by Tim Sandle that examines what makes for bad science and contrasts this with some examples of good science. The article also looks at what makes for a good science paper, and provides advice for those wishing to try their hand at writing a science article.

Sumant Gadge tells us about his vision and future of infusion devices, Raffaele Conte describes the analysis of volatile organic compounds, and Kevin Fletcher continues his series by looking at cognitivist theories. Alan Gall gives us an insight into the history of pharmacist Philip Harris and the company he created, and in his "From the Archives" series he tells us about the misfortunes of John William Bell.

Russell Parry relates his fascinating story of the Appley Bridge meteorite while, in a two-part series, Paul Marshall looks at making old television technology make sense.

Lastly but not least Kate Dixon tells us about how "Technicians Make it Happen" at Manchester Metropolitan University.

We would love to hear about you and your technician journey, or your work, or your interests – so please do get in touch and tell us about it.

This year we are holding our conference in Birmingham. Take a look at our website for more details **istonline.org.uk/ist-conference-19-18th-september-birmingham/**

And save the date:

IST One-day Technical Conference 2019
Birmingham Conference and Events Centre
Wednesday 18th September 2019

Back issues (from 2006) of our bi-annual publication of The Journal have now been converted so that they are viewable online in pdf format. Some of the files are quite large, so calling up individual Journals may take a minute or two to load. See our web page **istonline.org.uk/resources/ist-journal-publication/**

If you are interested in publishing in our Journal or in our blog articles section we would be happy to hear from you; please email **office@istonline.org.uk**

Our e-Newsletter has had a change … tell us what you think and contribute to future editions. Take a minute to check out the new look of IST's regular e-Newsletter and get up to date news of what is happening in the technician community. Subscribe free at **istonline.org.uk** and follow the links to a series of periodic newsletters that we generate quarterly – please feel free to browse our newsletters and see what we have been doing and what we have planned for the near future.

We are happy to include short articles and news items in the IST's e-Newsletter that you feel would be of interest to the technical community, or if you would like to promote a technician event, or advertise a job vacancy. Please do get in touch with any of the newsletter's editors below, or through our IST Office. E: **office@istonline.org.uk**

e-Newsletter Editors

John-Paul Ashton j.p.ashton@istonline.org.uk

Natalie Kennerley n.j.kennerley@istonline.org.uk

Kevin Oxley k.m.oxley@istonline.org.uk

Twitter (@istonline) – we encourage ideas, feedback, and discussions using #istforum

Ian

Chairman's view

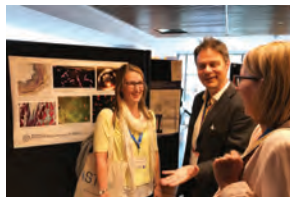
Terry Croft, MBE, FIScT, CSci, IST Chairman

Hello and welcome to the spring/summer version of The Journal.

Since the last journal edition, the IST and our valued volunteers have been up and down the country both promoting the Technician Commitment Initiative, keeping our members up to speed with the rapidly changing environments that we work in and supporting members on completing professional registration opportunities. We have also made changes to our e-newsletter and I encourage all our members to take advantage of publishing their work in future e-newsletter and journal publications.

This work has been well received and has brought about (positive) change by increasing visibility and allowing more recognition for vital technical skills. It is also evident that steps are being taken in the right direction to provide career development opportunities as well as sustainability for technical jobs across the Higher Education sector.

As we are starting to approach early summer I am pleased to announce the team has been working hard to deliver yet another exciting conference this September. Not only will our president Helen be chairing the day's events, but she will also be giving an inspiring workshop on astronaut training and maintaining CPD. Please do book your place as soon as possible, as we had to disappoint a large number of technicians last year due to venue capacity limits. This year we have increased the venue capacity to over 300 attendees, to let even more people attend, but please secure your place now as it is a popular event. You can find out more information at: **istonline.org.uk/ist-conference-2019/.**



To ensure a broad perspective of members views we are working on our future strategy and marketing options to improve the visibility and support for our members from the whole of the IST community. We have met already with our board, co-opted members and advisors, who represent working technicians, specialists and technical managers from across the UK and representing all disciplines from arts, media and digital, to science engineering and medicine. We are reviewing and making recommendations to improving the support and benefits of being a member of your professional body.

I would like to personally thank Joan Ward and John-Paul Ashton for their work on updating and developing our website. We are keen to ensure that our website provides our members with resources necessary for their careers – if you have any suggestions, opinions or would just like to tell us what you think about the website then feel free to contact Wendy at the IST Office.

Our work with our official nominated charity WorkFit and the National Laboratory Service is continuing to make progress on working towards a bespoke laboratory qualification for people with Down's Syndrome. My thanks go out to James Trout and Philippa Nobbs for their efforts on this.

I want to also extend my thanks to the editors and contributors of the Journal, who have worked hard to ensure the content remains relevant and useful for our members.

If you wish to play an active role in your professional body please contact me at **t.croft@istonline.org.uk**.

We would like to give members the opportunity to work with and influence the executive but also gain experience and benefits from opportunities to develop current and new skills. I encourage you to really get involved and contribute to your community.

Once again, many thanks to all our volunteers and our members who make the IST what it is today.

all the best,
Terry.

President's view

Helen Sharman
OBE, FRSC, FIScT

As I write, news about Brexit being postponed until the end of October is coming in. Hopefully this means lab supplies will be included in any deal but if not, you have a bit more time to make sure you have what you need.

Spring is in the air again and the IST has been thinking about how best to support members and the technical community at large. On 15 February, the IST held an event specially designed for technical managers and their staff working in the arts, media and digital fields, to enable them to input into a framework to support professional registration. I am told that talks were interesting and informative; of course, some of the development requirements of technicians are quite specific to the area of expertise but the IST will be able to use the synergy of the knowledge, skills, and needs of a wide range of technical staff to benefit everyone.

The IST is proud to continue its partnership with the National Technician Development Centre (NTDC), which is going from strength to strength, having just celebrated one year since its official opening. The Centre is a one-stop shop, providing universities and other research organisations with access to information, expertise and a range of research and tools (including the nationally recognised TDM Toolkit) specifically designed to support the delivery of high-quality technical services across all areas including Arts, Science, Engineering or Medicine. A sign of how important the country perceives its technicians and technical skills base to be, is the investment of £546,000 into the NTDC by the former Higher Education Funding Council for England (HEFCE), now Office for Students. You (or your manager – do pass this on!) can find out more information about the work of the National Technician Development Centre at their website on **nationaltechnicianscentre.ac.uk.**

Talking about technical development, spring is a good time to freshen up skills with something new. Rather than wait for a review by your manager, why not take a moment to think about what would make you better at your job now, and what would make you more fulfilled? The IST provides a range of courses and ways to recognise technical skills and development for people wanting specific skills training as well as for those more interested in leadership and management. Courses and advice for the Higher Diploma, Professional Registration or Leading Your Technical Team Programme and others can all be found on the website.

I would urge members to let the IST know what issues they foresee with Brexit for their work and workplace. Please send your comments on this subject to JP (**j.p.ashton@istonline.org.uk**) or Kirsty (**k.parkin@istonline.org.uk**).

So, enjoy springing into a new (or slightly modified) you and make sure you get the recognition you and the technical community deserve!

Best wishes,
Helen

IST Journal Publication

Back copies of our bi-annual journal publication are viewable online.

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

Article submissions for the IST Journal
The IST Journal is a quality biannual publication. Its style and content strongly reflect the IST's unique standing as a professional body that has an extremely diverse and vibrant technical membership.

The Journal's informal style offers an opportunity for our members and guests to freely present and publish articles, papers and news items that would be of interest to our readership's varying expertise and extremely broad subject range. We do try to encourage articles to be written with our diverse technical membership in mind.

We positively welcome article submissions from all and any areas of technical interest, including areas such as IT, media, medicine and the arts. We like to cover existing, historical and new technological advances, and also unusual aspects of science or technology.

We particularly want to encourage technical people to publish for the first time, as part of their career development, and we can offer help and assistance in putting a first article together.

Contact
IST office: **office@istonline.org.uk**

We can provide subscriptions for hard copies of our Journal, rates for 2019 are as below. For further details please contact **(office@istonline.org.uk)**:

UK – £25 per year (2 editions per year)
EU – £40 per year (2 editions per year)
Non EU – £55 per year (2 editions per year)

The guidelines for article submissions to the IST Journal are:

1. Article submission deadlines for 2019/2020
   - Autumn/Winter edition is 1st September.
   - Spring/Summer edition is 1st March.
2. Your article should be submitted electronically in Microsoft Word .doc format; with its images supplied separately as JPEG files (it is important that all your article images have a minimum resolution of 300dpi. Images embedded in a Microsoft Word document are not usually reproducible to the necessary print resolution).
3. Short articles: these can be any length up to roughly 2,000 words.
4. Major articles: these are normally no longer than roughly 6,000 words. We can only publish one or two major articles per edition. Larger articles may need to be accommodated across two or more editions.
5. All articles should be written in UK English. This is important as, depending on the content size and quality of English, they can take up a lot of editing time. Some can require extensive re-writing. We may have to decline very poorly translated articles.
6. Editing – we will edit all articles into the IST Journal's house-style, and may have to correct for spelling and grammar. Text layout and images may need to be changed, altered, or omitted. Pease see "IST Journal house-style" description on our web site. It will help enormously if your article follows this style as much as possible.
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 separate images sent with it as email file attachments.

New members and registrations

New members November 2018 – April 2019

Membership No.	Name	Grade
T8534	Prof G J Pilkington	FIScT
T16078	Dr S Reiff-Marganiec	MIScT
T16116	Mr N T Woodger	MIScT
T16117	Dr Pestinger	MIScT
T16118	Mrs F Lawal	AssocIScT
T16119	Mr L Metcalfe-Chase	MIScT
T16120	Mr N L Bickle	AssocIScT
T16121	Mr A W Elliott	AssocIScT
T16122	Dr S H Nggada	MIScT
T16123	Mr S J Callaghan	MIScT
T16124	Ms L Newton	MIScT
T16125	Ms J Hibbard	MIScT
T16126	Mrs J Kaur	MIScT
T16127	Mrs S Raza	MIScT
T16128	Miss A Edwards	MIScT
T16129	Mr L Gentle	AssocIScT
T16130	Mr B Robertson	MIScT
T16131	Mr A Namadi	MIScT
T16132	Dr I Sargent	MIScT
T16133	Dr S Williams	MIScT
T16134	Mr S A Abdullahi	MIScT
T16135	Mr J M Allred	AssocIScT
T16136	Mr I L Haruna	AssocIScT
T16137	Mrs C K Parsons	AssocIScT
T16138	Dr Y Y Wong	MIScT
T16139	Mr A R Lewis	MIScT
T16140	Mrs R L Hoare	MIScT
T16141	Dr B G Caswell	MIScT
T16142	Dr S Youde	MIScT
T16143	Ms C McCallum	MIScT
T16144	Mr M Jones	MIScT
T16145	Mrs J Grimstead	MIScT
T16146	Mr G A Abuh	MIScT
T16147	Mr A I Osuntoogun	MIScT
T16149	Mr M Bowkis	MIScT
T16150	Mr S H Ahmed	MIScT
T16151	Ms L J Tee	MIScT
T16152	Mr J S R De Saram	MIScT
T16153	Dr S Jones	MIScT
T16154	Dr Chanda	MIScT
T16155	Dr J H Sier	MIScT
T16156	Mr Y-L Chiu	MIScT
T16157	Dr T J King	MIScT
T16158	Prof L Bacon	FIScT
T16159	Dr N Beacham	MIScT
T16160	Prof T P Breckon	MIScT
T16161	Dr Harlow	MIScT

Membership No.	Name	Grade
T16162	Mrs D Roberts	MIScT
T16163	Mrs R J Williams	MIScT
T16164	Dr G Warren	MIScT
T16165	Mr M A Boyes	MIScT
T16166	Dr J D Stockton	MIScT
T16167	Mr R Aliyu	AssocIScT
T16168	Ms C M Davies	MIScT
T16169	Mr A Martin	MIScT
T16170	Mr L J D'Souza	MIScT
T16171	Dr E M Monaghan	MIScT
T16172	Miss N Aoudjane	MIScT
T16173	Dr G R Ribeiro-Justo	MIScT
T16174	Dr J G Hall CEng	MIScT
T16175	Ms J Newton	MIScT
T16176	Dr F Crawford	MIScT
T16177	Mr A A Olajide	MIScT
T16178	Mr G P Freegard	MIScT
T16179	Mr S Nader	MIScT
T16180	Dr J M Fox	MIScT
T16181	Mr H R Zolfagharinia	MIScT
T16182	Mr N Galvin	MIScT
T16183	Mr G Shaw	MIScT
T16184	Ms Y Suriel	MIScT
T16185	Mr D J C De La Haye	MIScT
T16186	Mr F S M Hollingsworth	MIScT
T16187	Mr J Davoll BA MRes	MIScT
T16188	Mr M A Robinson	MIScT
T16189	Mr A J Ladlow	MIScT
T16190	Miss A K Listeri	MIScT
T16191	EurIng Professor M Ross MBE	FIScT
T16192	Miss A Cobourne	MIScT
T16193	Mr T Roush	MIScT
T16194	Miss N L Franklin	MIScT
T16195	Ms M K Subair	AssocIScT
T16196	Mr Pineda	MIScT
T16197	Mrs B E King	MIScT
T16198	Dr U S Idachaba	MIScT
T16199	Dr C J Ireland	MIScT
T16200	Mrs J Critcher	MIScT
T16201	Mr M G Robinson	MIScT
T16202	Mr A Clough	MIScT
T16203	Mr W Daw	MIScT
T16204	Miss E Edwards	MIScT
T16205	Mr Gilbert	MIScT
T16206	Miss A Gledhill	MIScT
T16207	Ms L Lorenz	MIScT
T16208	Miss G L McKay	MIScT

Membership No.	Name	Grade
T16209	Mrs S Prestbury	MIScT
T16210	Mr R Walker	MIScT
T16211	Mr A Stead	MIScT
T16212	Mr J White	MIScT
T16213	Dr M Santamas	MIScT
T16214	Mr K Tanna	MIScT
T16215	Mr J Jack	MIScT

Total: 102

Science Council Registrations

Membership No.	Name	Grade
T14855	Mr S Franey	CSci
T15717	Mr S F Hale	CSci
T16078	Dr S Reiff-Marganiec	CSci
T16114	Mr P Ashford	CSci
T16122	Dr S Nggada	CSci
T16123	Mr S J Callaghan	CSci
T16132	Dr I Sargent	CSci
T16138	Dr Y Wong	CSci
T16139	Mr A Lewis	CSci
T16141	Dr B Caswell	CSci
T16142	Dr S Youde	CSci
T16144	Mr M Jones	CSci
T16145	Mrs J Grimstead	CSci
T16149	Mr M Bowkis	CSci
T16150	Mr S H Ahmed	CSci
T16153	Dr S Jones	CSci
T16154	Dr S Chanda	CSci
T16156	Mr Y Chiu	CSci
T16157	Dr T King	CSci
T16158	Prof L Bacon	CSci
T16159	Dr N Beacham	CSci
T16160	Prof T Breckon	CSci
T16161	Dr Harlow	CSci
T16162	Mrs D Roberts	CSci
T16173	Dr G R Ribeiro-Justo	CSci
T16174	Dr J Hall	CSci
T16181	Mr H R Zolfagharinia	CSci

Membership No.	Name	Grade
T16191	Prof M Ross MBE	CSci
T16198	Dr U S Idachaba	CSci
T16199	Dr C J Ireland	CSci
T15650	Ms M H Craigon	RSci
T15691	Mr K Bright	RSci
T15791	Mr R Cargill	RSci
T15977	Mr G Magro	RSci
T16034	Mr N French	RSci
T16040	Ms E Chapman	RSci
T16070	Ms R Garcia Vigo	RSci
T16124	Ms L Newton	RSci
T16125	Ms J Hibbard	RSci
T16164	Dr G Warren	RSci
T16172	Miss N Aoudjane	RSci
T16180	Dr J M Fox	RSci
T15267	Mr S Atkin	RSciTech
T15270	Mr T Templeman	RSciTech
T15991	Mr N Bethune	RSciTech
T16071	Mrs M Beck	RSciTech
T16076	Mr M Lovett	RSciTech
T16094	Dr B Kirby	RSciTech
T16133	Dr S Williams	RSciTech
T16143	Ms C McCallum	RSciTech
T16163	Mrs R J Williams	RSciTech
T16200	Mrs J Critcher	RSciTech

Total: 52

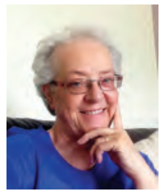
IST Organisation

Executive board

President: Helen Sharman CMG OBE FRSC FIScT
The main role of the President is to lead and guide the Institute in its strategic and operational development. Helen is ideally suited to this role having become the first British astronaut when she launched into space on board a Soyuz space craft on 18 May 1991. Helen graduated with a degree in chemistry from the University of Sheffield before working in industry. Following which she trained at the Yuri Gagarin Cosmonaut Training Centre in Star City near Moscow. Helen became a science communicator after her space flight, and 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.
E: office@istonline.org.uk

Chairman: Terry Croft MBE FIScT CSci
Terry is the Chairman of the IST. He is passionate about, and is committed to, the technical community. His work involves promoting the professionalisation of the technical workforce. He brings a wealth of experience to the board through his involvement with the wider sector and as Director of the first National Technician Development Centre for Higher Education.
E: t.croft@istonline.org.uk

Secretary & Public Relations Adviser: Natalie Kennerley FIScT CSci
Natalie became the IST Secretary in 2016, and has responsibility for ensuring that we comply with legislative requirements and that we maintain suitable official records. Natalie is also Public Relations Advisor, and in that role she represents the IST at events, conferences, exhibitions, and open days. Planning PR campaigns and strategies as well as writing and editing marketing material are also key. In addition, she is a Senior Assessor, assessing applications for Registered Science Technician, Registered Scientist, and Chartered Scientist.
E: n.j.kennerley@istonline.org.uk



Deputy Chair & Finance Officer: Joan Ward FIScT
Joan is Deputy Chair of the IST. As Finance Officer, 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 tasks agreed by the Executive to maximise overall financial wellbeing.
E: joanward@istonline.org.uk

Education Officer: Philippa Nobbs FIScT
As Education Officer, Philippa maintains knowledge of vocational training and qualifications for technical practitioners. She also participates in regional and national development programmes. Philippa 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

Membership Development Officer: Kevin Oxley FIScT CSci
As Membership Development Officer, Kevin develops strategies for membership engagement with the IST. Working alongside the Marketing Officer and PR Advisor, Kevin develops the implementation of recruitment and retention campaigns. He also promotes the benefits of membership to Higher Education institutions and industry. Kevin is also the Institute's Diversity Champion and works to ensure that the IST operates in line with the principles of diversity, equality, and inclusion, and to measure progress in that regard.
E: k.m.oxley@istonline.org.uk

Registrar & Marketing Officer: Michelle Jackson FIScT CSci
As Registrar, Michelle oversees the registration schemes run through the IST and contributes to the development of associated strategic and operational procedures. She liaises with the Science Council with respect to continuing development of the registration process and monitors all aspects of the IST registration and assessment processes. As Marketing Officer, Michelle looks at new and existing ways in which the IST markets itself to its members, prospective members, and the science and technology community. Michelle is the Deputy for the Faculty of Engineering's Director of Operations at the University of Sheffield with regard to technical resources, H&S and Infrastructure. She manages all aspects of these areas within the FoE alongside the Departmental Technical Managers and Departmental Safety Officers.
E: michellejackson@istonline.org.uk | E: marketing@istonline.org.uk

Executive support/advisors

Administrator: Wendy Mason
Wendy supports our memberships, registrations, committees and meetings, and manages the IST's office. She deals with all our general enquiries and helps to organise our events, visits, and conference. She also coordinates and supports training courses (eg. Leading Your Technical Team) and examinations (eg Higher Diploma).
E: office@istonline.org.uk

Executive Support Officer & Social Media Advisor: John-Paul Ashton MIScT RSci
John-Paul is an IST Executive Support Officer and also the IST's social media/engagement advisor. He works closely with the Executive to enhance engagement with the wider technical community helping the IST to develop its profile/presence across various marketing platforms including Twitter, Facebook, and LinkedIn. He is co-editor of the IST e-Newsletter and IST website. John-Paul has been part of the technical staff at the University of Sheffield since 2012. He has also worked in the healthcare industry for 12 years and is currently Operations and Recruitment Manager, responsible for company operations and over 50 staff whilst also regulating finance, writing quotes and medical plans for large scale events.
E: j.p.ashton@istonline.org.uk

Fellowship & Overseas Advisor: Derek Sayers FIScT FInstLM FRMS
As Fellowship & Overseas Advisor, 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 our point of contact for overseas inquiries from members and for organisations wishing to work with the IST; he liaises with such organisations and reports back to the Executive. Derek is a Vice President of the IST.
E: dereksayers@istonline.org.uk

Partnerships/Champions Coordinator: John Dwyer FIScT
John is co-ordinator for Partnerships/Champions. His role involves actively promoting professional registration for the IST throughout the UK: attending meetings, workshops, and conferences, and seeking champions for this cause at institutions nationally.
E: J.dwyer@istonline.org.uk

Industry Liaison/Advisor: James Trout FIScT CMgr RSci
James is the Laboratory Manager for the National Laboratory Site at Starcross in Devon. The NLS is a national service of the Environment Agency and provides analytical data for a range of sample types. James is a Chartered Manager and a Governor of Newton Abbot University Technical College. He will be helping the IST develop industrial links and promoting frameworks for professionalising science/technical staff working in that sector.
E: j.trout@istonline.org.uk

IST Archivist: Alan Gall BSc MSc MMath MInstP MRSC FIET FIScT CSci

Alan has been IST Archivist since 2004. Originally a laboratory assistant, he has worked in industries concerned with edible oils, food additives, polymer stabilisers, electroplating and explosives. He is currently a company director involved with magnetic materials, electrical engineering and general mechanical engineering. Contributions to the Journal began in 2003 with an article on the Manchester University technician William Alexander Kay. He has provided regular articles since then.

