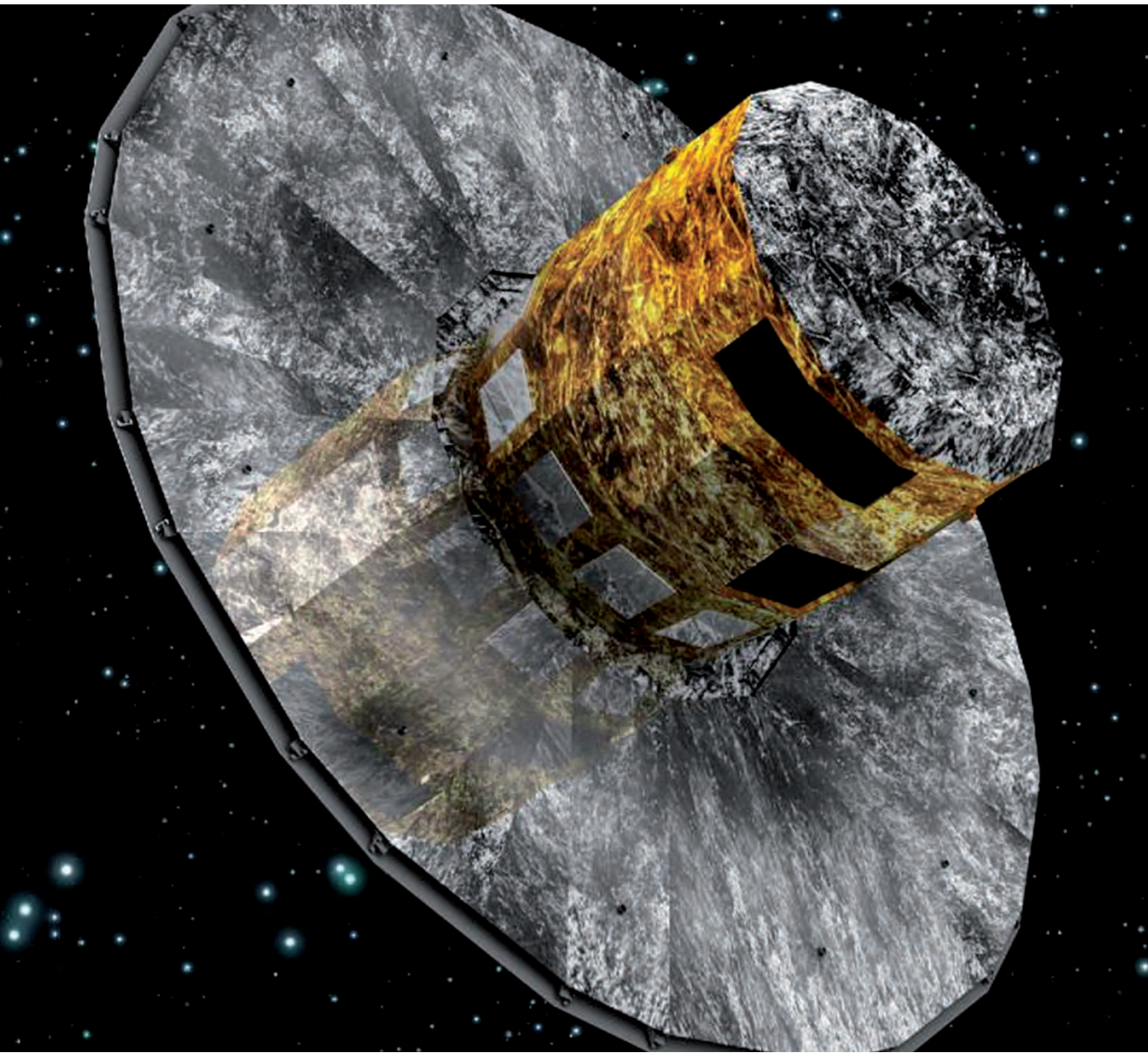
The Institute of Science & Technology



The Journal

Summer 2013

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Cover image courtesy ESA (European Space Agency)

The Journal

The Official Journal of The Institute of Science & Technology

The Professional Body for Specialist, Technical and Managerial Staff

Summer 2013

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Editor's welcome

Welcome, to a truly international edition of our Journal. I'm thrilled that we have article contributions from across four continents, all of which I'm sure you will find interesting. We have articles from Australia, Venezuela, Thailand, Malaysia, and of course the UK. We also have reports from Malta and an article about the rich natural "deposits" to be found on some far away islands.

My thanks go to everyone who contributed to this summer edition. Alan Gall, who is our IST Archivist and a mainstay of our editorial team, deserves a special mention. As does Chris Smith, who once again has done a great job leading the layout design and managing the printing. Welcome also to Adam Booth[1], our new resident cartoonist.

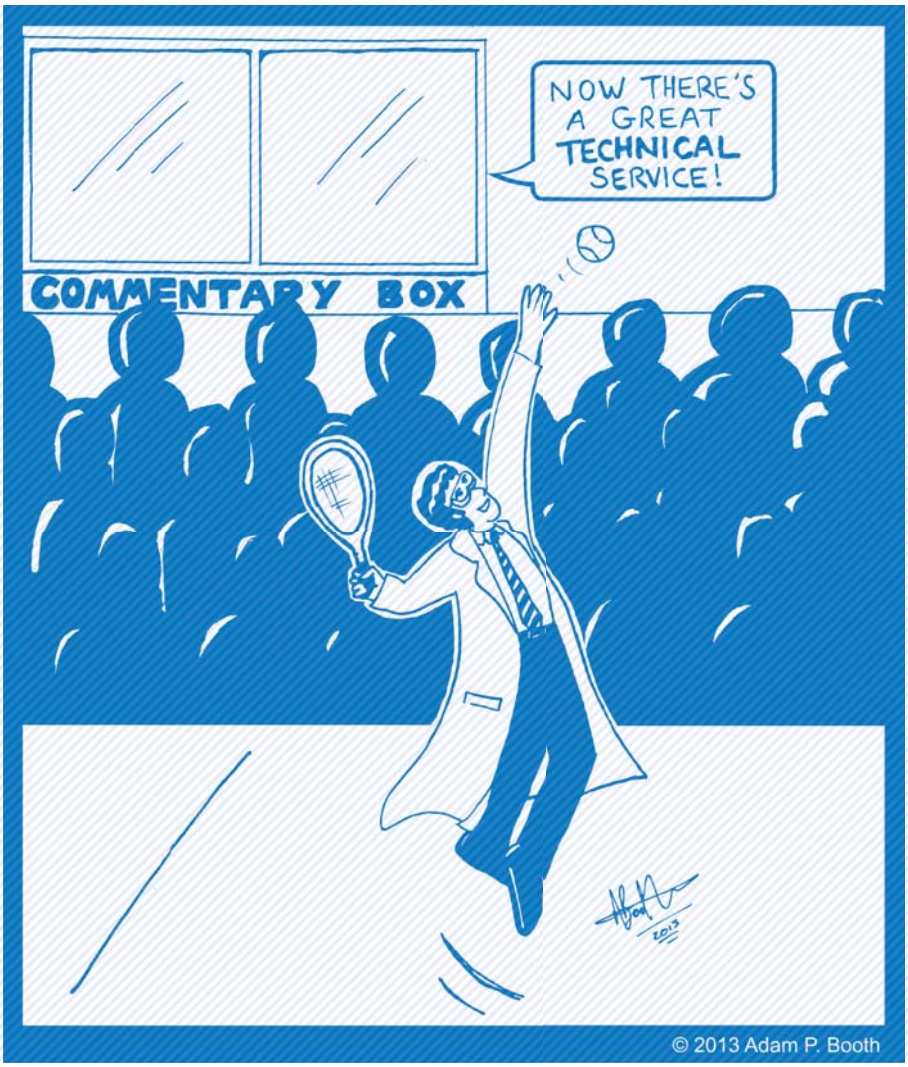
I would also like to include my thanks to Professor David Conroy, who continues to work tirelessly in promoting the IST and its Journal in Venezuela.

I have enjoyed the Wimbledon tennis tournament this summer, and as I followed it on the TV I heard one commentator refer to a particular player as "a great technician".

It appears that commentators in sport and also the arts regularly use this particular trope to separate skill from visual or emotional performance. They are implying that "the technician" is undoubtedly better skilled but that "the performer" is more fun to watch or engage with. And I guess that might be true, but it also depends on your definition of fun.

I take great comfort from a quote of A.N Wilson[2], who said of the recently deceased Apple supremo: "No one would deny that Steve Jobs[3] was a brilliant and highly innovative technician, with great business flair and marketing ability."

Wilson had of course, quite rightly, put technician skills first.



As did Jacques Pepin[4] when he said: “I tell a student that the most important class you can take is technique. A great chef is first a great technician.”

We know that technical roles are rarely glamorous, but they are grounded in reality and can be just as exciting and indeed fun.

The IST joined forces with S-Lab to stage this year’s S-Lab Conference held in Liverpool 17th-19th June. It was a great success, with well over 300 delegates. Terry Croft, our Chairman, chaired the event and our registrar, Michelle Jackson, led the organising and running of the conference. Michelle will be telling us how it all went in the next Journal edition.

Lastly, it is pleasing to see that our membership is continuing to grow and spread across the globe, and it is also good to see that our professional registration for technicians in the UK is now taking off.

Ian Moulson
Editor

1 Adam’s gallery link: http://mumblingwildebeest.deviantart.com.

2 Andrew Norman Wilson is an English writer and newspaper columnist, known for his critical biographies, novels, works of popular history and religious views.

3 Steven Paul "Steve" Jobs was the co-founder, chairman, and CEO of Apple Inc.

4 Jacques Pépin is an internationally recognized French chef, television personality, and author.

IST’s Derek Sayers and Philippa Nobbs man the IST stand

Left to right: Terry Croft, Sir Ian Diamond, Peter James, and Michelle Jackson

Terry Croft, IST Chairman, addressing the IST Conference Dinner held in Liverpool’s historic Liver Building

Chairman's view

I am a very lucky man. Not only do I have the privilege of leading the IST and working with your Executive team and backroom staff but also I believe I get a number of bonuses. Yes bonuses, a word that creates all sorts of feeling and reactions. However let me tell you about the bonuses I've received this year. The first one has been the opportunity to present to members of our technical community their richly deserved certificates of professional registration and the national recognition of their achievements that the Professional Registration scheme brings to them and you as a technician. This was highlighted at the recent S-Lab/PTSE Conference in June earlier this year where members received their certificates at the conference dinner celebrating their achievements amongst a wide audience of delegates and specialist group members (EMU, UCLAS and UBMA).

The second bonus has been the opportunity to present certificates to members who have been elected to Fellow of the Institute of Science and Technology. Their election has been for outstanding contribution to their area of work, dedicated commitment to their company or institution, outstanding research or academic achievement in their roles or a major contribution to their sector both locally and nationally.