E: alangall@hotmail.com

IST Journal Editor: Ian Moulson FIScT

Ian has been editor of the IST's biannual publication "The Journal" since 2009. Before his retirement he was Departmental Manager of the Department of Electronic & Electrical Engineering at the University of Sheffield (UoS). His career at UoS spanned some 40 years, beginning there as an electronics technician following a number of years in the electronics industry and an electrical engineering apprenticeship in the steel industry. Ian developed technical knowledge across a diverse and wide range of engineering disciplines including electronic, electrical, control, computing, civil, mechanical, process, and materials engineering. Ian is a Vice President of the IST.

E: i.moulson@istonline.org.uk

IST Journal & e-Newsletter Assistant Editor: Kirsty Parkin

Kirsty is Assistant Editor for the IST Journal and IST e-Newsletter. She also works as a Research Support Officer for the National Technician Development Centre for Higher Education and studies business management with the Open University. Kirsty is also heavily involved with a local theatre company, doing production and stage management.

E: k.parkin@istonline.org.uk

Technical Advisor/Representative: Geoffrey Howell MIScT RSci

Geoff is a member of the IST Education Board and one of the assessors for professional registration. His background is the in the planning and management of technical training programmes. He is Chairman of the Technical Managers in Universities organisation (TMU).

E: g.howell@istonline.org.uk

Advisory boards

The Education Board – Chaired by Philippa Nobbs

- Ian Gray MIScT
- Melanie Hannah MIScT, RSci
- Geoff Howell MIScT RSci
- Michelle Jackson FIScT CSci
- Chris Pambou MIScT RSci

The Marketing Board – Chaired by Michelle Jackson

- John-Paul Ashton MIScT RSci
- Natalie Kennerley FIScT CSci
- Kevin Oxley FIScT CSci
- Joan Ward FIScT

The Editorial Board – Chaired by Ian Moulson

- John-Paul Ashton MIScT RSci
- Alan Gall FIScT, CSci (IST Archivist)
- Stephen Gamble MIScT, FIBMS
- Michelle Jackson FIScT, CSci
- Natalie Kennerley FIScT, CSci
- Kevin Oxley FIScT, CSci
- Kirsty Parkin (Assistant Editor)
- Joan Ward FIScT

IST Vice Presidents

- Maida Davidson FIScT
- Terry Evans MIScT
- Simon Fairnie FIScT
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How to switch "bad science" for "good science"? (and how to approach writing a science article)

Tim Sandle

Introduction

There are many excellent science studies based on well-designed experiments and which make reasoned claims based on the assembled experimental data. While the majority of scientific findings and papers issued each year offer valid findings and contribute to the body of knowledge, there are, unfortunately, many cases of "bad science" out there.

Another concern is that outcomes from science papers are sometimes misinterpreted or overly exaggerated by the media. This is perhaps reflective of society increasingly seeking quick answers. The reality of science is that progress is invariably slow, based on incremental findings, and occasional contradictions. As science blogger David Berreby has written: **"there are many experiments, some of which contradict each other, some of which don't reproduce or are reinterpreted to mean something other than what their originators intended. With three steps forward and two back and one sideways, usually, with serious people saying we're marching in the wrong direction, science moves along".[1]**

This article examines what makes for bad science and how bad science occurs, and then contrasts this with some examples of good science. The article also provides advice on what makes for a good science paper and for those wishing to try their hand at writing a science article, advice as to how to approach this is provided.

What is bad science?

There are multiple reasons for "bad science": poor research, poorly designed experiments, misconduct by researchers, and accidental or deliberate misinterpretation of data. Sometimes this is not the fault of the scientists, for the media can take a small observation or a statement that is written in a guarded way as a possibility, and turn this into established facts. A "cure for all types of cancer" is one of the most common (and misleading) headlines.

In another example, a few years ago Mother Jones featured a science article based around the idea "Gasoline lead is responsible for a good share of the rise and fall of violent crime over the past half century".[2] Now lead poisoning is a destructive neurotoxin, but as Julia Belluz critiqued it, were the scientists behind the research really claiming that economic factors, like unemployment; social factors, like the rise of gangs; and psychiatric factors were lesser reasons for violent crime?[3] This is probably unlikely, as reading the actual research reveals.

However, scientists themselves can be guilty of making bold and unsubstantiated claims based on relatively flimsy research. One problem is extrapolation, where an outcome is extended beyond what is reasonably credible. This can sometimes occur with experiments carried out on cells (in the metaphorical Petri dish). Here the results of these often small-scale studies are transmogrified into something that can affect the health and well-being of a human being.

Simply put, cell studies are not always good predictors for what will happen in a person. For example, if a study has found an antioxidant, extracted from blueberries, works on mouse cells in a laboratory, in terms of lowering the risk of cancerous cells forming, this doesn't mean that if a typical person suddenly sips blueberry juice each morning they won't develop cancer. There are many complexities with human physiology that a laboratory study cannot replicate.

In relation to this, some animal studies can act as good predictors of what might happen if a developmental drug product is administered into a human being (as set out by the American Physiological Society)[4]. Matters of safety are an example of where this is important (although something went tragically wrong in 2016 with safety checks in a recent clinical trial in France; here one person was rendered brain dead and later died).[5]

At other times, animal studies are not a good predictor for what will happen in people. A satisfactory test on a new drug on mice, for example, does not necessarily mean the same physiological or biochemical reaction will occur in a person. A study by Bracken, reviewing the usefulness of animal experiments, additionally noted from his review of scores of animal research: "many animal experiments are poorly designed, conducted and analysed".[6]

Then there are genetic, environmental and lifestyle factors. Considering again "miracle cures", taking a probiotic in a yoghurt, this might have a measurable benefit with one person but not with another. This is because the bacteria in the guts of these two people (the "microbiome") might differ significantly, allowing the probiotic organisms to work in the intestines of one person but not in another.[7] With lifestyle, someone could take as many vitamins as they like ("proven to work in a clinical trial") but if that person is a heavy tobacco smoker, the risks from smoking will outweigh any benefits from pill popping.

Good science needs to be repeatable. Sometimes claims made in journals cannot be replicated. One of the reasons for publishing scientific papers is so another qualified scientist can replicate the research. The experimental claims made don't always stack-up. One group from Stanford University attempted to reproduce the findings of 100 psychology papers. They only managed to achieve similar results for 39 of the studies, meaning that around 60% of the described studies were so poorly constructed they could not be proven.[8]

There are also risks with scientific data being biased. Questions of bias often arise when laboratory research is sponsored by a company with a vested interest in the outcome (such as the manufacturer of a medicine). In such circumstances, care needs to be taken when reviewing sponsored findings, even when interests are declared upfront (and if the declaration of interest has been obfuscated, a strong dose of scepticism is in order).

A darker side of "sponsorship", which occurred in 2015, was when several academics received an unsolicited marketing email from a research company called Cyagen (who produce transgenic mice and stem cells). According to medical doctor Ben Golacre, the email was headed "Rewards for your publications". In the message, Cyagen stated: "We are giving away $100 or more in rewards for citing us in your publication." It would seem that 164 scientists took up the offer.[9] There is no indication that this led to any biases or adding references that invalidated the research, but it does leave an unsavoury taste about the objectiveness of the referencing – at least.

Another reason for "bad science" is unintended and intended "errors". Back in 2012, the journal *Proceedings of the National Academy of Sciences* tallied up 2,047 recent retractions from journals. "Retraction" means a journal paper has been pulled because of an error. The review article found about 20% of the retractions were due to unintended errors (like a badly performed calculation, of the sort that should be picked up using statistical techniques like Benford's law – a law of anomalous numbers, first proposed in 1938). However, and more seriously, about 67% of the papers reviewed were retracted due to misconduct. Of these, 43% were due to deliberate fraud.[10]

A survey discussed in *The Atlantic* found that 2% of scientists openly admitted to having falsified data, and around one third confessed "a variety of other questionable research practices" including "dropping data points based on a gut feeling," or "changing the design, methodology or results of a study in response to pressures from a funding source".[11]

Why do this? The most common reason given was peer pressure or the tough competition for scientific jobs. In the science world, the merits of most scientists are judged on finding something remarkable and getting it published in a journal with a high impact factor (which basically means a few people actually read it and took notice).

One of the most serious cases of falsified data occurred in 2014 (with a conviction made in 2015). Researcher Dr. Dong Pyou Han was imprisoned for 57 months for making misleading claims in relation to research on the HIV, where he made out he had created a vaccine for AIDS. His research was funded by the U.S. National Institutes for Health to the tune of over $7 million. For several years Dr. Han was successful in convincing top-notch scientists and research grant awarders that his experiments were legitimate. In reality he was passing off adulterated samples of rabbit blood.[12]

Sometimes a single journal is faced with the ignominy of retracting papers. In 2015, an article reported that a major British science journal called BioMed Central was forced to retract 43 papers due to evidence of faked peer review. Each of the papers was written by scientists and medics based in China.[13]

Another area of risk to scientific validity comes in the form of e-journals. The digital age has seen a range of new "science journals" appear. These are sometimes referred to as "predatory journals", seeking out scientists to write for them and charging the scientists for the privilege. The robustness of the review process is often questionable or non-existent. The idea that they are "predatory" is based on the view that academics are tricked into publishing with them.[14]

In one example of the loose quality control surrounding "predatory journals", one scientist succeeded, with minimum effort, in tricking four publications into accepting a made-up paper about midi-chlorians (the fictional life forms in Star Wars that, at least in the prequels, give "force" users their powers). The researcher even used the false name Dr Lucas McGeorge as the author of the paper. One of the four journals, the *American Journal of Medical and Biological Research*, accepted the paper and demanded a $360 fee to publish it.[15]

The second area is about some journals being potentially open to influence in terms of receiving external funding. This issue has been taken up by researcher Jason Fung. Fung has written an article on Medium, presenting data that shows how some medical journal editors are paid huge sums by pharmaceutical companies each year.[16]

This follows on from a paper that was published in the *British Medical Journal* in 2017 ("Payments by US pharmaceutical and medical device manufacturers to US medical journal editors: retrospective observational study"). The paper looked into how much funding editors of some of the most influential medical journals were receiving from industry sources. This review noted that 50.6% of editors had received money from the pharmaceutical industry, with the sums extending to hundreds of thousands of dollars in some instances. The research showed that the mean general payment was $28,136 and the highest payments went to the subject areas of endocrinology, cardiology, gastroenterology, rheumatology and urology.[17]

This type of practice matters, according to McDonald, because some journal editors could be persuaded to print research that supports products from the companies that are providing the funding. More concerningly, this could lead to ignoring some of the evidence that might go against the products themselves. Even where everything is above board, there is a risk that the general public will be less convinced with research findings about, say a medicine, where payments have been made by the very company that developed the drug in the first place.

How to spot "bad science"

There are many other examples of "bad science". While many of the findings are legitimate it is worth maintaining an air of scepticism. Here is a checklist for spotting "bad science":

1. Misinterpreted findings: many research briefs and press releases misinterpret findings and journalists can do so as well. Science journalists should strive to provide a link to the original research paper, so readers can check facts for themselves.

2. Correlation and causation: this is a big problem of misinterpretation. Because A influences B in an experiment, does not mean A causes B to happen. There are often other factors at play.

3. Replication: can the results of the study be replicated? Has a different research group attempted this, and, if so, what did they find? If a different conclusion was reached, this undermines the original claims.

4. Unrepresentative subjects: how many test subjects were used and whether they were representative of the general population as a whole is important. For instance, a study carried out in Poland using women aged 40-50 years may not be applicable to teenagers living in Utah. In relation, it is important to note the sample size. A study involving 1000 test subjects will be more robust than one including just 25 people or animals.

5. Failure to use a control group: studies where experimental drug A has not been compared with a placebo are often unreliable. This is because it is unknown whether the results obtained are due to the drug itself or simply to chance.

6. Selective data: it is important to note if all of the experimental data has been used for the data analysis. Sometimes scientist excluded the odd data point for good reason (such as a contaminated test tube). But have they declared what and why? Related to this, literature-based papers can sometimes "cherry-pick" certain evidence in order to prove a certain perspective while ignoring another.

7. Blind testing: linked to controls, in ideal experiments, subjects should not know which drug they have been give – the experimental one or a placebo.

8. Sensationalised headlines: like the "cure for all cancers." A good headline should entice the reader in, but it shouldn't mislead or over-simplify the findings.

9. Conclusions: linked to the headline, does the conclusion made actually reflect the data. Sometimes conclusions made in papers are not supported by the actually data gathered.

10. Conflicts of interest: has any company sponsored the study and why? And most importantly, has this been declared?

11. Peer review: has the study been published in a reputable peer reviewed journal? Sometimes this doesn't guarantee a solid and reliable piece of science, but in many cases it does. Certainly, non-peer reviewed studies should be regarded with caution – if the scientists behind the study are confident as to its reliability, then why not send it for peer review?

Science scams

As well as intentional or unintentional bad science, there are also, occasionally, science scams. Sometimes this is the case of "Chinese whispers," where one journalist misinterprets a story and others repeat it; another way is when false information is put out to see how many journalists run with it. Here caution is required.

One classic example is with an invented material called "boimate." The foodstuff was said to be a mix of tomatoes and beef, put out as a joke by *New Scientist*. The story about the food was run by several reputable periodicals. Another scam is with fake journals, with slightly misspelled names.

A more recent example was the hoax that chocolate was good for your health. This was invented by John Bohannon, who set up a fake open access journal and website. The aim was to see how many websites and magazines ran with the story, without critically appraising it.[18]

What makes for good science?

To begin with, what is good science? Good science is based on examination of empirical or measurable evidence, with the findings subject to specific principles of reasoning (in essence, the "scientific method" first proposed by Issac Newton in 1726).[19] This is where disciplines masquerading as science fall foul. Here belief-systems like homeopathy and chiropractic cannot be said to be "sciences"; they are pseudoscientific in that they are presented as scientific but they do not adhere to evidence-based studies. These should be given a wide berth.

Good science draws a distinction between facts, theories, truths and opinions. A fact is something generally accepted as "reality" (although still open to investigation); it contrasts with "the absolute truth," which is not science as it cannot be challenged. A theory is based on an objective consideration of evidence, and is different to an opinion. An opinion is subjective. For example (using a fictitious person called Fred):

- To say Fred is an affable person is an opinion;
- If Fred says if he drops his glass on the floor it will break is a theory; although one which can be tested by the glass being dropped multiple times onto different surfaces to see how often it breaks, and whether this is more likely with concrete or carpet;
- If Fred jumps from a diving board, he predicts he will fall downwards into the water due to gravity. This statement is a fact and a theory, something with a high probability of being correct, and based on scores of research dating back to Isaac Newton.

To produce good science a "good scientist" is required. A good scientist is not simply someone who has studied a scientific subject and who is keen to learn. A good scientist will always have about them a degree of uncertainty and will be prepared to question, and acknowledge there is always something to learn. A good scientist will never claim to know all there is to know about his or her subject.

The foundation of good science is independent research. There are signs that this is becoming more commonplace. As to why this is necessary, the *British Medical Journal* found 97% of studies sponsored by a company delivered results in favour of the sponsor.[20] By declaring interests up front, a degree of assurance prefixes the study.

Where the results of a scientific study can be closely scrutinized, researchers are more likely to be surer of their findings and less willing to present weak research. A recent trend in the scientific world has been towards open access. This is where science papers are made available for any person to read for free and not hidden behind a pay wall. Accessing a journal that requires an upfront payment isn't cheap and if you want to look at several papers, this starts to go beyond the reach of most people. Not all journals have adopted the open access model, although more are doing so. This can only be encouraged.

Linked to open access, and this is still not as common as it should be, is open access to the experimental data. Many medical doctors, for example, work with evidence-based medicine. Not to be able to see the full-set of results from a clinical trial hampers their assessment of a drug's efficacy. To some commentators, like Goldacre, the biggest culprits remain pharmaceutical companies[21]; although government run health and science agencies have become much better in recent years. To help push through access to clinical trial data, a campaign website has been set up. Called "All Trials" (**http://www.alltrials.net/**), the site has succeeded in convincing some journals to only accept papers where there is full disclosure of data. To encourage more openness, the site also carries a petition (**http://www.alltrials.net/petition/**).

Another area to improve findings is with ensuring that research papers, which undertake "systematic reviews", are sufficiently wide ranging in their scope.[22] Some literature reviews cherry-pick certain facts and figures to suit an argument. The better review articles consider and use a range of databases and assess all of the literature on a given subject. For example, a review of Czech studies on mouse models of cancer would not be as comprehensive as a review of cancer cases in animals and humans in all of Europe.

Science journalists can also do better. The perennial problem for the science journalist is "how can I sum up this topic in just one or two sentences that will make audiences want to read more?" Sometimes the scientist behind the research will like this and enjoy seeing their ideas reaching a large audience. At other times, the scientists might be thinking: "how dare you try and reduce a body of research into a shallow soundbite?" Science journalists must try to present the facts; avoid exaggeration; but also engage their audience.

To close out, just as the previous article concluded with a checklist for spotting bad science, this article ends with the foundations of "good science":

1. Good science starts with a question worthy of answering.

2. This question should lead into some research, to look at what has been studied before. Research should always build-up on what has gone before. Scientifically recognized mechanisms should be employed.