My third bonus was the icing on the cake. I was privileged and delighted to be a guest of Professor Martin Humphries, Vice President and Dean of the Faculty of Life Sciences at University of Manchester, for their degree congregation where John Robinson, my predecessor and our current President of the IST, was awarded the University's Distinguished Achievement award. The University was recognising a member of our technical community for his lifetime commitment and dedication as a Professional Technician to their institution but also for his work nationally on your behalf through his Chairmanship of the IST. This was a wonderful day in an appropriate setting recognising an outstanding career (more on this in the Winter Journal) so richly deserved. So in the right situation bonuses can be a good thing!

Now a plea to all members: The IST has been rapidly moving forward with Professional Registration and with members support services (benefits) including mentoring for members particularly in career development advice. However we still need more members to be "Ambassadors/Champions" for the IST in **YOUR** place of work. We will supply training and expenses to undertake a number of tasks and to help our team to bring workshops and events to your area particularly our "Master Classes". So if you want to make that contribution to your colleagues and the IST then please contact the office on office@istonline.org.uk or phone 0114 2763197. Your support and active involvement will guarantee a successful future for the technical community in these difficult and challenging times that the UK is currently experiencing.

I look forward to hearing from you and welcoming you to our band of volunteers whose contribution is often unsung but who are the heart of the IST.

With sincere thanks.

Terry Croft
Chairman

Who are we?

The Institute of Science and Technology has been supporting specialists with the technical skills that the world's economy needs for more than 65 years. We represent all sorts of technicians, experts and managers wherever they work: from science labs and engineering facilities to recording studios and IT departments.

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

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

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

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

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

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

We know how important it is for technicians to be able to develop their skills and have their expertise recognised in 2013. We know too, as we look to the future, that many more highly skilled technicians are needed. That's why the IST has dedicated itself to continuing to raise the status of specialist, technical and managerial staff and to continue to support their progression.

The IST is an organisation run by technicians for technicians.

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

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

To register, technicians must be able to show that they have the skills to qualify for professional status, while always continuing their professional development. A full explanation of what you need to do to get registered status can be found on the IST website:
istonline.org.uk/professional-registration

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

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

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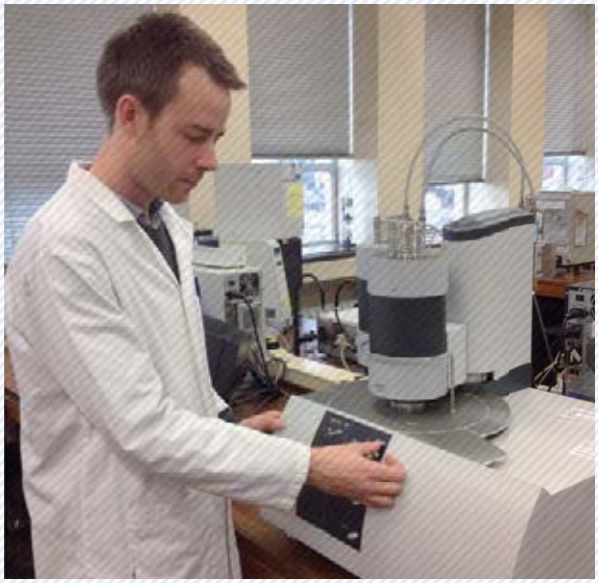
Ben Palmer RSci, Materials Characterisation Research Technician at University of Sheffield, said registering brought him many benefits:

"I believe the key benefits of joining the register are accredited recognition of the wide range of skills and experience I have gained; it provides a means to develop myself professionally in the future given the constant need to show ongoing CPD; and improved job security in an increasingly uncertain market. There is also a benefit to the organisation in that the support provided by their technical staff will constantly improve as technicians on the register continue to develop themselves."

Clinnt Gouveia RSci, MRI & OEM Production and Test Manager at Varian Inc., saw the advantages of going for RSci:

"I chose to become registered because I believe it provides professional recognition for someone like me, who has significant experience working in a scientific and higher technical position. Professional status helps to differentiate you from your peers and of course, within the broader job market."



Melanie Hannah RSci, Chemistry Senior Research Technician at Sheffield University, got registered after doing all sorts of activities to continue her professional development.

"I have found that a lot of my regular work comes under the remit of continuing professional development. I regularly research papers on the chemistry of the research group for writing protocols and designing experiments. I take advantage of free webinars from manufacturers to keep up to date with the latest technologies. I am always eager to learn new skills and when the opportunity presents itself in the department I am always willing to undergo in house training. For more soft skills training I have made use of the panosphix courses through the Heated website. This type of online training suits me as I work part time and a lot of the more formal training offered by the University is at times that would be awkward for me to attend."

IST members' news

John Robinson FIScT – Distinguished Achievement Award

The Institute was delighted to hear recently that our President (and former Chairman), John Robinson, is to be presented with a Distinguished Achievement Award by The University of Manchester at one of its forthcoming graduation ceremonies. The Award is to recognise John's significant and important contribution to the University of Manchester, the Higher Education sector, the IST and the technical community as a whole over the past 20 years. It is an Award that we feel is thoroughly deserved, and one which we were delighted to be able to support whole-heartedly.

John's major contributions to The University of Manchester came within the period 1993-2010, during which time he was involved heavily in a number of restructuring exercises, and he was responsible for developing/delivering a range of initiatives that supported and helped enable advancements in both the School of Biological Sciences, Faculty of Life Sciences and the School of Chemistry, Faculty of Physical Sciences.

During all his time at Manchester he was also a member of the IST and was elected as our Chairman in 2000. This was not only a time of change in the Higher Education Sector but also within Professional Bodies and the wider community and John was to lead major reform. He understood well the needs of the IST, and more importantly its members, and recognised the importance of providing guidance and training to position them to meet the demands of the ever-changing environment. His drive to establish the IST as a modern professional body dedicated to the recognition and support of the technical community led to a restructuring exercise within the IST that would deliver a lean, efficient structure that is geared to respond to member's needs and to future environmental developments.

In recent years, as a result of hard work with colleague Matt Levi and others within the IST and the wider community, HEFCE was persuaded to provide major financial support for the development of the HEaTED initiative (now funded by the Gatsby Foundation), that gave the technical community a vehicle for delivering training and

development in a coordinated manner. This was a major achievement and without John and Matt's enthusiasm and determination this project would not have got off the drawing board.

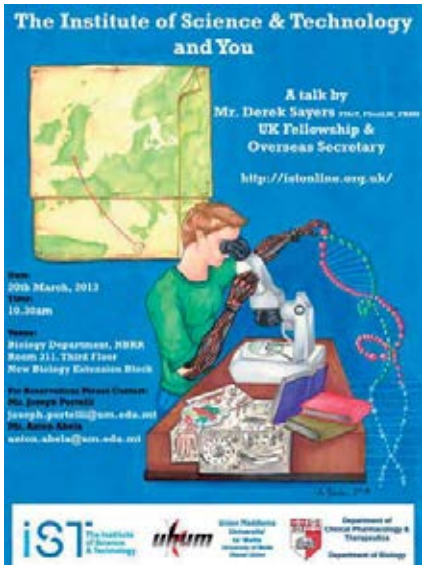
John's foresight and vision have also been responsible for ensuring that we were positioned appropriately to gain recognition by the Science Council as one of their Licensed Bodies for the Registered Scientist (RSci) and Registered Science Technician (RSciTech) awards on their new Technical Registers. The new Registers, without doubt, will provide a mechanism for enhancing and developing the professional status of the technicians, specialists and managerial staff that the IST serves.

We welcome, without reservation, John's Distinguished Achievement Award in recognition of his tireless hard work, enthusiasm, determination, and foresight – and we feel lucky to have had him as our Chairman and now as our President. Well done John!

The IST in Malta

Derek Sayers FIScT, our Fellowship & Overseas Officer, gave a talk to technical staff at the University of Malta on 20th March 3012, entitled "The Institute of Science and Technology and You".

The talk was advertised on their Campus online bulletin board and promoted further by this poster. This was designed in-house by one of our member Laboratory Officers there to highlight the strong link between Malta and the UK in the various fields and sectors of science, technology, arts, and engineering in both teaching and research.



The talk was very well attended, especially considering that it was at a time that unfortunately clashed with the examination period at their university. The delegates who attended came from a wide variety of the university's academic departments. These included amongst others Biological Sciences, Medicine, Engineering, Malta State Hospital, Malta College of Arts, Science & Technology, Medical Research Facility, Allied Research Unit, Chemistry, and Systems Engineering.

Using the aid of a pertinent IST power point presentation Derek explained who we are and what we are about, our aims, our objectives, and our current remit. He highlighted what the benefits are to our members, the value of professional registration, and explained in detail the various grades of our membership. Derek explained that the IST is a recognised awarding body licenced to award professional registered science technician RSciTech, registered scientist RSci, and for non-science technical staff our own registered practitioner MIScT(Reg) award. He also pointed out that our international membership community continues to expand and grow, using examples such as our new links with emerging countries like Ghana. He explained how we continue to embrace a much wider and diverse interest in the IST that is now beginning to come from all corners of the globe.

The talk stimulated and facilitated much vibrant discussion, particularly when the delegates explored with Derek the opportunity for an IST branch in Malta and the possibility that this might be established. Finally, following a brief period of open questions and answers to conclude the talk, Derek also made himself available to delegates who wished to talk to him on a one-to-one basis. There was a significant amount of very useful feedback and a good deal of further interest, especially regarding professional registration.

Delegates also enquired about the possibility for IST technical specialists to come over to Malta to deliver small technical skills workshops, servicing courses, etc. and also about details and instructions to follow up on the possibility of forming an IST Malta branch.

Derek's post visit comment:

> The idea of an "IST Malta" will be floated with Malta's highest education authorities, possibly also involving discussions with Malta University and the Malta College of Arts, Science & Technology.

NEWS 11

OURIMBAH

Looking at big picture

Geraldine Cardozo

ASTEROIDS, aliens and other astronomical phenomenon will be up for discussion in Ourimbah next week.

Curious minds searching for the meaning of life can head to Central Coast Community College for its first beginners course in cosmology, the study of the evolution of the universe.

The eight-week course is being headed by respected cosmologist and academic Estelle Asmodelle of Niagara Park.

The cosmologist and science writer, who also has a background in computer science and is studying for an honours degree in astrophysics, is keen to share her universal passions.

"Exploding stars, supernovas, asteroids, exoplanets (Earth-like planets); these are all real possibilities," Ms Asmodelle said. "There is a mathematical probability that these do exist. Life is teeming out there but we just haven't found it yet.

"It's pretty amazing when you look up at the night sky and realise that we are quite insignificant in the grand scheme of things."

While Ms Asmodelle doesn't aim to provide the answer to "Life, the Universe and Everything" in her sessions, she says the course will cover an introduction to cosmology for beginners.