3. Research should use natural mechanisms. There is no recorded case of where a non-natural explanation has proved scientifically useful. For example, a study that looked into drinking 30 cans of Coke in 10 minutes concluded it made people feel ill. This would be something that has strayed well away from what might really happen in society.

4. From the question, a hypothesis should be generated upfront. For example, "smoking tobacco does not cause cancer". Having set this, scientists would then go off to prove whether or not this hypothesis is true or false.

5. The best hypotheses lead to predictions that can be tested in various ways. Based on the recommendations of the philosopher Karl Popper and his theory of "falsifiability", these predictions should be tested experimentally; and the experiment should attempt to disprove the assumption rather than prove it.[23] So, with the cancer example, scientists would attempt to investigate the question "smoking tobacco does not cause cancer" by trying to prove that it does (and if the question had been the other way around, the scientists would be attempting to prove smoking does not cause cancer.)

6. Similarly, the research should be free of dubious assumptions.

7. Having gone through these though-processes the experiment should then be designed. Asking questions like: how much data will be needed? For how long will the experiment run for?

8. Where test subjects are used, the subjects — especially people — should be representative of the larger population that the results are intended to apply to. Note should be made of gender and demographic differences.

9. When an experiment is run, there should be controls. In a chemical study this might be something known not to react; in clinical trials, this will be the inclusion of placebo. For human research studies, the gold standard is a randomized control trial (this is a type of study where the scientist randomly assigns participants to either receive the treatment/exposure or not, and is ideally unaware which participants are receiving the treatment).

10. Good experiments are repeated many times, and the results subject to a robust statistical analysis. If an experiment cannot be repeated to produce the same results, this implies that the original results might have been in error.

11. The collected evidence should be peer reviewed by the scientific community. These external experts should give their views anonymously.

12. Findings should be cautious and include study limitations. A theory may or may not be formed.

13. One study inevitably leads onto another. The evidence will rarely be the end of the inquiry; instead it should serve as the basis for further studies.

How to write a good science article

Some readers of this article may be keen on writing about science and technology. This could be collaborating on a paper to be published in a journal, or it could be a more general article. There is advice available from reputable journals about writing papers; however, advice about writing science articles in general is harder to track down.

My advice for putting together a good science article is:

1. Be sceptical of things that claim to be "new." Things that are "new" are either not so new since there are other studies having covered similar ground; or the research really is so new that no one else has attempted it and the results are therefore not reproducible.

2. Avoid, if possible, research that has not been published in a peer-reviewed journal. Papers submitted to conferences are the only exception since these will be subject to rigorous debate.

3. Always cite the original science paper. Press releases, even research briefs, are full of headline-grabbing stuff but they are often produced by universities or government bodies, seeking to get the story to a media outlet. Sometimes they exaggerate the scientific findings and sometimes they misrepresent it. A key reason being is they are often written by PR people and not the authors of the paper.

4. If there's a chance for a primary source, like a direct quote from a researcher, then take it – it helps put the findings into context.

5. Look out for related news and parallel studies; that adds an extra interest to the research being reported and shows its wider application. This can help, given the true significance of most research won't often be known for several years.

6. If you are writing about science and you think the results or findings (or the interpretation) is questionable, then say so. Don't simply reproduce "poor science" in an unquestioning way.

7. See if there were any vested interests with the research, such as who funded it. Sometimes this can "influence" the direction of the research.

8. Treat the reader with respect.

In terms of where to go for information, outside of journals, some general news websites are better for science coverage than others and are better at presenting science stories in a more factually accurate way. Examples include BBC, The Guardian, New York Times, *Scientific America*, *New Scientist* and *Wired*.

When approaching a science paper that you want to review or summarise, try to:

1. Summarise what the research is about early on.

2. Avoid jargon where possible – science has a conspicuously compact and jargon-laden language. If technical terms are required, attempt to define them otherwise the reader's interest will be lost.

3. Then go into detail about the research – what method was used. Use occasional metaphors and analogies, if this helps.

4. Then explain the significance of the research, without this the research won't mean much to the reader and it becomes an article about "science research for science's sake." Here it is important to try to bridge the gap between scientific research and people's everyday lives.

5. If there is more than one point of view, to represent this where applicable.

6. Discuss any future applications, including where the research may go next.

7. Link to the research paper or conference proceedings.

8. Mention any related research likely to be of interest to the reader.

One question that is useful to keep in the forefront is "How can I sum up this topic in just one or two sentences that will make audiences want to read more?" If you have not written a science article and want to try it, hopefully, these tips and ideas will be of benefit.

Summary

This article has presented examples of bad science and of good science. To produce good science key criteria are required and by following these, scientists can produce better research and the general community will have greater confidence in the information presented.

Given the tendency for the media to use very loose "headlines" from scientific papers (and sometimes a willingness for scientists to provide them), it is recommended that those with an interest in the subject at hand read the source paper and keep in mind how the research was conducted and what inferences can be drawn from the subject matter. Those wishing to go even deeper may wish to keep in mind some of the points raised in this article when seeking to verify if the findings of a science paper are robust and repeatable.

The article has also included some advice for aspiring writers on how to put together a good science article.

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Infusion devices: vision and future

Sumant Gadge

An infusion device is a medical device that delivers drugs and nutrients to a patient in a precise and controlled manner. Infusion devices are extensively used in clinical settings such as hospitals, nursing homes, and even in the home care environments. They can be used on a patient ranging from a 28-week (gestational age) neonate to a patient receiving palliative/end of life care.

Infusion Devices. (Credit Google)

Apart from delivering medications and antibiotics, they can also deliver nutrients, hormones, chemotherapy drugs and pain relievers. Depending on what they deliver they can be classed as volumetric pumps, syringe drivers, enteral feeding pumps, insulin pumps, elastomeric pumps or PCA (patient-controlled analgesia) pumps. These pumps can be stationary, kept near patient's bed or ambulatory to be portable and/or wearable.

These devices come with significant advantages over manual administration of fluids; they offer the ability to deliver fluids in various levels of volumes, at precisely programmed rates and/or automated intervals. These devices must be operated by a competent clinical user, who programs the rate and duration of fluid delivery through a built-in software interface.

As these devices are regularly used to deliver high risk but lifesaving medications, any deviations from normal working will endanger patient safety. This is the very reason why these devices must be kept well maintained to avoid any such situations. This also accounts the need for a failsafe design and future proofing of the pumps.

Over a ten-year period (1990–2000), 6,773 infusion incidents were reported to the MHRA (Medicines and Healthcare products Regulatory Agency). Around 90 fatalities were reported during this period (i.e. any incident report where a patient has died and an infusion device was involved in the treatment).[1]

Although some adverse events may be the result of user error, many of the reported events were related to deficiencies in device design and engineering, which can either create problems themselves or contribute to user error. The most common types of reported problems have been associated with software defects, user interface issues, and mechanical or electrical failures.

These are one of the most frequently used devices in a clinical environment and yet we can find clinical staff having difficulties in using them correctly.

Below are a few of the areas to consider while designing a future proof, intuitive, and robust infusion device.

Simple to use

With the technology continuing to move forward quickly, every device now comes loaded with lots of features. This sometimes makes the user interface a bit more complicated and thereby increases a risk of making an error. The user error in infusion device incidents is almost three times as likely compared to other medical device groups. Approximately one in five infusion device incidents can be attributed to user error. Examples of reported user error include:

- errors in reading syringe, leading to over-infusion
- confusion during set up of pump
- patients tampering with pump in order to obtain over-infusion
- wrong rate of infusion set due to device interface ambiguity
- administration set misloaded

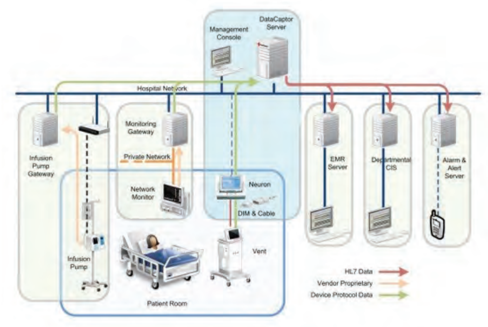
The range of examples above illustrates the complexity involved in establishing the root causes of incidents. Nursing time is very vital especially while caring for critically ill patients. Quite often there are situations where nurses have to do multitasking and don't have much time to sit and think. If pump can be made as simple to programme as a 1-2-3 step process, it helps nurses immensely and also reduces the risk of errors. It is also clear that the evaluation of infusion devices before purchase could play a significant role in reducing these errors – by avoiding devices that are highly technical, confusing and generally not user-friendly.

Easy to clean

According to IPAC (Infection Prevention and Control), most of the hospital borne diseases are caused due to devices not being cleaned properly. Any device should be easy to clean, especially when it gets used on multiple patients. Infusion devices are most widely and frequently used on multiple patients and so must be kept clean all the time. The user will be more encouraged to clean it with simple cleaning instructions. The device must be made up of a good quality material to withstand the frequent cleaning with the harsh chemicals. Generally, manufactures produce a list of chemicals which can be used to clean their device. Departments should refer to these while choosing the right disinfectant.

Networking/connectivity

This is becoming one of the major prerequisites for any medical device. The ability to connect to a hospital network opens up so many doors, good and bad. On the positive side, you will be able to monitor the pumps remotely, update the software on them at once, check on the high-risk errors to be proactive as well as synchronise the drug libraries. On the other hand, pumps will become more prone to malware, software corruption and ultimate malfunctioning and become a threat to a patient. There needs to be a balance. Manufacturers are already working on this. Some have achieved a good deal and some are still learning.



Networking the Infusion Devices. (Credit Capsule tech)

The NHS is digitising at a far greater pace than before. One of the drives is to aim for a paperless PAS (Patient Administration System). The first stage of medical device procurement is providing a specification to filter out the makes which are fit for the purpose. Almost all of the device procurement groups make this as the top of the priority list. When the device is able to automatically synchronise with the electronic patient records, the clinicians can then review the patient notes anywhere anytime to come to a correct diagnosis and ultimately correct treatment. This gives NHS the ability to securely store the patient records at a central location for as long as it is deemed necessary. This also conforms to information governance and data security regulations.

Safety features

Almost all the medical devices in the market are loaded with safety features to alert users in case a failure or an error occurs. The infusion devices are no exception to this. It becomes very beneficial if a pump can display some usage indicators such as battery life, service due and how long a pump has been running for. If a pump can give out such details, things can be planned in advance. Some infusion pumps employ soft and hard limits while setting the infusion rates and volumes for certain drugs. However, there is still some scope for improvement.

The principles of Human Factors in Healthcare also play an important role in deciding which safety features to employ. NHS is a healthcare knowledge economy of our nation. By working in partnership with NHS, device manufacturers can link with clinicians to get valuable feedback and improve the product which is intuitive, effective, resilient and safe. An example of such a partnership is the DOME (Designing out Medical Error) project.[2]

Error log/event log

An error or event log is very helpful while fault finding at a technical department. Some have just a basic log whereas some include a more detailed explanation such as air in line, occlusion, mains disconnect even up to each key press. Also, when there is a serious clinical incidence, event log can give you such details as every key press and changes to drug concentrations or volumes. This makes it easy to perform the RCA (root cause analysis).

Drug library

An up to date drug library will help the healthcare professionals to program the pump quickly and easily minimise the inputting errors. Also, with the well-maintained drug library, the pump can be configured for specific areas like Emergency, Theatres, ITU or NICU as per their regularly used drugs. It should be possible to add/edit/delete the default drugs (of course by a trained professional!) to make it future proof.

Multi licence
It is becoming a normal practice for community nurses to deliver medications while the patients are at home. One of the device regulations dictates that a pump must be licensed for such a use. From the manufacturers' point of view, this adds value to a pump if it is licensed for hospital and home use.

Traceability
The NHS is a vast organisation. Sometimes devices travel with patients and may end up in a different location. Also, there are certain devices which are configured for specific areas and must not be used anywhere else. The Radio-frequency Identification (RFID) technology enables the users to locate the items accurately. Nowadays, the devices are coming with an in-built RFID tag to get location and ultimately track usage, service and error details and ultimately increase inventory accuracy. There are two types of tags; active and passive. Active tags have a transmitter and in-built power source whereas passive ones use power from reader or receiver to communicate. Both of these comply with GS1 coding (A Global Standards organisation).

RFID along with NFC (near field communication) can enable intelligent devices for central device management.

MR compatibility
It is becoming a norm for clinicians to request an MRI scan for patients due the extent of details you get which in turn counts towards treatment accuracy. It becomes difficult to scan patients who are infused with medications by the pumps if they are not MRI safe. Obviously, making a pump MRI safe is an expensive task but it definitely pays off when there are very less such pumps in the market.

MRI Compatible Infusion Pump. (Credit MRI Devices)

Non-vendor specific
A manufacturer should aim for a universal product which can be easily customised for any environment. A device that is made to care for patients! It should be able to communicate with different systems on universally accepted HL7 or FHIR standards.

Provision of training
Nationally there has been a yearly increase in the number of reported infusion device related incidents received by the MHRA. In a review of these incidents it was shown that in 53% no cause could be established and "no fault" was ever found with the infusion device. Although difficult to prove, it is possible that many "no fault" incidents could be related to user error and ultimately lack of training. It is vital to achieve device competency before users are allowed to set up the pump. Clinical Trainers from device manufacturers should be proactive in this and so should be the clinical areas. Having a link support worker and a practice development team on board will help for cascade and refresher training sessions. A department should also maintain staff competencies for these very high-risk devices.

Author
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References

1. MHRA, www.mhra.gov.uk
2. Designing Out Medical Error (DOME) Project. Available at: http://www.domeproject.org.uk/overview.html

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Conference 2019

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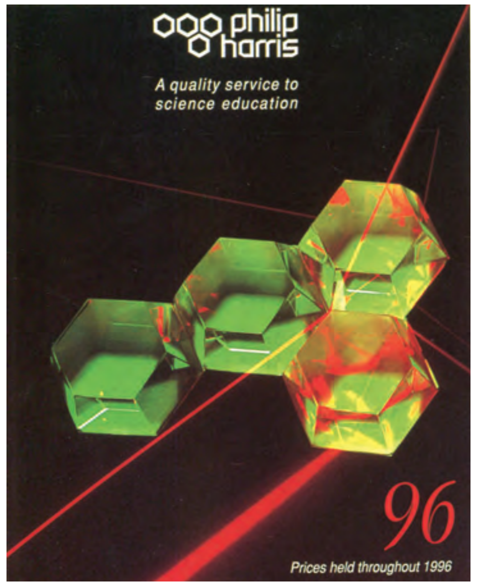
Philip Harris of Birmingham

Alan Gall, IST Archivist



Introduction

Born during the reign of King George III, pharmacist Philip Harris created a successful commercial enterprise, and over two hundred years after his birth there are still educational products sold under the Harris name. Philip Harris built up his business over a period of thirty-five years, then retired in favour of his son-in-law because he had no children of his own. During the early years the patent medicines, ointments, tonics and beverages commonly sold at chemists shops were supplemented with increasingly scientific commodities. Wholesale trade and manufacturing also developed and at one time the company had a good reputation for producing acetic and hydrofluoric acids.

Control passed out of family hands in 1886. This change of ownership saw the formation of Philip Harris & Co Ltd, later Philip Harris (1913) Ltd. By 1929, the scientific supply side of the business had reached a low ebb and came near to closure.

A big boost to the sales of laboratory glassware and general apparatus came in the 1960s with the introduction of the Nuffield Science Teaching Project. This scheme helped Philip Harris become a "household name" in schools. Pharmaceuticals also performed well. As a group, Philip Harris could claim over 165,000 square feet of manufacturing and operational space by the 1970s. Various competitors were absorbed along the way in the search for market dominance.

A merger with Nottingham Group Holdings plc in 1997, under the name Novara, did not end well. The Medical Division was sold in 1998 to the German pharmaceutical wholesaler Phoenix Pharmahandel Aktiengesellschaft & Co KG and Philip Harris is now a trading name used by Findel Education Ltd, part of Findel plc, carrying on the supply of science equipment to the educational sector.

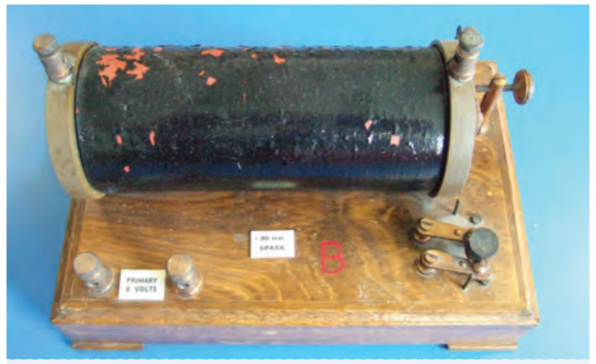


Figure 1. Philip Harris induction coil to generate high voltages (picture courtesy of Alex Marsh)

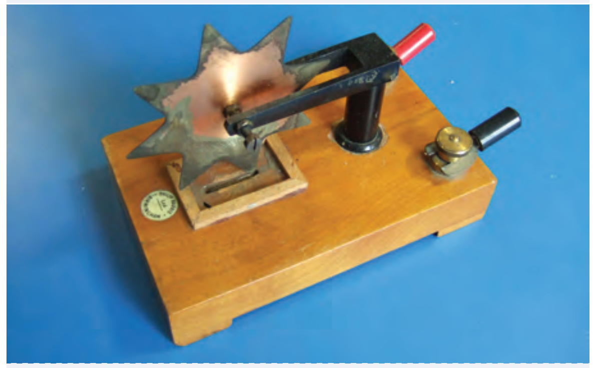


Figure 2. Philip Harris Barlow Wheel to demonstrate the rotation of a conductor in a magnetic field (picture courtesy of Alex Marsh)

The big bang

At a chemists and grocers shop on Jamaica Row, in Birmingham, the proprietor George Barnett and his assistant were looking over the sales book at around eleven o'clock in the evening on Saturday, 7 December 1861. Without warning, Mr Barnett found himself flung into the air and transported into the cellar, accompanied by broken timber and shattered glass. There had been a large explosion that newspapers vividly described on the following Monday.

The whole of the plate-glass in the windows was blown across the road; show globes, drug bottles, chemical apparatus, and glass of every description was smashed to atoms; and many of the shelves in the grocery department were cleared and ripped from the walls. With the exception of a few drawers and canisters, the shop is gutted, and the stock, which was very valuable, utterly destroyed.[1]

Barnett managed to extricate himself from the debris and reach the street with his coat on fire and lacking much of his hair. Mr Thomson, the assistant, escaped without any significant injuries. Opportunist thieves were soon at work as the *Birmingham Daily Post* reported: " … a host of scoundrels in the mob were, with diabolical coolness, plundering the ruins and running off with their begrimmed [sic] booty."

The press reports were unable to specify the exact cause of the explosion. With an investigation still to be made, the papers resorted to speculation: "… whether the cause was an escape of gas, or an ignition of inflammable vapour, no one can tell." Enter amateur sleuth Philip Harris.

Harris must have had some reputation as an astute chap because he received a request "by the friends of Mr Barnett" to conduct an examination of the premises. In the company of a builder and one or two others he duly inspected the rubble-filled cellar.

These were the days before electricity, and in this case illumination for the cellar came from a gas light that ran constantly in a place where volatile chemicals were stored. In Philip Harris's own words:

… I fully expected to find the explosion had originated from the pent-up gases of the hydro-carbons which are now in general use … the tin containing naphtha and the cask with the paraffin remained as they were before the accident, therefore it was evident that the combustion by gas was not the cause; and we were therefore quite unable to offer any explanation …[2]

Apparently defeated, the investigators were about to leave when one of the shop assistants suggested checking on the store of gunpowder!