The lessons will look at the evolution of ideas from the ancient Greeks like astronomer Aristarchus of Samos and renaissance mathematician Nicolaus Copernicus to theoretical physicist Albert Einstein and English physicist Sir Isaac Newton.

Like these influential scientists, Ms Asmodelle says she always "tries to look at the bigger picture" while acknowledging that there "is a plan".

Cosmologist and academic Estelle Asmodelle will host a course on the science of the universe. Picture: WADE MACLEAN

COSMOLOGIST ESTELLE KEEN TO EXAMINE UNIVERSAL TRUTHS

ON COURSE

Estelle Asmodelle's cosmology course Our Universe at Central Coast Community College starts next Wednesday, 6.45pm to 8.45pm. Cost: $176. Details: 4348 4300

AVOCA BEACH

Project puts art on tanks

THE Avoca Beach Markets Art Tank project is looking for participants, especially from retirement villages, art groups, senior citizen groups and youth groups. Aiming to unite the younger and older members of the community, the project will result in the beautification of water tanks in Headlet Park. Workshops on the project will be held on Sundays, May 26, June 23, July 28, August 25, September 22, October 27 and November 24, from 9am-2pm. Details: 0416 923 655.

KINCUMBER

Day to unleash the inner artist

THE Kincumber Sketch Club will hold a full day of life drawing/painting on Thursday, May 9, at the Kincumber School of Arts.

It will begin at 9.30am and run until 3pm at a cost of $18 (half day) or $35 (full day).

Bring your own lunch, materials and drop sheet but no turpentine-based oils. Morning and afternoon tea provided. All skill levels. Details: 0409 134 271.

CENTRAL COAST EXPRESS ADVOCATE, Friday, May 3, 2013 11

IST members in the news – Estelle Asmodelle

Estelle is a Fellow of the IST and is a major contributor to the IST Journal, with six articles so far, including the one in this edition.

She is a computer scientist and a student in Astronomy.

She also writes articles in astrophysics and is a member of the *Australian Society for General Relativity & Gravitation.* She also runs a blog on astrophysics at www.relativecosmos.com

EMU enjoys itself in Liverpool

Some of the EMU members who attended the two day S-Lab conference at Liverpool University in June

EMU, Engineering Managers in Universities, along with other technical specialist groups UBMA (University Biology Managers' Association), and UCLAS (University Chemistry Laboratory Administrators and Supervisors) joined with the IST and S-Lab for their national conference in Liverpool 17th-19th June.

EMU is a loose association of those managers and supervisors who have responsibility for staff and resources in support of engineering in UK HEIs. It was formed way back in 1992 with the aim that, through its annual conference, EMU would help to foster a corporate spirit, to help share best practice, to add to individual and corporate knowledge, and to broaden understanding of the profession. EMU is an autonomous special interest group of the IST and is also a member of PTSE, Professional Technical Specialist in Education. Moreover, because a great many disciplines in higher education have engineering and technology elements to them, the technical support for them has an enormously wide and diverse scope; and so EMU includes members who are in a senior technical, supervisory, or management role from any discipline where their work has a major engineering or technology element.

Are you a university technical manager or supervisor in a discipline related to engineering and technology, or working in engineering and technology/technical support to non-engineering disciplines?
If you are then why not join us, membership of EMU is free.

To join or learn more about EMU please contact:

Ian Lyne: i.lyne@sheffield.ac.uk

or

Geoff Howell: g.howell@sheffield.ac.uk

GAIA: The dawn of micro-arcsecond astrometry

Estelle Asmodelle

Introduction to astrometry

Since antiquity astronomers have attempted to catalogue the stars of the Milky Way, which was believed to be the entire universe. A Greek astronomer and mathematician, Hipparchus [190–120 BC], produced the first astronomical catalogue of the western world, and later Claudius Ptolemy [90–168 AD] published a 2nd century astronomical treatise, the *Almagest*, in which part of the work covered the motions of the fixed stars, including a star catalogue of 1,022 stars.

Early pre-telescopic instruments, such as the quadrant and sextant, used for measurement of large angles between stars, were improved by Tycho Brahe in 1570–1590 (Høg, 2009). After the discovery of the telescope and its use in astronomy, such angular measurement instruments were fitted with telescopic sights and wire micrometers from around 1660 (Kovalevsky, 2002), and proved to be reasonably accurate. In 1705 Ole Rømer invented the "meridian circle," a new type of angular measuring instrument, and it would later prove to become a fundamental astrometric instrument for centuries (Høg, 2009).

Proper motions of stars were first measured successfully in 1718 by Edmond Halley, who measured the proper motions of Sirius, Aldebaran and Arcturus, relative to surrounding stars, while the first stellar parallax was detected in 1838 by Friedrich Wilhelm Bessel, who measured a parallax of a 5th magnitude binary star 61 Cygni ≈ 0.29 arcsec (Binney & Merrifield, 1998).

Other astrometric developments followed from 1925 in photoelectric astrometry (Høg, 2009), and then CCD detectors were first used in astronomy in 1976 (Parimucha & Vanko, 2005).

Advancements in space technology provided the first astrometry satellite, Hipparcos, which was launched by the European Space Agency [ESA] in 1989 (Perryman et al., 1997).

In a real sense positional astronomy, otherwise known as astrometry, is the oldest area of astronomy and perhaps all of the sciences, (Reffert, 2009). Parallax is the first rung in the cosmic distance ladder, and all subsequent rungs are calibrated on this primary foundation (Turon et al., 2012). Therefore our understanding of the Milky Way, and indeed other galaxies and the universe as a whole, is the result of astrometric data.

In this report the focus will be on the forthcoming GAIA mission, and how it will improve upon the Hipparcos catalogue, and other data reduced catalogues derived from the Hipparcos mission, and how GAIA functions to improve our understanding of our Galaxy.

Astrometry & catalogues

Astrometry is essentially the precise mapping of the position and proper motion of stellar objects. All astrophysical objects are in constant motion, so the Milky Way, and so too the universe, is a complex dynamic system. The Milky Way comprises numerous inertial reference frames. Stars that were once in one position at a given time, or epoch, will have moved to another position some years later, while some stars move in groups in different directions to other groupings. And so knowing the precise position and proper motion of a given object, at a specific epoch, can allow for accurate astrometric calculations (Kovalevsky, 2002).

If astrometric measurements are made by ground based observatories, then the precession within our solar system and the rotation of the Earth must be taken into account (Vondrák & Štefka, 2008). Precession can consist of: the luni-solar precession ≈ 25,800 years (Binney & Merrifield, 1998), or precession that the Sun and the Moon exert on an asymmetric Earth, and nutation, or periodic variation in the Earth's orbit which can be as short as 18 years and as long as 26,000 years. The amount that the vernal equinox precesses is currently estimated at ≈ 50.25 arcseconds per year (Binney & Merrifield, 1998).

Parallax is synonymous with distance in astronomy whereby distance, in parsecs (pc), is defined as equal to the inverse of the parallax in arcseconds: d = 1/parallax.

In the past parallax was determined by the movement of specific stars relative to more distant stars, but those "more distant stars" were other bright stars in the Milky Way, which were also in motion and so the errors were large. Currently, extra-galactic radio positions of 212 quasars which are cosmologically distant are used as background references, with an uncertainty of 100 and 500 micro-arcseconds (μas) (Perryman et al, 2001). This astrometric system is called the International Celestial Reference System [ICRS] (Wenjing et al., 1999). The ICRS has superseded all other reference systems and, "transformations are computed by means of vectors, no longer by spherical trigonometry," (Høg, 2009).

In 1989 ESA launched Hipparcos which stayed in operation till 1993. The name was an acronym for High Precision Parallax Collecting Satellite, and also sounded like the Greek astronomer, Hipparchus. Hipparcos was the first optical astrometric space mission which produced a primary catalogue. The Hipparcos Catalogue consisted of 118,218 stars with a mean sky density of ≈ 3 stars deg^{-2} (Perryman et al., 1997). A secondary catalogue, the Tycho Catalogue, consisted of ≈ 1 million stars (USNO, 2012), with less precision. ICRS is a manifestation, in the optical realm, of the positions and proper motions in the Hipparcos Catalogue, which is officially referred to as the Hipparcos Celestial Reference Frame (HCRF) (Høg, 2009). With the use of ICRS for all catalogues, astronomical application of such data is simplified as precession and nutation only need be taken into consideration for ground based telescopes (Høg, 2009).

The Hipparcos mission produced optical data with resolution in the milli-arcsecond (mas) realm, but the forthcoming GAIA mission will optically measure the positions of stars in the μas range (Perryman, 2009).

Astrometric catalogues are fundamentally different from other astronomical catalogues. Below is a list of modern astrometric catalogues in table 1, which have now been superseded[1].

Catalogue	Stars
FK5 Part I (Fifth Fundamental Catalog - The Basic Fundamental Stars):	1,535
FK5 Part II (Fifth Fundamental Catalog - The FK5 Extension):	3,117
IRS (International Reference Stars):	36,027
ACRS (Astrographic Catalogue Reference Stars):	1,700,000
PPM (Catalog of Positions and Proper Motions):	181,731
Tycho-1 Catalog:	1,000,000
ACT Reference Catalog:	988,758
Tycho Reference Catalogue, TRC:	990,182
AC 2000.2 (The Astrographic Catalogue):	4,600,000
UCAC1 Catalog (USNO CCD Astrograph Catalog, 1st release):	27,000,000
GSC 2.2 (Guide Star[2] Catalog 2.2):	435,000,000
GSC 1.2 (Guide Star Catalog version 1.2):	19,000,000
USNO A2.0 Catalog:	526,230,881
USNO Select A2.0 Catalog:	54,787,624

Table 1: Contains a list of widely used or well-known catalogues which now are outdated. Other catalogues existed, such as FK3, FK4 & FK4, but only those recently superseded are shown. Data summarized from The United States Naval Observatory website (USNO, 2012).

The Hipparcos data is a primary catalogue, but there are other catalogues, which are in use today and are provided below in table 2.