Figure 3. The man himself – Philip Harris (1801-1866) c. 1850

Mr Philip Harris

I am told by Peter Herriot, a retired Divisional director, that the generally accepted time and date of birth for Philip Harris is "Half past midnight", 3 December 1801. On this basis, a number of ex-employees meet up for a reunion in Birmingham as an annual homage to the founder.

Philip was not a native of Birmingham. He originated from Hereford in Herefordshire, and like the Cadburys probably came to the City for its commercial opportunities. He had definitely started trading on his own account by 1825 as, in that year, he needed an apprentice and advertised in *Aris's Birmingham Gazette* for a "respectable, well-educated youth". The Philip Harris company often quoted 1817 as the foundation date, basing this on a connection with a surgeon called Thomas Ellis at 102 Digbeth, Birmingham. According to Richmond, Stevenson & Turton's book *The Pharmaceutical Industry: A Guide to Historical Records*, Philip Harris became Ellis's partner in 1825 and moved to 1 Bull Ring (the previous occupant being an apothecary called Evans). An alternative account of the beginnings suggests that Philip Harris succeeded S. Evans at 1 Bull Ring and then partnered with Ellis. The second version features in some of the company's catalogues.

Ellis departed at some point and a partnership of Harris & Margetts appears in the records. The new man was John Peck Margetts, like Harris a young, up-and-coming pharmacist. For whatever reason, the collaboration did not last long and a notice announcing the dissolution of partnership appeared in the *London Gazette* on 20 October 1835.

The severity of the law is something that young Philip Harris would have been well-acquainted with, if only from reading his local newspaper. The Georgians had a way of keeping the prison population down - by deportation to the colonies or the death sentence. Many of what we would now consider to be lesser crimes were subject to capital punishment. Take the case of William Cattermole, aged 18. In 1829 he set fire to a stack of clover in Suffolk. The judge in passing the death sentence said: "We trust that the untimely end of this unfortunate young man will operate as a serious warning to others, that the highest penalty of the law will in future be exacted from the perpetrators of arson …"[3]

An advertisement of 1831 promotes a powder for treating worms in horses and lists Philip Harris as one of a number of suppliers. Similar adverts indicate that customers could count on Philip Harris's shop for a great variety of products, from Asam Tea ("a flavour of exquisite delicacy") to leeches ("fine healthy pond leeches, speckled and green"), to Pharaoh's Serpents ("the scientific miracle of the age"). Scientific equipment featured increasingly and by 1851 estimates were offered for the construction of complete laboratories. Indeed, as early as 1826 Philip Harris promoted goods for "Philosophical Chemistry", ie for purposes other than pharmacy.

P. Harris, Operative Chemist, No. 1 Bull-ring, Birmingham, respectfully announces to Chemists, Artists, and Philosophical amateurs, that he is continually receiving every description of Apparatus, and making every preparation necessary for the pursuit of Experimental, Philosophical, and Analytical Chemistry … Portable Chests, containing a selection of Re-agents for the travelling mineralogist.[4]

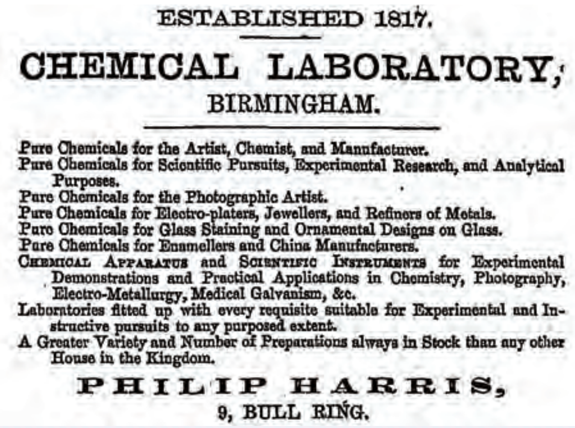
A company history records that Philip Harris was a founder member of the Pharmaceutical Society (later the Royal Pharmaceutical Society of Great Britain) in 1841. Not quite the accolade it might seem – there were about four hundred other founder members! However, he did act as secretary for the Birmingham branch in the early years. The Society came into existence after a public meeting held at the Crown & Anchor Tavern in London. There were two prime reasons for its creation: a united front to oppose what was seen as hostile attacks on the trade by Parliament and the need to promote the respectability of pharmacists.

Between 1830 and 1835, Philip Harris moved up the road from number 1 Bull Ring to a more spacious property at number 9. Both premises stood opposite and to the north of St. Martin's Church in the centre of Birmingham. For a short time in the late 1840s, the business operated as Harris & Pierce, dispensing and operative chemists at 140 Digbeth and 9 Bull Ring. This partnership with Perceval Pierce ended on 16 July 1849.[5] It is possible that the arrangement with Pierce only concerned the chemists shop at Digbeth and not the other operation at 9 Bull Ring.

Figure 4. Date unknown but possibly 1850s

Philip Harris married late in life, at the age of 55. His bride, a widow called Eliza Heeley, brought with her a retinue of several children. The youngest of these would eventually be the successor to the business. How did Philip meet someone who would become Mrs Harris at so late a stage in his life? One possibility for the meeting is through Eliza's son Frederick, who may have been employed by Philip Harris since he is recorded as a chemist's apprentice five years before the marriage.

Eliza's previous marriage took place on 24 May 1827 when Eliza Toney and John Heeley joined together in holy matrimony. They had just over twenty years together before John died. Arthur, their last child, followed his brother Frederick as a trainee chemist, certainly under the instruction of Philip. Given the age of Eliza at the time of her marriage in 1856 (estimated as around 50) it is no surprise that Philip Harris died "without issue". So, after his death at home on 18 September 1866, the future of the business rested mainly in the hands of his stepson Arthur Heeley.


ESTABLISHED 1817.

CHEMICAL LABORATORY,

BIRMINGHAM.

Pure Chemicals for the Artist, Chemist, and Manufacturer.
Pure Chemicals for Scientific Pursuits, Experimental Research, and Analytical Purposes.
Pure Chemicals for the Photographic Artist.
Pure Chemicals for Electro-platers, Jewellers, and Refiners of Metals.
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Pure Chemicals for Enamellers and China Manufacturers.
CHEMICAL APPARATUS and SCIENTIFIC INSTRUMENTS for Experimental Demonstrations and Practical Applications in Chemistry, Photography, Electro-Metallurgy, Medical Galvanism, &c.
Laboratories fitted up with every requisite suitable for Experimental and Instructive pursuits to any purposed extent.
A Greater Variety and Number of Preparations always in Stock than any other House in the Kingdom.

PHILIP HARRIS,
9, BULL RING.

Figure 5. A directory advertisement from 1865, just before the death of Philip Harris

It seems likely that Arthur took over running the business in 1860, although he did not officially inherit until the proving of Philip Harris's Will in 1868. We do know that the two men enjoyed a particularly good relationship: Philip referring to Arthur as "my friend and son-in-law". It was apparently Philip's desire that Arthur should take on a partner – Arthur's college friend James Jevons Aston. The pair assumed joint control until the next change of ownership in 1886.

Big bangs averted

Considerable excitement in Birmingham followed the arrest of several members belonging to a group of Fenians (a movement seeking to overthrow British rule in Ireland) who were intent on causing mayhem with a considerable quantity of explosives. The plan consisted of purchasing nitric and sulphuric acids to produce nitroglycerine as a precursor for dynamite. To avoid too much suspicion, the acids were bought from Henry Judson & Sons, and the glycerine from Philip Harris & Co. Arthur Heeley gave evidence in court that a Mr Whitehead had bought a large amount of glycerine on the 23 February 1883[6]. These ingredients were delivered to premises leased by Thomas Whitehead at 128 Ledsom Street. Under the guise of running a shop for the supply of glass, paperhangings, oil colours and "other glaziers commodities" Whitehead set about the dangerous job of nitrating the glycerine. His efforts to conceal the pungent odours were not totally successful and comments from a neighbour about the smell elicited the response that it was due to "boiling oil for colours".

Events moved rapidly after the police apprehended a co-conspirator in London with a case full of explosives, presumably someone already under observation by the authorities. A raid on the house in Birmingham revealed the large scale of production; Whitehead had bought in the region of 1500 lbs of nitric acid and 3000 lbs of sulphuric. The *Illustrated Police News* of 14 April 1883 went into great detail about the removal of the nitroglycerine from Ledsom Street. No less than the Mayor of Birmingham, the Chief Inspector of Explosives to Queen Victoria (Colonel Vivian Majendie) and leading analytical chemist Dr August Dupré descended on the makeshift factory. The following day, Mr Macready, an expert from Nobel's dynamite factory in Glasgow, arrived to offer his expertise. Large vessels of nitroglycerine were found, sufficient to reduce the whole street to brick dust. As carefully as could be managed, the sensitive explosive was poured into smaller containers and "several gentlemen who had been witnessing these operations judiciously withdrew." Outside, spectators had gathered and when the buckets of nitroglycerine finally emerged, "The crowd scattered in all directions". An armed police contingent escorted the dangerous cargo to a local sewage farm for disposal, carried by hand to avoid sudden movement. There, and somehow without exploding, the entire stock went up in flames.

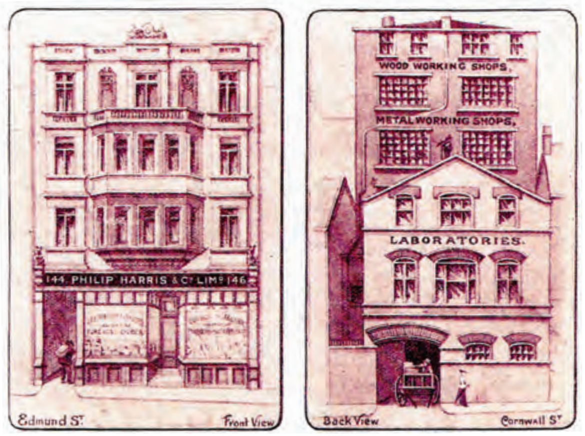

Figure 6. The Edmund Street Premises c. 1899

1883 turned out to be a memorable year for Arthur Heeley and James Aston, with another court appearance. In December several Philip Harris employees went before magistrates charged with systematically stealing goods over a long period. The size of the Harris premises meant that keeping tabs on the movement of personnel had become difficult, but the loss of stock could not be ignored. Fortunately for company finances, the partners had a trusted chemist by the name of Alfred Edward Robinson, well placed to keep an eye out for suspicious actions. His discoveries assisted in handing the matter over to police and resulted in the arrest of Edwin Perryman ("laboratory man"), Josiah Harrison ("laboratory man") and warehouse porter George Sanders. A search of Harrison's house revealed a stash of around 300 bottles of chemicals. Mr Bickley, defending, caused laughter in court when he suggested that the articles might have been taken to treat Harrison's six children and wife who suffered from bronchitis.[7] All were convicted of the charges. Employee Robinson went on to start his own company manufacturing phosphorus.

In an incidence that had occurred 26 years previously, Arthur Heeley spotted one of Philip Harris's employees carrying a bottle near the Pump Tavern. Quizzed about the contents, the man's statement that the bottle contained beer quickly proved to be false after Heeley marched him into the tavern for verification. It wouldn't have been too difficult to discover that the syrupy liquid was, in fact, sulphuric acid.[8]

Philip Harris & Co Ltd

The family connection ended in 1886 when Henry Burman Lowe acquired a controlling interest. An immediate consequence of the start of Henry Lowe's next twenty-nine years as managing director was the formation of Philip Harris & Co Ltd (hereafter referred to as PHCL).

By 1890, PHCL had relocated to 144 and 146 Edmund Street, Birmingham. The premises, fronting onto Edmund Street and backing onto Cornwall Street (once called Bread Street) offered multi-level accommodation. They stood close to what became the Birmingham and Midland Ear & Throat Hospital and The Birmingham and Midland Eye Hospital, respectively. Some idea of the scale of operations at Edmund Street sixteen years later comes from a report in the *Chemist & Druggist* for 21 July 1906.

"In recent times the whole superintendence of the business has devolved upon Mr. H. S. Shorthouse, F.C.S., who, with highly trained coadjutors and 160 employees, have enough to do to complete comfortably each day's task."

One employee, Standley Belcher, had the initiative to set up his own business in direct competition. While still at PHCL he is named on patent number 2876, accepted on 2 January 1902, in connection with improvements to Attwood's machine. This device allowed students to measure acceleration due to gravity using a falling weight. The improvement consisted of an electromagnet holding the cord that supported the weight, so reducing the error due to release timing. Belcher teamed up with Edward Mason in 1906 to form Standley Belcher & Mason. In a short time the new enterprise developed into a serious competitor. Edward Mason later became vice-president of the Family Planning Association.

A restructuring resulted in the formation of Philip Harris & Co (1913) Ltd to carry on from PHCL. The new entity, formally incorporated 4 June 1913, had a long list of shareholders. In charge were Lowe, Herbert Shorthouse, Robert Shorthouse, and Roland Felton. Gentlemen in those days paid their tailors in guineas (one pound and a shilling) and Philip Harris directors were paid in guineas per annum: 250 for Lowe as chairman and managing director, 500 for Herbert Shorthouse as joint managing director and general manager. Henry Lowe did not survive long enough to see his contracted seven-year salary – he died towards the end of 1915.

World War One

The government received a rude shock when scientific supplies from the continent were stopped by the war. Government suddenly had to face up to the fact that laboratory staff were important to the war effort, and how reliant the country had become on imports of apparatus, particularly those of German manufacture.

The University of Birmingham hosted an exhibition of laboratory apparatus in 1917 to showcase home-produced items. As the *Chemist and Druggist* of 28 July commented:

"... it may be stated that British manufacturers have risen to the occasion, and that many of the goods are far better than the enemy products which they are designed to replace."

Philip Harris & Co Ltd sent a Mr Lorton to the event with a range of chemical-ware, placing particular emphasis on a range from the Worcestershire Royal Porcelain Co Ltd. These products went on to provide important stock items for laboratory suppliers throughout the country. Basins, beakers, combustion boats, funnels, mortars & pestles, and various crucibles are just some of the porcelain forms once available. The firm also introduced a budget range under the trade name Sillax "For Routine and Educational Workers". Other developments were sintered calcium fluoride crucibles (resists attack by fluorine compounds at high temperature but is mechanically weak compared to other ceramics) and alumina ware.

In 1916 Roland Felton resigned, to be replaced by Rowland William Muscott. A 1960 catalogue shows a photograph of R. W. Muscott (figure 7), then chairman of the board, with the statement "Apprenticed to the Company after leaving Bromsgrove School in 1896". Yet, his father George ran a tannery at Acocks Green and the occupation of R.W. M. in both the 1901 and 1911 census returns is given as a tanner. It seems likely that he left after the apprenticeship at Philip Harris, later to rejoin in a senior role.

Figure 7. Rowland William Muscott. Appointed chairman in 1937 but said to have first started in 1896 as an apprentice (see text)

Unhappy times followed WWI. The 1920s were notable for trade depression and unrest, with strikes affecting many sectors, including the police. One report in October 1920 stated that over 30 million working-days had been lost so far that year. As the decade came to a close, there were discussions at Philip Harris about the viability of the scientific division, which had suffered from lack of sales. However, it soldiered on to see better days.

Figure 8. Shop frontage at 144 & 146 Edmund Street, Birmingham as shown in The Chemist and Druggist 15 July 1939

Another conflict came and went, but before the end of WWII the company passed a resolution to change from Philip Harris & Co (1913) Ltd to plain Philip Harris Ltd. The Board of Trade gave its approval and registration went through on 24 July 1943.

Figure 9. The showroom of the Scientific Instrument Department at 63 Ludgate Hill, Birmingham (Catalogue of Chemical Apparatus 1952)

Figure 10. Export Department at Ludgate Hill (Philip Harris Catalogue of Chemical Apparatus 1952)

Figure 11. Balance Department at Highgate Square, Moseley, Birmingham (Philip Harris Catalogue of Chemical Apparatus 1952)

Figure 12. Woodworking Department at Highgate Square, Moseley, Birmingham (Philip Harris Catalogue of Chemical Apparatus 1952)

Capacity ml.	1483A Monax each	1483A Monax dozen	1483B Hysil each	1483B Hysil dozen	1483C Pyrex each	1483C Pyrex dozen
50	1/10	18/7	1/8	18/2	1/8	17/7
100	1/10	19/-	1/9	18/6	1/9	19/-
125	—	—	—	—	2/2	23/8
150	—	—	2/2	23/-	2/3	24/2
175	2/5	25/-	—	—	—	—
200	—	—	2/4	25/3	2/6	26/-
250	2/2	22/10	2/1	22/-	2/2	23/1
300	—	—	—	—	2/9	29/3
350	2/10	30/2	—	—	—	—
400	—	—	3/1	33/-	3/-	33/-
500	2/10	30/3	2/9	29/9	2/10	30/1
600	3/8	39/8	3/7	39/-	3/7	39/6
700	—	—	—	—	3/10	42/6
750	4/5	47/3	4/3	46/3	—	—
800	—	—	4/6	49/-	—	—
1,000	4/5	47/6	4/4	46/6	4/-	43/8
1,250	6/-	65/-	—	—	—	—
1,500	6/6	71/6	6/5	70/-	6/5	69/-
2,000	6/5	69/3	6/3	67/8	6/6	71/6
3,000	10/-	108/-	9/8	—	10/-	109/-
4,000	12/6	135/3	12/2	—	12/-	131/-
5,000	14/6	156/-	14/1	—	12/3	133/-
	Monax		Hysil		Pyrex	

Figure 13. Prices of flat-bottomed flasks in 1953, given in shillings and pence

Figure 14. Philip Harris offered borosilicate glassware under the brand names Monax, Pyrex and Firmasil. Although this Firmasil flask appears in the 1952 catalogue, Wood Brothers Glass Co Ltd did not register the trade name Firmasil until 1953

The 1960s and beyond

Figure 15. A letterhead from 1963

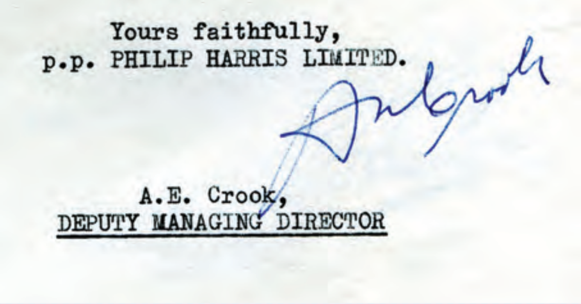

Figure 16. Albert Ernest Crook. He joined in 1930, having previously worked in the laboratory supply industry, becoming Managing Director of the group in 1970

Figure 17. Mr Meeks, a representative in the 1960s

Peter Herriot gives the following account of his time in the business.

I joined Philip Harris Ltd in June 1964, working at Ludgate Hill until transferring down to Weston-super-Mare in July 1966 as Admin Manager of Harris Biological Supplies, which removed from old premises in Arundel Street, Sheffield in October 1965. This subsequently became Philip Harris Biological Ltd, a separately registered company within the group. That was the beginning of a longish story, which ended with about 39 years of unbroken service within the group, albeit effectively as a "prisoner of war" for the last four years, after Novara sold the medical company – renamed as Philip Harris Ltd, and me with it, to the German company Phoenix.

Apart from my early stints in the Sales Office, Repairs & Returns Department and the Buying Office in Ludgate Hill, I worked in the Biological Supply Company for most of my time in Weston-super-Mare, joining the board in 1978 and in due course taking full responsibility there as Director – General Manager, before adding responsibility for the rest of the Manufacturing Division and relocating all into one facility. The "Works", incorporating Philip Harris Electronics Ltd, had relocated from Birmingham to the Oldmixon Factory Estate, close to us, around the end of the 60s.

I worked also on Export, mainly focused on peddling our own manufactured biological products to distributor competitors in the USA, Europe and Scandinavia; and whilst still operating as Divisional Director for Manufacturing, was seconded to the Scientific Division, to deal with the integration and relocation of Kernick Scientific, Pentwyn when acquired in the early 90s. In 1995, I was seconded to "sort out" and relocate Harris Surgicon, an Occupational Health business acquired by Philip Harris Medical and was subsequently invited to join the Medical board as Operations Director; which led to me eventually selling up my home in Weston-super-Mare and returning to the Midlands in '98. This latter period was particularly hectic as we added and integrated further depots – mainly by acquisition, as well as establishing and relocating others.

Peter Herriot is a member of a group who were employed in the Philip Harris group prior to the Novara merger. They meet together in Birmingham each December for lunch and fellowship at The Old Royal, a few yards from Edmund Street and Ludgate Hill, on or close to "Uncle Philip's" birthday.

Figure 18. An apparatus to demonstrate the transmission of fluid pressure (Philip Harris Chemical and Physical apparatus Catalogue 1960)

Figure 19. Clement and Desormes' Apparatus. By measuring air at two different pressures with a manometer, this simple glass bottle can be used to calculate the ratio of the two specific heats (Philip Harris Chemical and Physical apparatus Catalogue 1960)

Figure 20. Another simple idea, an Erlenmeyer flask turned into an electroscope (Philip Harris Chemical and Physical apparatus Catalogue 1960)

Later years

The highlight of the decade must have been the 4-5 year contract, signed in August 1985, to supply scientific equipment to Sultan Qaboos University, Oman. The importance of this deal is reflected in the fact that the logistics required an Oman office to be set up with a staff of 70. On the downside for the group, a bad debt provision of £338,000 had to be made when a large customer for medical supplies went bust in 1986.

The 1980s and 1990s saw considerable growth by acquisition. Incorporated in 1918 at 52 Hatton Garden, London, The Scientific Supplies Co Ltd had many years to build up its laboratory supply business and so represented an attractive take-over proposition. Philip Harris made its move in 1986.

Figure 21. Good times for the Philip Harris group in the 1990s

Figure 22. The Park Royal Site at 618 Western Avenue, in London W3

Figure 23. Unilab premises in Blackburn

Philip Harris group's other acquisitions were South Yorkshire Biological Supplies Ltd, the Northern Media Supply Ltd in 1988, Kernick & Sons 1992, and Scotlab 1992.

Figure 24. By the time of this catalogue in1990, Philip Harris and Northern Media had combined

Figure 25. A sign of the times – a digital burette in the 1990 catalogue, but costing £258

The combining of Northern Media with Philip Harris divided the country into five sections for the purpose of distribution. Philip Harris Scientific served the South, North West, and Scotland from three bases: Western Avenue, Park Royal, London; North Avenue, Clydebank, Glasgow, and Trafford Park, Manchester. Northern Media covered the North East and Midlands from Hessle, North Humberside, and Wilford, Nottingham. Northern Media also had a plant for injection and blow moulding disposable plastic products, operating as Northern Media Supply (Plastics Division) Ltd. This factory produced sample tubes, pipettes, Petri dishes etc. 1995 turned out to be a particularly busy time. During the year more companies were added: Ballpark Figure 2 Ltd, Flowgen Instruments Ltd, Sutcliffe Leisure Ltd and the Unilab group.

Peter Herriot comments on the above acquisitions:

They are mainly Education & Scientific but easily matched in number by Medical's additions of the likes of Bleasdales in York, Hamiltons in Glasgow, Northern Coop in Penrith, Fosters in Burnley and in Derby, plus Fosters Healthcare. We also took Branded Goods in Stoke and of course the Occupational Health business of Surgicon which initially took me back up to Birmingham. While all of this was going on we were also buying a few Retail Chemists and the two Handicare rehab shops in Hucclecote and Long Eaton.

Figure 26. An example of a pharmacy in the Philip Harris chain. These were based in Cheltenham, Nottingham, Norwich, Banbury and Oxford (Philip Harris plc, advertising flyer printed in 1995)

Figure 27. A range of products offered by Harris Medical at Stirchley (Philip Harris plc, advertising flyer printed in 1996)

What seemed like a good idea at the time turned out to be the beginning of the end. A merger of Philip Harris with Nottingham Group under the name Novara (Philip Harris already had a subsidiary called Novara Ltd at the time) came with consequences. Centralising operations at Ashby de la Zouch resulted in the loss of experienced staff, and a computer system that managed to lose orders didn't help. The share price plunged during 2000 and left the group exposed to predatory actions. In 2001 Findel plc made a successful bid for the educational and scientific supply interests.

And finally

Keeping track of the "Philip Harris" name is a job and a half. The company that originated as Philip Harris (1913) Ltd changed to Philip Harris (Holdings) Ltd in 1963, transferring business to four trading subsidiaries: Philip Harris Ltd, Philip Harris Medical Ltd, Harris Biological Supplies Ltd and Swingler Brothers Ltd. On the purchase of the Scientific Supplies Company Ltd in 1986, this new acquisition changed name to Philip Harris Ltd, briefly back to Scientific Supplies, and on 7 March 1987 back to Philip Harris Ltd again. Philip Harris (Holdings) Ltd converted to a plc in 1981 and lost its brackets in 1987 to become Philip Harris Holdings plc, then in 1993 reverted to Philip Harris Ltd. The old Philip Harris Ltd (which had been the Scientific Supplies Company) at the same time changed to Philip Harris Education & Scientific Ltd. This company had already ceased trading some months before the name change and remained as a non-trading entity until 2012 when renamed by Findel as NCN7 Ltd. The Scientific Supplies Company had a second life and is listed as a subsidiary of Philip Harris Ltd in 1992.

To complete the picture, Philip Harris Medical Ltd (previously Philip Harris Holdings plc) was sold and became Phoenix (West Midlands) Ltd, then Phoenix Healthcare Distribution Ltd based at Runcorn; Philip Harris Ltd joined NCN7 Ltd as NCN8 Ltd under Findel, and likewise Philip Harris (International) Ltd ended as NCN20 Ltd – non-trading companies.

The Philip Harris name lives on under Findel Education Ltd

Appendix

Premises occupied by the Philip Harris group as of 1972.

Location	Tenure	Use	Sq. ft.
Highgate Square, Moseley Road, Birmingham	Freehold	Manufacture of scientific apparatus	54,000
Oldmixon Industrial Estate, Weston-super-Mare	Freehold	Manufacture of scientific apparatus	31,000
61 & 64 Ludgate Hill, Birmingham	Freehold	Warehouse & distribution centre	38,600
105 & 106 Lionel Street, Birmingham	Freehold	Warehouse and export distribution	8,000
Oldmixon Industrial Estate, Weston-super-Mare	Leasehold expiring 1986	Manufacture of biological supplies	16,500
4 to 7 Highgate Street, Birmingham	Leasehold expiring 1991	Woodworking manufacture	8,000
50 & 52 Birmingham Factory Centre, Kings Norton	Leasehold expiring 1978	Export warehouse	5,500
Cornwall House, Lionel Street, Birmingham	Leasehold expiring 1986	Head Office	3,700

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Prospectus for Philip Harris (Holdings) Ltd, *Financial Times*, 10 April 1972.
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Other sources are given in the text and references.

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Analysis of volatile organic compounds by direct infusion mass spectrometry (dims)

Raffaele Conte

Abstract

Volatile organic compounds (VOCs) exposure can have long term health effects. The accurate quantification of VOC metabolites is conducted, in this article, using direct infusion mass spectrometry (DIMS). The optimised DIMS method shows comparable classification and prediction capability to LC-MS and GC-MS but consumed only 5% of the analysis time, decreasing costs and improving productivity.

Introduction

Volatile organic compounds (VOCs)

VOCs are organic chemicals that have high vapor pressure at room temperature. Consequently, large numbers of molecules evaporate in the surrounding air.

VOCs are classified in naturally occurring chemical compounds and human-made derived substances. The first category comprises substances produced by plants for communication and scents.[1] According to their biosynthetic origin and chemical structure, plant volatiles can be grouped into isoprenoids or terpenoids, but also oxygenated VOCs (e.g. methanol (CH_4O), acetone (C_3H_6O), acetaldehyde (C_2H_4O), methyl-ethyl-ketone (MEK, C_4H_8O) and methyl-vinyl-ketone (MVK, C_4H_6O)), sulphur compounds and furanocoumarins.[2] Anthropogenic VOCs derive from the emissions of power and industrial plants, chemical production, petroleum refining and vehicle engines. Harmful VOCs are not usually acutely toxic, but can have long-term health effects. Long-term exposure to certain VOCs may increase the risk for cancer, birth defects, and neurocognitive impairment.

For example, acrolein is a substance ubiquitously present in cooked food and in the environment. It is formed from carbohydrates, vegetable oils, animal fats, and amino acids during heating, and by combustion of petroleum fuels and biodiesel. However, smoking of tobacco products is typically the largest source of acrolein exposure. Acrolein can induce necrotic and apoptotic cell death in humans.[3] Acrylamide is formed during the heating of carbohydrate rich food and is used for the production of polymers, formulation of cosmetics and body care products, and in the textile industry. It is carcinogenic and mutagenic.[4] Acrylonitrile is a VOC widely used in the manufacture of plastics, acrylic fibres, and synthetic rubber. It is considered as a probable human carcinogen.[5] Similarly, benzene, toluene, and xylene are known to be carcinogenic in humans.[6] 1,3-butadiene is mainly used alone in the production of synthetic rubber, or as a copolymer with styrene. It is also found in automobile exhaust, exhaust from heating, and cigarette smoke. 1,3-butadiene is carcinogenic to humans by inhalation.[7] N, N-dimethylformamide (DMF) is a solvent that is used in the production of electronic compounds, pharmaceutical products, textile coatings and in the manufacture of synthetic leather, polyurethane, and polyacrylonitrile fibres. It is found to be carcinogenic in humans.[8] Styrene is one of the most important chemicals used worldwide to manufacture plastics, synthetic rubber and resins. It is also an environmental contaminant present in food, tobacco, and engine exhaust. It is classified as a possible carcinogenic to humans.[9]

Vinyl chloride exposure can cause angiosarcoma.[10] Perchloroethylene, 1-bromopropane, and trichloroethene are constituents of tobacco smoke and are widely used in dry cleaning and metal degreasing solvents. They are a hazardous air pollutant and a common contaminant detected at waste sites.[11]

VOC measurement challenges and commonly used methods

VOCs metabolites are useful biomarkers for assessing VOCs exposure. However, most of the VOCs are only in very low concentrations (ppt to ppb) in biological samples. Therefore, the accurate quantification demands a technique with great sensitivity, selective to the target VOC, reliable and user friendly. Originally VOCs measurements were made using Gas Chromatography with flame ionization detector (GC-FID) or mass detector (GC-MS). However, when conducting environmental analysis using a GC mass spectrometer there are numerous inefficiencies, such as laborious and expensive sample preparation stages, and long chromatographic run times. As a result, liquid chromatography-mass spectrometry (LC-MS) solutions were introduced that are less time-consuming and have simpler sample preparation. Such methods are characterised by the direct injection of a water sample with no need for derivatisation, short chromatographic run times, and screening for a wider range of compounds in a single analysis.

Although being beneficial to comprehensive analysis, the chromatographic step of LC-MS limits the throughput, especially when the number of samples is large. Furthermore, there can be possible loss of some relevant analytical signals or the generation of artefacts by erratic retention time shift correction or background subtraction. Alternatively, direct infusion mass spectrometry (DIMS) provides a high throughput and more concise raw data than LC-MS by avoiding any chromatographic steps. Electrospray ionisation (ESI) is the most common method used for ionisation in the DIMS analysis of VOCs. The electrospray process ionization is accomplished by the loss or gain of a proton or other adducts, such as Cl- ions in negative ion mode or K^+ and Na^+ in positive ion mode. The formation of such adducts is highly dependent on the salt content of the sample matrix. ESI produces minimal (usually no) fragmentation and the protonated or deprotonated analyte is referred to as the "pseudo molecular ion" of the parent molecule. This property means that DIMS analytical approaches using electrospray ionisation are able to directly predict m/z signal identity based on measured mass. The lack of extensive molecular fragmentation during electrospray ionisation results in reproducible ionization patterns for extracts representing similar biological matrices, and offers an experimental robustness suitable for larger scale investigations.[12]

Materials and method

Materials

VOCs standards were bought from Sigma Aldrich (Sigma-Aldrich S.R.L., Milan). acetonitrile, N-hexane and water were obtained from Carlo Erba (Carlo Erba reagents, Milan).

Sample preparation

VOCs characterised by strong lipophilicity are extracted from urinary and blood matrix by liquid-liquid extraction with N-hexane (ratio 1:2 matrix\N-hexane). While compounds with negative LogP are directly injected into the mass detector.

DIMS conditions

Sample are analysed with LCMS-8060 of Shimadzu (Shimadzu Italia S.R.L., Milan) using injection volume of 5µl. Mobile phase is acetonitrile (or n-hexane) for organic compounds and formic acid in water 0.01% v/v for hydrophilic compounds. Capillary used for the infusion has internal diameter of 0.01 mm and length of 1 meter. Mass condition are summarised in table 1.

Nebulizing gas flow	2.9 L/min
Heating gas flow	10 L/min
Interface temperature	300°C
DL temperature	250°C
Heat block temperature	400°C
Drying gas flow	10 L/min

Table 1. Mass conditions

Results and discussion

Table 2 lists examples of used mass fragments for quantification.

Substance	m/z	ESI condition
Benzene	78	+
Methyl ethyl ketone	73	+
Acetone	59	+
Ethanol	47	+

Table 1. Mass conditions

Figure 1 shows the mass spectrum obtained for benzene.

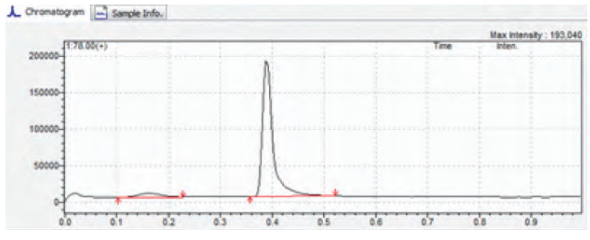

Figure 1. Mass spectrum of benzene by DIMS

The optimised methods permit analyses of VOCs in less than one minute with no need of derivatisation. DIMS has comparable classification and prediction capabilities to LC-MS but consumes only 5% of the analysis time, decreasing costs and improving productivity. However, matrix effects are inevitable because the samples are infused together without separation, which may result in reduced sensitivity and deteriorated capability for metabolite identification. In order to minimise such an effect, the mobile phase should coincide with those used to extract the analyte from the biologic matrix.

Conclusion

A method using direct infusion mass spectrometry was developed to analyse VOCs. DIMS shows a similar classification and prediction capability to LC-MS and GC-MS but with the advantage of having a much higher throughput without chromatographic steps. DIMS can potentially be further developed as a fast-diagnostic method for VOCs exposition.

Author

Dr. Raffaele Conte, PhD, MIScT, RSci is the director and responsible chemist of the toxicology laboratory of "AMES polydiagnostic centre" in Casalnuovo, Italy and a research associate of the "Research Institute on Terrestrial Ecosystems" of the Italian National Research Council (CNR) in Naples, Italy. Apart from his working activity aimed on the detection of drugs and metabolites in biological matrices, his research interests are focused on the design of novel delivery platforms able to minimize degradation, prevent undesirable side effects and increase bioavailability of drugs or genetic materials. He also follows different projects as an independent researcher and has authored several research papers. In 2018 he obtained a Ph.D. in clinical and experimental medicine at the University of Naples "Federico II" with a project on the synthesis of polymeric fillers with anti-biofilm activity for dental composites. His email address is **raffaele.conte86@tiscali.it**

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How far can cognitivist theories be applied to science & technology teaching and learning?

Kevin Fletcher

Introduction

I have already given a brief consideration in a previous article[1] to the extent to which a model of Neo-Behaviourism can be applied to science and technology teaching. This was then followed by a similar consideration of Gestaltist models[2].

In this brief discussion I hope to consider cognitivist theories of learning and map the extent to which they can be applied to, and used in, science and technology teaching.

In future articles I intend to discuss Humanist Theories and how far these learning theories can be applied to science and technology teaching, with a view to relating theories to practice in the hope of understanding and improving teaching and learning in the science and technology classroom.

For now, I turn to Cognitivist Theories of Learning.

Cognitivist theories

The Cognitivists place their focus on students and how they gain and organise their knowledge (that is, cognize). Students do not merely receive information, but actively create a pattern of what it means to them. The implications of this are that, if you have a class of sixteen science and technology students, they probably have sixteen slightly different understandings. The students "fit" their new learning onto their own existing mental structure and experience.


John Dewey

John Dewey (1859–1952) defined learning as **"learning to think"** and the process of learning is not just doing something, such as a task, but reflecting and learning from this.

The teacher is the key to Dewey's work because, he says, the teacher must plan for reflective thinking to take place. Education being firmly linked to social growth was one of Dewey's main claims.

Another Cognitivist thinker, Jerome Bruner (1915–2016), was insistent that students must be taught how to analyse problems and how to think for themselves in order to become independent learners. The implications of this include the idea that teaching a lot of factual information is unproductive since the learner forgets most of it in a relatively short time and will use very little of it. However, teaching generalities is efficient as generalities can be applied in a number of situations over a period of time.


Jerome Bruner

Bruner considers the learning process as the acquiring of new information, transforming that learning with regard to existing knowledge and then checking it against the new situation. So, knowledge is a process rather than a product. Models are constructed by the learner, which explain the existing but can also predict what might be.

Bruner sees the teacher's role as one of facilitating the student's own discovery known as "inquiry training".


David Ausubel

David Ausubel (1918–2008) sees the key to effective learning as the students relating their new learning to existing cognitive structures. He advocates the use of "advance organisers" (that is, bridges between what the students know and what they need to know). Such an organiser is a short description of the new material before the lesson so that the students are prepared to accept the new materials.

These cognitive theories point to the active engagement of the mind in relation to the subject matter under consideration. They stress the processes involved in creating responses (as opposed to the responses themselves that are the aspect of behaviourism) and the organisation of perceptions that go on in the mind. The theory is similar to behaviourism, however, because in order to learn, understanding is necessary: the materials must be marshalled step by step and then mastered. The setting of goals is related to each part of the materials, and feedback is an essential element in the process of learning, but not separate from it.

Cognitive psychologists argue that we are not passive receptors of stimuli when we learn: the mind actively processes the information it receives and converts it into new forms and categories. So how do we apply cognitive theories in the science and technology classroom?

The following ideas may suggest a few strategies:

1. Call attention to, and take advantage of, the structure of the subject. Stress relationships in what you present. Use advance organisers where appropriate and urge students to seek patterns of their own.
2. Take advantage of students wanting to find answers to problems that have personal significance to them, so relating the learning to their own personal situations.
3. Arrange the learning so that students discover things for themselves.
4. Structure discussions by posing specific questions.
5. Use discussions and give students themselves the responsibility for leading them.

Through the use of these techniques, which are all related to the importance of the structure of the subject, teachers of science and technology can attempt to promote learning through insight of the cognitive structures of the subject: the concepts that are embodied within it.

It is argued that students learn the best when they gain insight into, and understanding of, the underlying structure of the knowledge embodied within the subject. They need to be active in seeking new information and participating in the teaching methods. They learn best when they discover concepts and principles for themselves.

Conclusion

As with all the schools of psychology, there is evidence that to some degree cognitivist theories can be mapped onto science and technology teaching and learning situations.

Unfortunately, as with other schools of psychology, these theories have some weaknesses. Principal among these is the fact that cognitivist theories lack validity as they cannot be studied scientifically. They take a "black box" approach as the processes themselves happen internally, within a person's mind, and these are not easy to explore or expose to rigorous scrutiny. In a similar vein, cognitivist theories have been criticised because they fail to consider individual differences in cognitive abilities e.g. memory or recall. Nor do they consider a person's state of mind or their emotional state.