Catalogue	Principal content	Objects
Hipparcos Catalogue	V=7.3. Positional accuracies ≈ 1-3 mas at epoch 1991.25. Proper motion accuracies ≈ 1-2 mas year^{-1}. Positional errors at a 2005 epoch are ≈ 15 mas.	118,218
Tycho-2 Catalog	A global reference, 99% complete to V=11.0 and 95% at V=11.5. Positional accuracies ≈ 10- 100 mas. Proper motion accuracies ≈ 1-3 mas.	2,500,000
UCAC2 (USNO CCD Astrograph Catalog, 2nd release):	UCAC2 is a preliminary catalog covering 86% of the sky. R=8.0 to 16.0 mag. Positional accuracies ≈ 20 -70 mas. Proper motion errors ≈ 1-7 mas year^{-1}.	48,000,000
UCAC2 Bright Star Supplement:	Meant to be used with UCAC2. All stars were extracted from either the Hipparcos Catalogue or Tycho-2. 2MASS photometry and cross-reference data also included.	430,000
USNO B1.0 Catalog:	All-sky: positions, proper motions, magnitudes in various optical passbands. The data obtained from scans of 7,435 Schmidt plates over last 50 years. V = 21, 0.2 arcsecond at J2000. Positional error at current epoch is ≈ 200 mas.	1,042,618,261

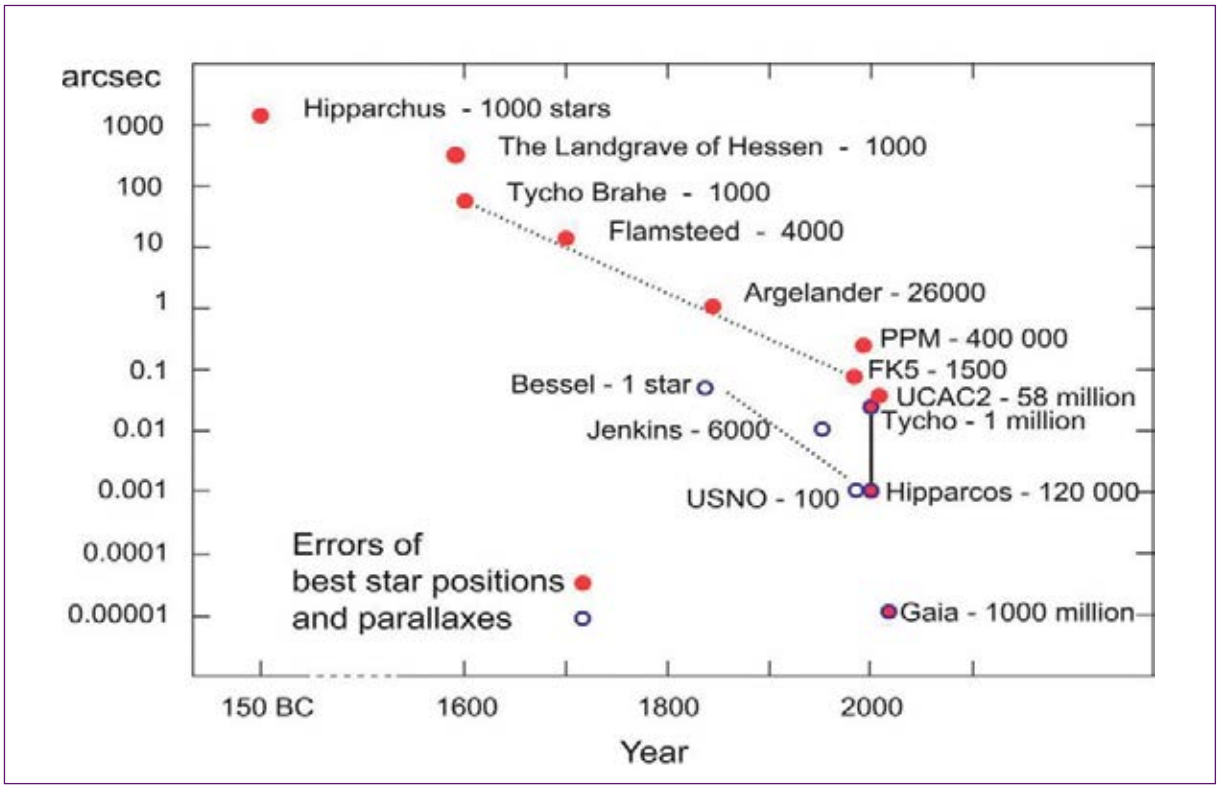
Table 2: Contains a list of current catalogues in use, for applications, as of 2012. Catalogues are shown in order of priority: Hipparcos Catalogue in the first place. Data summarized from The United States Naval Observatory website (USNO, 2012).

Several astrometric space missions were planned but have been cancelled due to funding issues. Table 3 shows all astrometric space-based missions.

Mission	Detail	Status
Hipparcos	Optical mas accuracy ≈ 120,000 stars.	Completed
The Fine Guidance Sensors [FGS] on board HST.	Optical sub-mas accuracy for faint stars in selected areas of the sky.	Currently being used on HST
Joint Milliarcsecond Pathfinder Survey [JMAPS]	Optical mas accuracy. Survey of nearby stars within 10 pc.	Funding Cancelled.
Full-sky Astrometric Mapping Explorer [FAME]	Optical & infrared, 5< V < 9 ≈ < 50 μas, for 40 million stars.	Funding Cancelled.
Space Interferometry Mission, [SIM, SIM Lite]	Infrared 20 μas accuracy for V ≈ 20, as well as an extra-solar planet hunter	Funding Cancelled.
GAIA	Optical 7–25 μas, 15 mag, sub-mas ≈ 20 mag, 1 billon of the brightest stars.	Due for Launch around 2013
Nano-JASMINE	Infrared, 1.8mas at z = 7.5 accuracy, Milky Way stars.	Due for Launch around 2013
James Webb Space Telescope [JWST]	Infrared, ≈4 mas accuracy, of the position of field stars	Postponed but due for 2015

Table 3: A list of astrometric space-based missions, past and present, or missions that include astrometry. Compiled from various sources: JMAPS (Dorland et al., 2006), FAME (Seidelmann et al., 1999), SIM (Ford & Tremaine, 2003), Nano-JASMINE (Michalik et al., 2011) & JWST (Nelan, 2005).