Despite these weaknesses, Cognitivist theories can be seen in operation in our science and technology classrooms.

Summary

In this article, I have outlined some of the basic concepts of Cognitivism and then attempted to show how they can be applied in science and technology. I have gone onto try to distil these ideas into a "checklist" which might be used in lesson planning and the delivery of science and technology in the classroom.

I hope, in a future article, to undertake a similar exercise with Humanism that is, to investigate how this particular learning theory applies to science and technology education.

Author

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Kevin is the retired Head of an East Yorkshire Further Education College. Having spent the first ten years of his career as a Laboratory Technician & Manager in various secondary schools, Kevin's first degree took him into secondary school teaching for a further ten years, ending up as a Head of Science and Deputy Headteacher. Finally, he moved into Further and Adult Education for a further ten years as Head of School in Hull before becoming Head of Goole College. Throughout his career, Kevin maintained a teaching commitment in his areas of interest which are Science, Education/ Psychology and Management. He still keeps abreast of developments in these areas despite having retired.

WEB Sources

I acknowledge the use of certain images (in the public domain) and information taken from various web sources such as Wikipedia which were found using search terms entered into search engines such as Google.

Acknowledgement

Much of the material for this article was taken from worksheets and hand-outs developed and used by the Teacher Training Team at Hull and Goole Colleges over many years. I freely acknowledge these documents, images and my colleagues as the source material for this article.

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The Appley Bridge meteorite

Russell Parry

I moved from the market town of Shrewsbury in Shropshire to the village of Appley Bridge in Lancashire in 1991 and being new to the area I soon read up on the local history and places of interest around and about. I read about the Appley Bridge meteorite in the local history section of Wigan library and having a keen interest in astronomy since I was a boy it captured my imagination. It was one of the largest meteorite falls in Great Britain and it just happened to land outside the village where I now live. In 1997, a local village publication, The Appley Bridge Year Book, included an article on the meteorite and this prompted me to find out more information on this fascinating event. Over the years I researched the story, unearthing more facts and figures as time went on. In 2013 I decided that I must start to produce a book on my findings so that anyone interested can share in this fascinating story. During my research I also found out that the meteorite, shortly after it was found, went on display in my next-door neighbour's house, which at the time was the village shop.

Maybe today the same incident would only have a brief mention in the news, but take a step back in time to October 1914, the meteorite fall, the explosions as it entered the atmosphere at an estimated 8 miles a second, and the confusion with an enemy zeppelin or aircraft dropping bombs, all caused great concern. The world at that time of course was a much quieter, slower place and it was in this environment that the meteorite appeared, exploded and came to earth in a field near Appley Bridge on Tuesday 13 October 1914 at approximately 8.45 pm and was discovered the following day.

The meteorite fall was actually found by two gentlemen described in the newspapers of the time as "sportsmen", one being an employee of Halliwell Farm where the meteorite was found. As the two gentlemen were walking the fields on the outskirts of Appley Bridge on the morning after the meteorite fall, they may have been discussing the events of the previous evening, the fireball and tail in the sky and the claps of thunder like explosions. Was it an enemy Zeppelin after all? Or was it the reported aeroplane dropping bombs on the nearby army camp at Winstanley?

It is likely they were discussing the events of the previous evening as it was seen by hundreds of people in the local Wigan area and lit up the night sky as it headed in a northerly direction. One account even said that Dr Wilson, a resident of Standish and the medical officer for the district, had spoken to numerous residents in Appley Bridge and many of them used the expression that although it was night they could "see to pick up a pin by the light given out." Local residents also reported the "buzzing of the engines of the Zeppelin".

Halliwell Farm

It was the newspaper reports of the time which really captured my imagination with the articles written and the event described in a way that had been lost in time. I have even tracked newspaper reports around the world to Australia where it made headline news.

It was reported the two gentlemen noticed what they thought was a hare or rabbit, another report suggested it was an upturned mound of earth which caught their eye. On approaching it they soon discovered this was no rabbit or hare; they had discovered the landing place of the meteorite, embedded in the earth in a hole approximately 2 feet across and 18 inches deep and in it, the dark red mass of the meteorite broken into two pieces. On getting a spade from nearby Halliwell Farm, they set about digging it out. Some reports say it was dug out by the farmer himself, Mr Eric Lyon. The meteorite was then taken back to the farmhouse.

Dr Wilson, the medical officer for the district, visited Mr Lyon at the farmhouse and inspected the object. He provided a description to a local newspaper as follows "The mass is just like a large stone, irregular in shape, and externally of a reddish colour similar to the appearance of rusty iron, or of iron drawn from a fire. It is also very friable" He went on to say "pieces can be broken from it by the fingers alone. Internally the prevailing colour is that of French grey, the material is of varying hardness, and some parts having the resemblance of lead. It is about 30 inches in circumference and weighs about 30lbs"

The Appley Bridge meteorite

The police were informed of the find and Superintendent Kelly of the Wigan County Police visited Halliwell Farm by motor car and promptly confiscated the meteorite on behalf of the Chief Constable of Lancashire County. The meteorite was then taken to the County Police Headquarters in Preston for investigation and examination.

Superintendent Kelly later gave an interview to the local newspapers and stated that the find entirely dispels the idea of an airship passing over the district. The fallen body he said weighed some 30lbs and is heavier than it looks. On the outside it is dark brown in colour like rust iron and is covered with a sort of burnt powder. Inside the colour is light grey with spots of gold and bright coloured metals. There is no doubt, the Superintendent added, that it is a genuine meteorite.

A week later in a letter to the Chief Constable of Lancashire County Police, Dr Wilson wrote asking for the meteorite to be returned or placed in some position where scientists could examine the rare find. He said that Professor Jenkins of the Godlee Observatory in Manchester, had been greatly interested in the meteorite, and was one of the first authorities to offer the explanation that the "airship" was in fact a meteorite. Dr Wilson went on to say in his letter that an exhibition of the meteorite would allay fears still entertained by some that it was a German Zeppelin on a bombing raid.

In actual fact a piece of the meteorite which had been detached from the larger mass was put on display in the window of a grocer and drapers shop on Appley Lane North in Appley Bridge. The shop was owned by Mr James Rigby and visitors were able to see the meteorite and view it under a microscope or magnifying glass which had been set up. Coincidentally, when I moved to Appley Bridge in the early 1990s I lived next door to the house which was originally the village shop where the meteorite was displayed.

James Rigby's shop where the Appley Bridge meteorite was displayed

Dr Wilson's letter to the Chief Constable obviously did the trick, as a week later the police did in fact release the meteorite. It is recorded in correspondence between Dr Wilson and Professor Jenkins that "the meteorite has been delivered to him by the police for examination".

Whilst in Manchester the meteorite was examined by Dr. Prior, who was Keeper of Minerals at the Natural History Department of the British Museum. His colleague at the British Museum, Mr L. Fletcher, M.A., F.R.S., who was Director of the Natural History Department, wrote a letter to the chief police constable of Lancashire confirming that it was a genuine meteorite. The letter also stated that in fact it was the largest to fall in Great Britain for 120 years.

The Godlee Observatory Manchester

Professor Jenkins gave the result of his investigations before a meeting of the Manchester Literary and Philosophical Society on Tuesday 3rd November 1914. This was the first recorded presentation of the Appley Bridge meteorite. The meteorite was on display and the results of their analysis presented.

The Appley Bridge meteorite

The Appley Bridge meteorite is an "Ordinary Chondrite" and has the classification of LL6, this being a stony, ordinary chondrite, low iron, low metal with indistinct chondrules. Ordinary Chondrites are divided into three Groups and each is given a letter designation and a number.

The letters designating the groups refer to the bulk iron content as follows:
H chondrites have high total iron contents.
L chondrites have low total iron contents.
LL chondrites have low metallic iron relative to total iron, as well as low total iron contents.
For ordinary chondrites, the number following the chemical class letter designation represents the petrologic type or degree of thermal processing, with lower numbers indicating less alteration.

H	Abundant H3-H3.9 Distinct H4 Less distinct H5 Indistinct H6 Recrystallized H7
L	Abundant L3-L3.9 Distinct L4 Less distinct L5 Indistinct L6 Recrystallized L7
LL	Abundant LL3-LL3.9 Distinct LL4 Less distinct LL5 Indistinct LL6 Recrystallized LL7

Although the Appley Bridge meteorite classification of LL6 does not make it a rarity, it is the fact that it is a meteorite "fall" that makes it so special. A "fall" means the meteorite was actually observed falling, very dramatically in the case of the Appley Bridge meteorite, and then found.

It was thought that after the analysis of the meteorite by the scientists it went straight into the hands of the museum in Manchester, but it appears that the meteorite was returned to Mr Lyon of Halliwell Farm. As it landed on his property, he was after all, the rightful owner of the meteorite.

Then, in January 1920, Eric Lyon decided to sell the meteorite. Perhaps he needed the money, or it was just gathering dust or maybe just wanted other people to have the opportunity to see the famous meteorite. Whatever the reason, we now know that the meteorite was sold to the British Museum for the sum of £250 in January 1920. At the time this was a very significant sum of money.

The meteorite was now in the hands of the British Museum. One of the first things they did was to commission an actual size plaster cast model of the meteorite and this can now be seen in the Manchester Museum.

Plaster cast model of the Appley Bridge meteorite

The main mass of the meteorite now resides at the Natural History Museum in London. The Smithsonian National Museum of Natural History in Washington D.C. also has a 598g sample, sent to them as part of an exchange in March 1920. Samples of the meteorite can also be found in museums around the world from Moscow to Canada.

My book was finally published and the launch took place in the Museum of Wigan Life on the 100 year anniversary of the meteorite fall on 13 October 2014. Coincidentally, the book launch and presentation took place in the local history section of the museum where the archive newspapers are held, which was where I discovered the story so many years earlier. A sample of the meteorite and the original plaster cast model were also present during the event.

Since then I have kept the story of the Appley Bridge meteorite alive with talks to many societies, groups, museums and schools throughout the UK. In 2018 I presented the talk on two transatlantic crossings on board Cunard's Queen Mary 2, and presented the talk at the Linder Theatre in the American Museum of Natural History in New York City where another piece of the Appley Bridge meteorite is on display. If someone had told me when I first discovered the story that I would be speaking in New York about the meteorite I would have said they were crazy – you never know where a local story will take you!

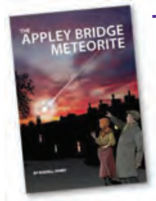
Author

Russell Parry is a Fellow of the Royal Society of Public Health and founded his company Advanced Food Safety Limited in 1995.

Russell and his company have won many awards including Best Trainer of the Year, Best Training Company of the Year, Entrepreneur of the Year. Several export awards have also been won for his overseas food safety projects in Jordan, Macedonia, Latvia and exporting food safety publications to over 60 countries.

Russell moved from his home town of Shrewsbury to the village of Appley Bridge in the North West of England in the early 1990s where he discovered the fascinating story of the 1914 meteorite strike on the village. His book was published to coincide with the 100-year anniversary of the event in 2014. Russell is currently working on a new project "safe food production from the space race" the story of the development of HACCP systems for food production.

Russell is available to present his illustrated talk on the Appley Bridge meteorite for organisations throughout the UK.



The Appley Bridge meteorite book is available on Amazon.

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Making old television technology make sense

A new approach to technological television history and conservation – part one

Paul Marshall

Abstract

How does traditional analogue television work? That's a question beyond the "comfort zone" of most media historians who have no knowledge whatsoever of analogue electronics. On the other side of the "two cultures" divide, even young engineers know little of thermionics, cathode rays and a myriad of other forgotten technologies. This important facet of television's history is now only recorded by older engineers and by amateur groups known rather disparagingly to media historians as "enthusiasts", "maintainers" or "collectors". Is this a problem? It certainly is, and in this paper, by using examples, I will show how material artefacts can help us understand television's history.

Introduction

Traditional media history research has concentrated on programme content, context, production and audience impact. Whilst these are important, the neglected industrial story is equally compelling, as are governmental politics, commercial imperatives and technological development in related fields. The academic discipline of HST (History of Science and Technology) goes a long way towards offering a proper methodology for the understanding of television's technological history, but it has generated little in the way of specific research. It does at least offer some explanations as to how the development of analogue television was shaped by contemporary politics, economics, user responses and cultural background, but there is precious little of it.

The public is not as technically illiterate as may be believed by some museum personnel and playing to the lowest common denominator is not the answer. Museums such as the National Science and Media Museum in Bradford (part of the Science Museum Group) have pushed out most of their television artefacts to storage and little remains of the once large television gallery. The original television galleries had gone to great lengths to describe how traditional analogue television works but those disappeared 20 years ago.

Other branches of engineering, notably aviation, motor engineering, computing, steam power, railways and maritime have all managed to achieve a balance between proper coverage of the technology and mass accessibility. It has not happened in broadcast engineering history and high-quality, technically competent graduates are not being produced as there is no funding from any source and no support from academe. In this, I include museum curators and administrators where there are precious few technically qualified individuals able to co-ordinate training and best practice. One of the few bright spots is the Sandford Mill Museum in Chelmsford Essex which is achieving results by using volunteer retired professional engineers. Sadly, there is no money there for training a new generation and long-term continuity will not happen. Except for Sandford Mill, most UK museums are merely storing and cataloguing items with no serious attempts to properly present technology-centred exhibits. Another small UK museum that is attempting to integrate technology is the Burntisland Museum of Communication, but television broadcasting is only a small part of its wide remit.[1] The situation in the USA is much brighter with several private museums now in existence concentrating on television technology and restoration.[2] These are proper bricks and mortar museums – not virtual, online operations – with significant collections and staff with high technical ability. There is no UK equivalent, and none that I know of in Europe other than in Russia.[3]

The UK population's fascination with old technology, be it aeroplanes, railways, steam power or cars, curiously, spans the generations. Major attractions having real, operational hardware such as at air shows, preserved railways and even steam water pumping stations attract a good mix of young and old, male and female. Steam power preservation attracts quite large numbers of younger participants keen to learn, pass the necessary safety examinations and work all hours. The problem of running period exhibits is not as daunting as cost-cutting major museums sometimes declare. There are certainly issues such as the availability of competent staff, but by running the equivalent of "steam and oil days" where exhibits are run for a limited period, the resources needed can be manageable – especially with volunteer labour.

The desire to use residual hardware rather than just a static exhibit is highly commendable, but there is also now a looming skills crisis. As an engineer working for decades on advanced electronic product design and research I have observed the gradual change in the knowledge base of new graduates entering the profession. This is to be expected as the vocational demands shift away from older forms of electronics towards digital platforms and computing. This has produced a mindset which thinks almost exclusively "digital" and any traditional analogue electronic skills are for older engineers and a relatively small cohort of modern entrants into specialist fields. Such has been the speed of progress that much of the knowledge base expected of an electronic engineering graduate forty years ago is now not required. This is particularly so in the sub-discipline of television and broadcast engineering. A humble modern television set bears little technological resemblance to one produced even as recently as thirty years ago. It still has a screen and a loudspeaker, but beyond that the core technologies are radically different.

At the same time, the recording and preservation of these older techniques and practices has not kept pace with the year-on-year loss of knowledge and practice from within the profession. In the specific case of broadcast television, the emphasis has been on programme production techniques, artistic considerations and audience response with the technology being considered only at a very superficial level, if at all. An important positive trend has been in the field of the History of Science and Technology (HST) where a multitude of external factors affecting the development and deployment of a technology are considered. Caught between the "user histories" (often oral with strengths and many weaknesses) and the broader HST analyses, the actual practice and history of television technology has been left to online forums, superficial broad-brush narratives and specialist internalist publications. This a problem, and the time has come for core technologies (not "computing", but in disciplines such physical optics and analogue electronics) to be appreciated and incorporated in the field of media studies history using the best HST methodologies.

Other than material produced by personal websites, clubs and societies, written television history in the United Kingdom over the crucial period 1960 to 1970 has largely been produced by journalists, media academics, broadcasting organisations, ex-cameramen and other programme production staff. The BBC manages its own history on its own terms and ignores important aspects such as domestic television development, transmitters, engineering infrastructure and absolutely all aspects of manufacturing. ITV does almost nothing as it has no desire to resurrect the once wonderful regional television companies. All the manufacturers were gone decades ago. The story is much wider and deeper than has usually been presented with many tens of thousands of people working in the UK alone just in domestic television research and development, production, retailing and maintenance. The broadcast engineering equipment did not just appear from nowhere and the complex issues have all but been ignored by existing media studies narratives. Sadly, these wider and deeper stories are in the process of being lost.

The possibilities of using residual television hardware are wide, and I will now offer an example narrative spanning the approximate period 1960-1970 as a frame-work to describe some past achievements and future possibilities. It is UK-centric, but it is likely that the situation can be replicated in one form or another in most countries. As the background narrative unfolds, I will consider how the restoration and conservation of items of television hardware can help our understanding and why there can be a useful role to wider society. In a small way, I have personally attempted to do this over many decades, but longer-term plans need to be made if future generations are to fully understand this vanishing technology. I have managed to fund operations through commercial hire of artefacts back into the sphere of film and TV production via a partnership known as "Golden Age Television".[4] I have not attempted to describe this business as it is a commercial operation, but it has served to fund what amounts to a "living museum" of broadcast technology.

Television engineering in the United Kingdom from 1960 to 1970

– some history and some opportunities in engagement with residual historic hardware.

Broadcasters and the television industry in the United Kingdom in the early 1960s

British television re-opened in 1946 using the pre-war BBC television standard of 405-lines, 50 field, interlaced. This was despite warnings that the system was already out-dated. By 1950 it was clear that the country had been left behind with 625-line, 50 field, interlaced becoming the standard as services began in Europe. By the late 1950s and early 1960s, broadcasters and government thoughts turned to how the country's technologically dated television service could be brought up to date and how a colour service might eventually become a reality.[5]

Meanwhile, the USA and other 60 Hz mains countries had adopted 525-lines at 60 Hz, interlaced. This was a clear demarcation based on the practical problems of avoiding "hum bars" in systems not using television field rates native to the local mains supply.[6] Services in France and Belgium with higher line rates (819 line) had suggested that was a step too far with the known technology. Thus, having 50 Hz mains, the UK could realistically only move to 625-line, 50 field, interlaced, but when – and what about colour?

In 1955, the BBC's monopoly was broken with the advent of Independent Television (ITV) which also had to operate using the national 405-line television standard. By the early 1960s, with vast numbers of domestic 405-line televisions deployed and the whole of the VHF television broadcast band in the UK taken up with the standard, the government finally decided to begin the new BBC2 service in 1964 on 625-lines on UHF as recommended in the Pilkington Report.[7] This was a step towards a modern service and with major European neighbours all planning for colour, the UK broadcasters had to act quickly if they were to keep up.

Whilst the UK broadcasters were behind with the national television standard, that was not the case with the UK's principal broadcast equipment manufacturers in the form of Electrical and Musical Industries (EMI), Marconi's Wireless Telegraph Company Ltd. (The Marconi Company) and Pye Ltd. All three were selling equipment across the globe to American, continental and colonial television broadcasters. Pye was a wholly owned subsidiary of Philips but had been allowed autonomy in the field of television, although this only continued until the mid-1960s. The two truly indigenous broadcast companies – Marconi and EMI – had previously joined forces in 1934 to form Marconi-EMI Television Ltd., with EMI developing cameras based on RCA's iconoscope technology and Marconi providing transmission systems. EMI needed the partnership as it had no transmitter capability and the key television camera patents came via the Marconi Company's close relationship and historical patent rights with RCA. The partnership did not last and was dissolved in 1948 with Marconi wishing to expand its rights to the RCA technology by developing its own 3" tubed Image Orthicon cameras. EMI continued to pursue development of their already dated line of Emitron cameras using its in-house UK manufactured tubes. Pye also developed successful 3" Image Orthicon cameras in the UK independently of its Philips parent. By the mid-1950s, the Image Orthicon technology had won out and had become the standard for black and white broadcast television throughout the world. Marconi, EEV and RCA went on to develop the superior 4.5" Image Orthicon used globally for quality black and white television, winning the company an EMMY Award in 1961.[8] The Marconi Company was arguably the pre-eminent manufacturer in the field and made its own in-house tubes via English Electric Ltd. (EEV) in Chelmsford, Essex. The company was also a powerful global player in the field of broadcast transmitters and antennas, both for sound radio and TV.

The domestic television manufacturers and markets were very parochial but there were several major players. Classic brands were being consolidated and the larger UK electronic companies were gradually buying up smaller competitors unable to reap the economies of scale. Production of consumer electronic equipment was slowly being concentrated in the hands of a few large companies, notably the Rank Organisation, Philips, GEC, Decca and Thorn. The UK's backward-looking television standard was a double-edged sword – on the one hand they struggled to export goods but on the other they were protected from imports as foreign manufacturers largely did not wish to make "specials" solely for the strange 405-line UK market. The small number of independents such as Ekco, KB, RGD and Defiant (part of the UK's Co-operative group) were facing challenges to survival and did not see the decade out. As BBC2 rolled out, "dual-standard" 405/625 sets became the norm and as colour became available, dual standard colour sets which were horrendously complex, expensive and unreliable. It was not a good situation for them.

Opportunities for engagement from the early period

The early period of my narrative – the early-1960s – has now passed into a time when the baby-boomer generation has become ever-more nostalgic and keener to re-live its youth, either openly or without realising it. Old television technology is part of that desire as memories of television sets and programmes come to mind. Over the years I have many times exhibited operational classic black and white Image Orthicon television cameras, both at public events typically using one of my period Outside Broadcast units, or as a "stand-alone" single camera at an event or project. One such project undertaken was "TV 70" developed at the request of a group known as the "Test Card Circle" (TCC) dedicated to research into television test cards.[9] The event was to celebrate 70 years of British electronic television marking the opening of the BBC's "high definition" television service in 1936. The BBC – for whatever reason – had declined to mark the event and the TCC set about organising their own event at the old BBC Studios at Alexandra Palace. Running three fully operational period Image Orthicon cameras from one of my large period Outside Broadcast units, we were able to produce a saleable programme on DVD celebrating the BBC history for it with no help or encouragement from the BBC. The turn-out of older presenters and important figures from British television history was gratifying and the event was a major success and an adventure in "living history". Whilst the BBC as good as cold-shouldered the event, it was a far better celebration than they mounted with budget and resources for the 75th and 80th anniversaries. In addition, it acted as a catalyst in the process to re-launch a complete period analogue television station in the London area running on the traditional 405 lines using as much period equipment as possible. This project is still on-going and now known as the British Television Heritage Group (BHTG), it has had some success in securing the vital transmission licensing with transmission tests about to begin in 2018.[10] Even vintage transmitters are to be incorporated into their plans with the restoration of a CG1 VHF Band I television transmitter.

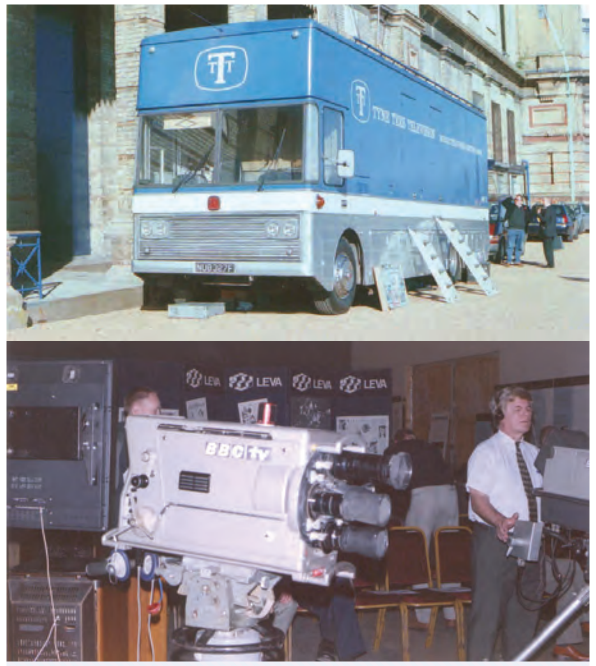

Figure 1 TV70 Event at Alexandra Palace, London 2006. Top: Restored 1968 operational Outside Broadcast unit and bottom: Marconi MkIV Image Orthicon television camera in use on the day.

One of my own group's activities, *Project Vivat*, will also have a part to play in this. Although *Project Vivat* concerns the re-creation of an operational early 1950s BBC/Marconi Outside Broadcast unit which is slightly outside the period under consideration here, it is of a type that was still very much in use in the early to mid-1960s.[11] 405-line television has a large following in the UK, although it must be admitted that it is primarily amongst the older generations. However, it has become encouraging to note the enthusiasm surfacing from younger people keen to understand how to restore cathode ray tube (CRT) televisions. This is evidenced by participation in several UK based online forums, the largest of which is the *UK Vintage Radio Repair and Restoration Discussion Forum*.[12] As in the world of steam power preservation, there is a new interest from younger people and BTHG 405-line transmissions will likely lift that as it develops.

Part two of this article will appear in the next IST Journal edition, where I will turn towards the stirrings of colour television which was a very hot topic in Europe the mid-1960s.

Author

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Paul began the early part his 40-year electronic engineering career as a student apprentice with The Marconi Company. He has since worked for a number of companies on many prestigious engineering projects in the UK and world-wide. In addition to his "main" career, Paul has run "Golden Age Television" (see: **www.golden-agtv.co.uk**) with Dicky Howett since 1992, which has helped to support Paul's ever-growing collection of broadcast television equipment. He has collected and restored to operational condition a vast quantity of broadcast TV equipment, including two 12 ton outside broadcast units. Paul completed a part-time PhD (Manchester University, History of Technology) researching the early history of TV.

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From the archives
The misfortunes of John William Bell

Alan Gall, IST Archivist

'Tis impossible to be sure of anything but death and taxes'
Christopher Bullock (1716), *The Cobbler of Preston*

Introduction

Pigot & Co's Directory of Lancashire for 1828/29 describes the industrial activities in and around the village of St. Helens: **"The manufacture of crown, plate and flint glass is a branch of great consequence here, and the 'Ravenhead Plate Glass Co.' and the works of 'Messrs. West & Co.' and others, are upon a very extensive scale."** Not yet listed under the heading of "Glass Manufacturers" is The St Helens Crown Glass Company. Formed in 1826, it would outlast all the others and eventually boast factories on five continents under the more familiar name of Pilkington Brothers.

The six founders of The St Helens Crown Glass Company were: John William Bell, Thomas Bell, John Barnes, James Bromilow, Peter Greenall and William Pilkington, although there is a suggestion that Pilkington joined the partnership later than the others.[1]

Of these men, only the Bells knew anything about glassmaking and the whole enterprise relied heavily on their expertise. The new company did, however, have substantial financial backing from the others. As we know, the firm went on to dominate plate glass making, and this despite the early setback of losing John William Bell. Financial problems caused the Bells to sell their stake in the embryonic "Pilkington" enterprise and lose out on future prosperity.

The Bells, the Bells

Figure 1. An early view of St Helens (A Scrapbook of Greenall Whitley, 1977)

John William Bell started making flint glass in a disused iron foundry around 1822. Seven years or so later, Pigot's directory gives the names of two businesses: Bell & Co for crown glass and John William Bell & Co for flint glass. At some point, John's younger brother Thomas joined the firm and the manufacture of crown glass appears to have been discontinued not long after. John would eventually leave his brother to be in charge of the Ravenhead Flint Glass Works while he concentrated on the Ravenhead Glass Bottle Works. These are not to be confused with the Ravenhead Plate Glass Company, which enjoyed fame as the largest glassworks in the country and was bought by Pilkington in 1901.

From burial records it is estimated that the birth of John William Bell occurred in 1783, possibly in Cumberland[2] like his brother Thomas. John's father, also called John, is described as a glass manufacturer in the banns posted for Thomas's marriage to Jane Robinson on 1 January 1840 at Prescot Church. John married Eliza, as is known from her role as executrix of John Bell's estate, but no record has been found that the union produced any children.

The taxman cometh

At the time of Pigot's 1828/29 directory, crown and plate glass makers suffered from what in modern parlance would be called "a double wammy": a glass tax and a window tax. The glass tax varied according to the type of glass and its form. Imported glass was subjected to both import duty and excise duty. Window tax severely reduced demand and when introduced led to the ridiculous situation of people bricking up windows to save costs.

A disgruntled reader of the *Morning Chronicle* wrote on the subject of crown glass for conservatories and glasshouses in 1817.

It is to be lamented that these beings [the tax collectors] **are generally paid by a percentage on what they can screw out of their fellow subjects. A liberal Government ought to repress that spirit of inquisition now displayed by their more sordid servants.**[3]

Professor Theo Barker (1977) reports in his history of Pilkington how some glassmakers had devious means of avoiding at least some of the tax on glass. There is no suggestion that Bell indulged in such activities but the Commissioners of Excise decided that he had, and estimated the missing duty at about £243. A considerable amount in those days, although in the light of future events it might have been wiser to pay up. Bell refused and it went to the Exchequer Court in London on 16 February 1828. An overwhelming majority of the jury found for Bell and the Commissioners were not pleased. This displeasure took the form of demanding a re-trial – again found in Bell's favour, but the Commissioners were not good losers. The threat of a third trial hung over John Bell as he continued with his business activities.

The Commissioners had another go at John Bell in 1833 over a quantity of flint glass delivered to Liverpool docks for export. Regulations decreed that any flint glass valued at less than 11d (old pence) per pound weight could not be exported. Any attempt to do so risked forfeiture of the entire consignment. Taxes were at the back of this edict. Glass produced for home consumption attracted a duty of 6d per pound but to encourage export received 7d per pound back. The Excise swooped on some 5000 pounds of Bell's glass products and carried them off into custody.

This latest assault returned Bell to the Court of Exchequer on 19 March 1835. The Crown did its best by calling on some London manufacturers to declare the value as less than 11d.[4] Witnesses from Liverpool, called by the defence, countered with figures between 12d and 12½d. Henry Leadbetter, Bell's clerk, gave documentary evidence that the 6d duty had been paid as required. Once again, the Excise men were defeated and, presumably, the glass returned or compensation made.[5]

An open letter to the MP Sir Henry Parnell, sent to *The Times* from a person identifying himself only as "R. L.C.", gave readers some statistics on the usage of window glass. The letter claims that comparing the three years ending in 1791 with the same period ending in 1828, glass consumption increased by less than two percent. Using the same criteria, building materials (bricks and tiles) had nearly doubled. The author put this down to window tax and proposed a replacement with a house tax that would generate the same revenue, stimulate the glass industry and be more palatable to the householder.[6] The hated tax eventually passed into history in 1851. Glass tax itself, introduced in Great Britain in 1746, had been repealed in 1845. *The Penny Satirist* celebrated the event with a cartoon (figure 2) entitled "THE DUTY OFF GLASS: OR, A COUPLE OF YOUNG SMASHERS."

Figure 2. Go it, my pippin, we'll have a regular smash at old unc's hot-house, by way of a jolly lark, now tax is coming off glass. It won't cost old Wirewig more than a penny a pane after the 14th of April (The Penny Satirist, 12 April 1845)

Pilkington

The formation of the St Helens Crown Glass Company in 1826 owed much to John William Bell who secured the land for a new factory near his own works and undertook to be both works and sales manager. In addition to teaching the other partners the art of glassmaking he had his own business to look after.

As pleasing as it must have been to get a successful outcome in the battle with the Commissioners of Excise during 1827-28, the protracted defence cost time and money. John Bell deemed it necessary to sell part of his shares in The St Helens Crown Glass Company. At the end of 1827, with the first court case shortly to begin, half of his two-elevenths went to Greenall, Bromilow and Pilkington. The other half followed not long after and Thomas Bell sold all of his eleventh. Thus, the Bell brothers lost their chance to capitalise on the good times to come.

Figure 3. Peter Greenall, founder member of the St Helens Crown Glass Company, brother-in-law of William Pilkington and brewer (A Scrapbook of Greenall Whitley, 1977)

Before his departure, John Bell must have actually had some spare time to teach William Pilkington the rudiments of glassmaking. Active day-to-day management now rested with Pilkington. Two other partners also departed: James Bromilow, son of local coal proprietor William Bromilow[7] and John Barnes. They were bought out by William Pilkington in 1829 after the discovery of Bromilow's lax accounting practices. The Pilkingtons now held eight of eleven shares, Peter Greenall the remaining three. Greenall's involvement ceased with his unexpected death on 18 September 1845. To cut a long story short, having invented the world-beating float process for sheet glass manufacture the firm lost its independence in 2006 when it became part of the NSG group (Nippon Sheet Glass).

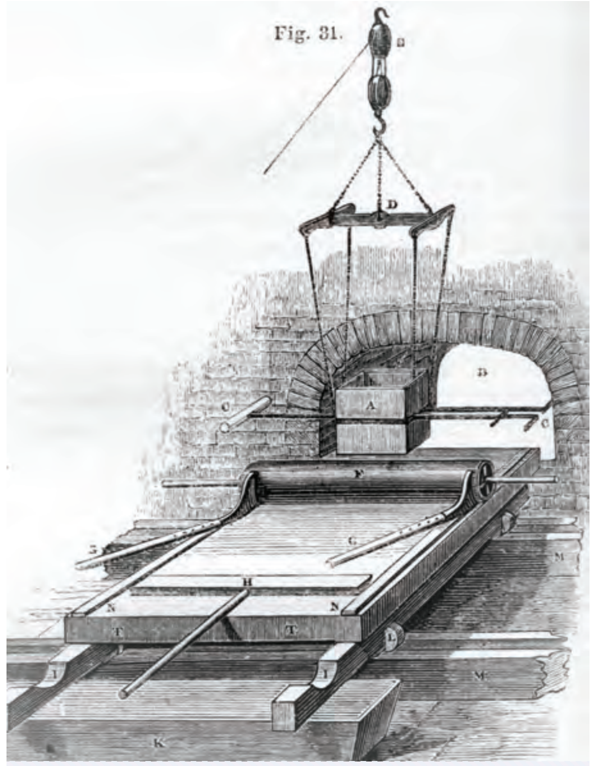

Figure 4. An illustration of plate glass manufacture from Chemistry as Applied to the Arts and Manufactures. See appendix for description

Figure 5. Like the St. Helens factories, this glassworks at Lemington-on-Tyne stood in an area well served with local coal supplies. The only surviving part of this works is a brick-built glass cone, constructed in 1797 and now a Grade II listed building (picture source: The War Work of the GEC, c.1920)

The runaway apprentice

Samuel Asbury agreed to serve a glassblowing apprenticeship at John Bell's works. This began in September 1832 and should have terminated after three full years. However, for reasons we do not know, he absconded with less than six months left of his contract. Now, others might have accepted the situation, but not John Bell. He sent Henry Leadbetter to see a local Justice of the Peace and secured a warrant for Asbury's arrest, citing "diverse miscarriages and misconduct".

In an attempt to put plenty of distance between himself and St Helens, Asbury had fled to Scotland. By some means his location was discovered and officers sent to apprehend the unfortunate youth. To complicate matters, he had signed up to a four-year apprenticeship with Watson, Pellatt & Company, flint glass makers of Glasgow. So, when Asbury received a knock on the door from officer's intent on enforcing the English warrant, a second one issued by request of Watson, Pellatt & Company prevented his removal. In fact, the return of Asbury to Lancashire almost succeeded. The Scottish authorities only caught up with the group as they were about to leave on a steam boat for Liverpool. John Bell and the Glasgow company then agreed that Asbury could remain at liberty pending resolution of the legal conflict.

The case came before the Court of Session in Edinburgh to decide which body had jurisdiction. It all hinged on whether the warrants could be considered as being for a civil or a criminal offence – if criminal, Asbury would face an English court. Bell maintained that since the offence could lead to corporal punishment it must necessarily be of a criminal nature and must be tried "by the criminal judicature." John Bell had his way.

An untimely end

In 1836, Bell passed on the running of the Ravenhead Flint Glass Company to his brother Thomas and two partners: Henry Leadbetter (who had acted as John Bell's agent in securing the warrant against Samuel Asbury) and John Barnes (likely to have been the solicitor helping with the defeat of the Commissioners of Excise, and an ex-partner in the St Helens Crown Glass Company). Business continued for John Bell as a glass bottle maker in partnership with Joseph Parkin and John Woolstencroft, known as J. W. Bell, Parkin & Co. Thomas Bell did not retire as a glass maker. The Ravenhead Flint Glass Company failed after the deaths of Leadbetter and Barnes.[9] Thereafter, Thomas found work as a commercial traveller in the glass trade.

John Bell had connections with Liverpool. In fact, while running the Ravenhead Flint-Glass Company at St Helens he also operated as George Burdy & Co, flint-glass merchants, in Liverpool. The partnership with George Bundy ended in 1824.[10]

A trip to Liverpool in 1838 turned out to be his last. While on the return journey in a gig (a light two-wheeled carriage) his horse caused him to be thrown to the ground where he was then run over and crushed. The horse made its way in the direction of the glassworks and the following morning John Bell died of his injuries.[11]

Appendix.

Glass varieties mentioned in this article

Crown glass

Used for making window panes. In John Bell's day the process of forming the panes started by blowing large globes on the end of a long pipe. These were then flattened into a circular plate by rapid rotation, and cut to size. The formulations in use varied considerably from one glassworks to the next. After 1831, when sodium carbonate was introduced to replace kelp ash, recipes for window glasses (crown and sheet glass) were chiefly based on sand, sodium carbonate and lime.

Flint glass

Also known as crystal, and more appropriately as lead glass, the name is a throwback to the days when the source of silica came from flints that were calcined and ground. Sand from selected locations replaced the flint and the other main ingredients were potash and lead oxide. It found use in the lenses for optical instruments and the manufacture of domestic products: bottles, drinking glasses, ornaments and vases, for example. The general method for blowing glass is described in *The Dictionary of Trade, Commerce & Navigation* (1844).

The art of glass blowing, or converting melted glass into the form requisite for the various utensils made from it, is performed by the workmen taking in hand a long hollow tube of iron, called a blow-pipe; dipping this into the glass pot, it will take up a portion of the melted glass or metal, as it is called by the workmen: then being withdrawn from the furnace, with the metal attached to it, the workman blows into the opposite end of the tube; the metal yields to the impulse of the breath, swells out like a bladder … and becomes a round hollow ball, which the workman fashions by rolling, pressing, and bending, while in a fluid state, into any required shape or size.

Plate glass

Basically, made from the same materials as crown glass, it differs in the forming method. With reference to figure 4, molten glass is poured from a cuvette (A) onto a flat surface. Two workmen move a copper roller (F), said to be three feet in diameter, to spread the glass uniformly, while other operators prevent overflow of the material from the sides with iron struts (G). Another workman draws a "washer" (H) over the surface to remove impurities. The sheet is then moved into the annealing oven. A labour intensive and punishing procedure for those involved.

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Other sources are mentioned in the text and in the notes.

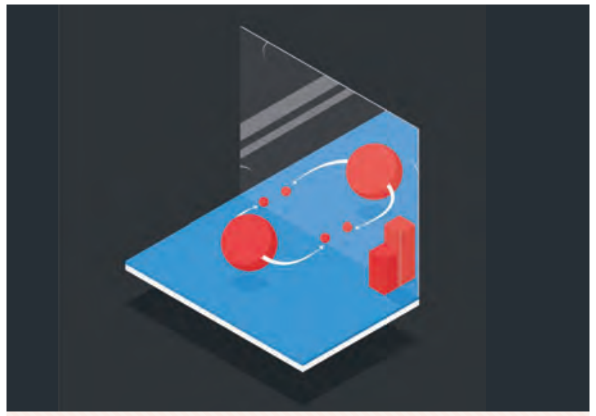
Acknowledgements

Thanks to criminologist and author Martin Baggoley for providing the report on John William Bell's runaway apprentice and to John Barlow for the loan of *Chemistry as Applied to the Arts and Manufactures*.

Notes

1. T.C.Barker (1977, 33-34).
2. In 1974, Cumberland was merged with Westmorland and parts of Lancashire to form Cumbria.
3. "Tax on glass-houses and conservatories", *Morning Chronicle* 9 December 1817.
4. One of London manufacturers called was Pellatt & Green. Its connection (if any) with Watson, Pellatt & Co of Glasgow in the runaway apprentice case mentioned in this article has not been investigated. Michael Faraday worked with Pellatt of London on flint glass for optical purposes. Apsley Pellatt is a notable figure in the chemistry of glassmaking.
5. *Liverpool Mercury*, 22 May 1835.
6. *The Times*, 31 March 1830.
7. James Bromilow's firm is listed under "Coal Owners" in Pigot's 1828/29 directory as "Bromilow, Haddock & Co, Ravenhead. The name Haddock also appears as Clare and Haddock, St Helens Colliery and Clare as William Clare & Co, Union Colliery.
8. *The London Gazette*, 2 February 1838.
9. *Liverpool Mercury* 29 October 1847.
10. *The London Gazette*, 1 January 1825.
11. *Liverpool Mercury,* 19 January 1838.

New research result from CERN is a milestone in the history of particle physics



A CP-symmetry transformation swaps a particle with the mirror image of its antiparticle. The LHCb collaboration has observed a breakdown of this symmetry in the decays of the D0 meson (illustrated by the big sphere on the right) and its antimatter counterpart, the anti-D0 (big sphere on the left), into other particles (smaller spheres). The extent of the breakdown was deduced from the difference in the number of decays in each case (vertical bars, for illustration only). (Image Credit: CERN)

The LHCb (Large Hadron Collider beauty) experiment has announced the first ever observation of CP violation in the decays of charm mesons. This represents a milestone in particle physics and UK physicists have been at the heart of this research.

The research finding from the LHCb collaboration at CERN shows, for the first time ever, the differences in matter–antimatter behaviour known as CP violation in a particle dubbed the D0 meson. The finding is sure to make it into the textbooks of particle physics.

Dr Marco Gersabeck, Lecturer in Physics, The University of Manchester said of the finding:

"The discovery of CP violation in charm is a major breakthrough in charm physics and for particle physics as a whole. Having pioneered the use of charm particles produced directly in the LHC collisions and having worked on the present analysis method before, it is great to have achieved this discovery. This marks the start of the era of precision physics in charm and I'm looking forward to many more exciting results."

Professor Tara Shears, who leads the University of Liverpool LHCb group made the point that:

"It's taken a full analysis of all the data we've collected so far to finally see this tiny but profound effect. Understanding the nature of CP violation is one of the biggest mysteries we have – and seeing it displayed here, in charm mesons, provides a whole new laboratory to study it in. This observation is just the first step in our exploration. Now we want to see what charm quarks can tell us about it."

The term CP refers to the transformation that swaps a particle into its antiparticle. The weak interactions of the Standard Model of particle physics are known to induce a difference in the behaviour of some particles and of their CP counterparts, an asymmetry known as CP violation.

Currently the LHCb detector at CERN is undergoing a substantial upgrade ready to come back online in 2021. The upgrade will allow it's LHCb to analyse ten times more data than it has taken so far.

UK Spokesperson for the LHCb is Professor Tim Gershon from the University of Warwick and he is keen to see just what the massive increase of data will be able to tell us.

"This CP violation is necessary to induce the processes that, following the Big Bang, established the abundance of matter over antimatter that we observe in the present-day universe. We have a lot more work to do in this research field to fully understand what is taking place and this means that when the LHC comes back online in 2021 the new capabilities of LHCb could bring us closer to answering key questions around the Standard model of Physics."

The size of CP violation observed so far in Standard Model interactions is too small to account for the present-day matter–antimatter imbalance, suggesting the existence of additional as-yet-unknown sources of CP violation.

The result has a statistical significance of 5.3 standard deviations, exceeding the threshold of 5 standard deviations used by particle physicists to claim a discovery, and proved that we finally have the capability to study the delicate effects of CP violation in charm quarks. But a discovery is just a beginning. In the larger datasets the upgraded LHCb will collect, charm quarks will allow a search for possible new sources of CP violation. The results will spur theoretical work on to see if they also reveal cracks in the Standard Model, or it stands firm again.

References

1. The **LHCb (Large Hadron Collider beauty)** experiment is one of seven particle physics detector experiments collecting data at the Large Hadron Collider at CERN. LHCb is a specialised b-physics experiment, designed primarily to measure the parameters of CP violation in the interactions of b-hadrons (heavy particles containing a bottom quark). Such studies can help to explain the matter-antimatter asymmetry of the Universe. The detector is also able to perform measurements of production cross sections, exotic hadron spectroscopy, charm physics and electroweak physics in the forward region. The experiment is located at point 8 on the LHC tunnel close to Ferney-Voltaire, France just over the border from Geneva. The (small) MoEDAL experiment shares the same cavern.

Heriot-Watt scientists use ultrafast laser to weld glass and metal together

Photo Credit: TRUMPF GmbH + Co. KG

A method of welding glass and metal using an ultrafast laser system, developed by EPSRC-funded scientists at Heriot-Watt University, has been described as a breakthrough for the manufacturing industry.

The materials are fused together using very short pulses of infrared light; the pulses last only a few picoseconds. A picosecond compared to a second is like a second compared to 30,000 years. To weld the two materials, the laser creates a microplasma, described as a tiny ball of lightning, between them.

The process could have direct applications in the aerospace, defence, optical technology and healthcare fields.

Professor Duncan Hand, Director of the EPSRC Centre for Innovative Manufacturing in Laser-based Production Processes based at Heriot-Watt, said: **"Traditionally it has been very difficult to weld together dissimilar materials like glass and metal due to their different thermal properties – the high temperatures and highly different thermal expansions involved cause the glass to shatter."**

Being able to weld glass and metals together will be a huge step forward in manufacturing and design flexibility. Various optical materials such as quartz, borosilicate glass and sapphire were all successfully welded to metals like aluminium, titanium and stainless steel using the laser system.

"The welds remained intact when tested at -50C and 90C. So we know they are robust enough to cope with extreme conditions" said Professor Hand.

Hens that lay human proteins in eggs offer future therapy hope

Chickens that are genetically modified to produce human proteins in their eggs can offer a cost-effective method of producing certain types of drugs, research suggests.

The study, which has initially focused on producing high quality proteins for use in scientific research, found the drugs work at least as well as the same proteins produced using existing methods. High quantities of the proteins can be recovered from each egg using a simple purification system and there are no adverse effects on the chickens themselves, which lay eggs as normal. Researchers say the findings provide sound evidence for using chickens as a cheap method of producing high quality drugs for use in research studies and, potentially one day, in patients.

Eggs are already used for growing viruses that are used as vaccines, such as the flu jab. This new approach is different because the therapeutic proteins are encoded in the chicken's DNA and produced as part of the egg white.

The team has initially focused on two proteins that are essential to the immune system and have therapeutic potential: a human protein called IFNalpha2a, which has powerful antiviral and anti-cancer effects, and the human and pig versions of a protein called macrophage-CSF, which is being developed as a therapy that stimulates damaged tissues to repair themselves.

Just three eggs were enough to produce a clinically relevant dose of the drug. As chickens can lay up to 300 eggs per year, researchers say their approach could be more cost-effective than other production methods for some important drugs.

Researchers say they haven't produced medicines for use in patients yet but the study offers proof-of-principle that the system is feasible and could easily be adapted to produce other therapeutic proteins.

Protein-based drugs, which include antibody therapies such as Avastin and Herceptin, are widely used for treating cancer and other diseases. For some of these proteins, the only way to produce them with sufficient quality involves mammalian cell culture techniques, which are expensive and have low yields. Other methods require complex purification systems and additional processing techniques, which raise costs.

Scientists have previously shown that genetically modified goats, rabbits and chickens can be used to produce protein therapies in their milk or eggs. The researchers say their new approach is more efficient, produces better yields and is more cost-effective than these previous attempts.

The study was carried out at The University of Edinburgh's The Roslin Institute and Roslin Technologies, a company set up to commercialise research at The Roslin Institute.

"These recent findings provide a promising proof of concept for future drug discovery and potential for developing more economical protein-based drugs," said Dr Ceri Lyn-Adams, Head of Science Strategy, Bioscience for Health with BBSRC.

Professor Helen Sang, of The University of Edinburgh's The Roslin Institute, said: **"We are not yet producing medicines for people, but this study shows that chickens are commercially viable for producing proteins suitable for drug discovery studies and other applications in biotechnology."**

Dr Lissa Herron, Head of the Avian Biopharming Business Unit at Roslin Technologies, said: **"We are excited to develop this technology to its full potential, not just for human therapeutics in the future but also in the fields of research and animal health."**

The research is published in BMC Biotechnology. The Roslin Institute receives strategic funding from the Biotechnology and Biological Sciences Research Council.

Space worms set to help researchers understand muscle loss

Following a space flight to the International Space Station and back to earth thousands of tiny worms are set to help researchers understand more about muscle loss in astronauts.

During spaceflight an astronaut's body changes. Losing muscle mass can affect their ability to work on a long space mission. Astronauts can lose up to 40% of their muscle after 6 months in space. Spaceflight is an extreme environment and changes to the body such as the loss of muscle and bone mass, can be the equivalent of ageing over 40 years in around a year-long mission. The loss of bone mass in space is only partially recovered within a year of returning to Earth. Astronauts have to exercise daily to limit harmful changes in the cardiovascular system and loss of muscle and bone mass.

The very small worms, which can only be clearly seen under a microscope are C. *elegans*. It seems incredible but, in many ways, the tiny worms are similar to humans and share some of the essential biological characteristics. The worms help show the effect of changes in space, including alterations to muscle and the ability to use energy.

Understanding the causes of muscle loss in space may help astronauts in the future and address health problems on earth. Muscle loss caused by ageing might be better understood and the research could improve treatments for conditions such as muscular dystrophies and diabetes.

The worm's flight to the International Space Station began from the Kennedy Space Centre in Florida, USA on 5 December 2018. The worms travelled in special bags full of food that allow gases to pass through. The bags were carried in an incubator. The worms reproduced in space and after growing to adults, in around 6.5 days, were frozen.

The worms returned to Earth on board the Dragon spacecraft capsule, splash landing into the Pacific Ocean on 13 January 2019. Upon returning to the University of Nottingham shortly after, they were unpackaged from their housing cassettes. The full post-flight analysis of the samples will commence this year.

The Molecular Muscle Experiment is being led by a team of scientists from Exeter, Nottingham, and Lancaster universities. This project is supported by The European Space Agency, UK Space Agency, BBSRC, MRC, and Arthritis Research UK.

For more information see: "Worms in Space: The Molecular Muscle Experiment" at **https://bbsrc.ukri.org/news/features/worms-in-space-the-molecular-muscle-experiment/**

Key role for UK industry in answering fundamental questions about the Universe

Powerful new particle accelerator will drive huge physics experiment

A major new physics facility near Chicago is expected to have UK technology at its heart, and lead to significant spin-off opportunities for UK companies.

In a cleanroom at Fermilab, a technician works on a string of superconducting 325-MHz spoke resonator cavities for the PIP-II particle accelerator. (Credit: Fermilab)

The new PIP-II particle accelerator at the Fermi National Accelerator Laboratory (Fermilab) will power the Deep Underground Neutrino Experiment (DUNE), which aims to address key questions about the origins and structure of the universe. The UK has committed a £65 million investment to help build and operate DUNE, PIP-II and technology for the neutrino beam.

British Consul-General for Chicago, John Saville, represented the UK Government at the PIP-II ground-breaking event at Fermilab today, which was also attended by members of the US Congress and Government.

Mr Saville, said **"The UK is proud to be a strategic partner in PIP-II through our provision of key accelerator components. The scale of PIP-II reflects the scale of our commitment to promoting scientific discovery and the benefits of innovation that flow from this. We are excited to work with our US and global partners in pursuit of these mutual goals."**

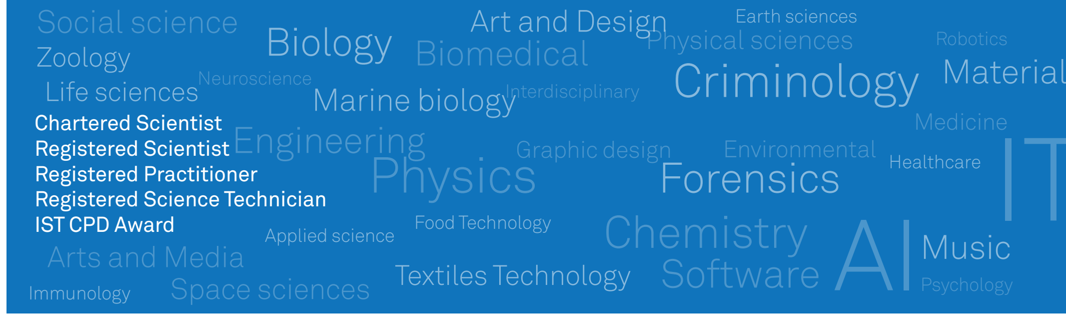
Professor Mark Thomson is the Executive Chair of the Science and Technology Facilities Council (STFC), and a former co-spokesperson for the international DUNE science collaboration. STFC is part of the national funding agency UK Research and Innovation.

He said: **"Projects like DUNE will provide new information about our Universe, but will crucially also provide inspiration to new generations of researchers, engineers and technicians. By stimulating the development of new technologies and their transfer to UK industry, these projects will help boost productivity and help achieve the Government's Industrial Strategy."**

The 200-metre-long PIP-II accelerator is the first accelerator project built in the United States with significant contributions from international partners. It will use the latest superconducting technology, and the UK is expected to win key contracts to provide the crucial cryomodules at the heart of the accelerator.

Peter McIntosh, the Deputy Director of the Accelerator Science and Technology Centre (ASTeC) at STFC's Daresbury Laboratory, which is the UK's Centre of Excellence for the study of the production, acceleration and delivery of charged particle beams, is leading one of the teams working on PIP II and said: **"LBNF/DUNE provides the UK's Daresbury Laboratory with a fantastic opportunity to harness its accelerator development expertise and use it to establish new manufacturing and system integration capabilities. Working in close partnership with UK industry and the team at FermiLab we can deliver critical superconducting accelerator systems for PIP-II, and this work will significantly strengthen the UK's accelerator delivery impact for decades to come."**

Dr Alec Gunner, New Business Streams Manager for the technology engineering specialists TWI said: **"The opportunities which arise from this project are firstly the project itself – the opportunity for UK industry to engage in large, prestigious Big Science programmes is an end in its own right. However, further possibilities arise from this programme as a consequence installing a world-class high vacuum electron beam welding facility in the UK. This is an enabling capability which is available for use by industry in the development and manufacture of high value assemblies, including niobium for the medical sector, titanium for use in satellite propellant tanks and zirconium for power applications. TWI will be engaging directly with its industrial members and the wider community to allow UK industry to take full advantage of this exciting new facility."**



Leading Your Technical Team

istonline.org.uk/training

The **Leading Your Technical Team Programme** (LYTT) consisting of the **Leading Your Technical Team** and **Building on Your Leadership Skills** courses is now offered through the IST.

The **Leading Your Technical Team** programme has a long and highly respected history. It has been running for well over 30 years. 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.

The courses are geared toward delivering the fundamental and key skill elements for leading and managing people, particularly in a technical team. Both programmes 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.

Each programme is delivered in the context of a higher education environment, but is not aimed at any specific job role or discipline. Participants are from a very broad range of higher education institutions, and from a very diverse range of academic disciplines and departments or service sections.

Leading Your Technical Team is intended for anyone, who might now or in the future, have technical management or supervisory responsibilities and is interested in developing their fundamental management/ leadership skills. It is a two-day programme that introduces the fundamental building blocks of management and leadership specifically in the context of technical support in universities and higher education colleges. The programme links practical leadership theories to dynamic team leading in context with the reality of managing in a technical university environment.

Deligate feedback

"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."

"I was able to learn the skills to solve some of the problems which I am facing myself in my leadership role."

Building on Your Leadership Skills 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 is applicable to support staff from academic and service areas. 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. The programme again puts practical leadership theories into context with the reality of managing and leading a technical team in a university environment.

Deligate feedback

"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."

For full course details and presenter profiles please see the LYTT Leaflet – Information (.pdf) and **LYTT Booking Form** at **istonline.org.uk/training** or contact:

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Technicians Make it Happen at Manchester Metropolitan University

Kate Dixon outlines initiatives in place at Manchester Metropolitan University (MMU) enabling Technical Services to overcome the national technical skills shortage.

At MMU, the Technical Services directorate employs 250 highly skilled and highly qualified technicians. Technicians are vital to delivering learning and teaching, research, and industry collaboration across a broad spectrum of subjects within STEM, creative, and digital subject areas. Technicians are the skilled workforce who ensure laboratories, workshops, theatres, edit suites, specialist computer labs, and TV and radio studios are equipped with innovative technology. Technicians provide the interface between a good idea and practical reality by guiding and making new technology accessible. Technical staff are vital to MMU's mission to educate industry-ready graduates.

Industry is becoming ever more technology enabled. With this in mind, the technology relevant aspects of MMU's courses and estate are becoming ever more important as we strive to ensure our graduates are work ready and our research facilities are cutting-edge, relevant and open to the wider business community. Our technology profile is of particular importance to many businesses wishing to set-up collaborative ventures and our technology portfolio relies directly upon the decision-making and knowledge of our technicians; this is another demonstration of the pivotal role technicians play within our university ecosystem.

In the UK 50,000 technicians are retiring every year and forecasts show UK PLC will need as many as 700,000 more technicians in the coming decade to meet demand from employers (Gatsby Foundation). MMU mirrors this national statistic; we have an ageing technician workforce of which 20% of our technicians across the university are ready for retirement in the next 3-5 years. In Manchester, our local digital, biotech, engineering, and creative industry sectors are performing well, and this is creating fierce competition when trying to attract skilled technicians into MMU's workforce. These factors combine to create a "perfect storm" – with an all-time high demand for technicians to work at our university against the very high demand across the region's industry to attract technical talent.

MMU is utilising the Apprentice Levy to respond to these challenges and to create a talent pipeline of technicians.

1. All of our technicians are offered the opportunity to be lifelong learners, enrol on CPD and, supported by the apprentice levy, undertake level 6 in-house degree courses, studying and developing their skills while they are in work.

2. Working in partnership with a local Further Education College the service recruited a number of level 3, post 18 Technical Apprentices. The apprentice technicians work across the University 4 days per week and attend college one day per week achieving qualifications as they work.

In summary: Using the apprentice levy ensures Technical Service teams are resourced to make a full contribution to the success of the university:

1. We produce Industry ready graduates with cutting-edge technology related skills, passed on by professional technicians

2. We maintain a cutting-edge technology portfolio

3. We attract and retain talented technicians to our workforce

Kate Dixon is Head of Technical Services at Manchester Metropolitan University

Cover images credit: Technicians Make it Happen For more information go to: technicians.org.uk