Graph 1 depicts astrometric accuracy over time.



GAIA

GAIA is an ambitious space mission, by ESA, that aims to create a highly accurate three dimensional [3-D] all sky survey of the Milky Way down to ≈ +20 magnitude (mag), providing unprecedented positional and radial velocity measurements, to produce a stereoscopic and kinematic enumeration, which will produce the GAIA catalogue (Lindegren et al., 2007).

The mission is scheduled for launch in 2013, lasting for a period of 5 years. The name GAIA is an acronym that originally stood for Global Astrometric Interferometer for Astrophysics, but the project has grown beyond the initial concept, yet the name remains (ESA, 2012)

GAIA will investigate the origin and evolution of our Galaxy by recording the astrometry, photometry, and spectroscopy of ≈1% of the Milky Way, or one billion stars, starting from the solar neighbourhood through the disk of our galaxy to the central bulge ≈8.5 kpc. Each of the billion stars will be observed ≈100 times from different positions. Furthermore, GAIA will observe different objects within the Milky Way, and at cosmological distances (Plez, 2011).

GAIA will be placed in an orbit at the second Lagrange point [L2] of the Sun-Earth system, allowing access to the entire celestial sphere over a year. The mission will take a Lissajous orbit

≈300,000 km, around the L2, being 1.5 million km from the Earth in a direction opposite to the sun, with an orbital period of ≈180 days, and an axial rotation ≈6 hours (Perryman, 2009). Figure 1 shows GAIA's alignment.

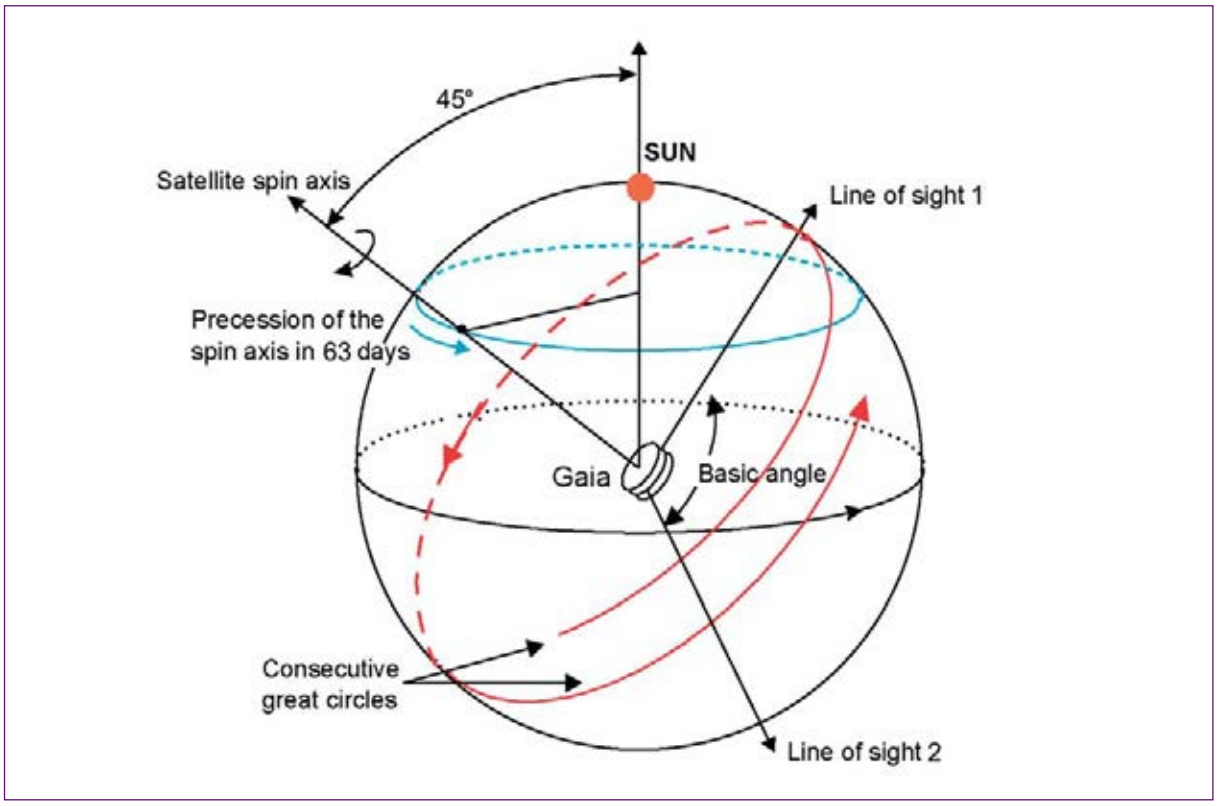


Figure 1 depicts GAIA's two astrometric fields of view, with a constant spin rate of 60 arcsec s^{-1}, providing 6-hour great-circle scans. The angle between the slowly precessing spin axis and the Sun is ~ 45°, while the angle between both telescopes is ~ 106.5°. Courtesy ESA, [www.rssd.esa.int/SA/GAIA/docs/info_sheets/IN_spacecraft_and_payload_section.pdf]

Instrumentation

GAIA is essentially a dual telescope with a common structure and a common focal plane, based on a three mirror anastigmatic configuration, with an aperture of 1.45m × 0.5m and a focal length of 35m. The two telescopes point in two different directions, at an angle of 106.5° (Jordi, 2009).

The telescopic arrangement is shown in figure 2.

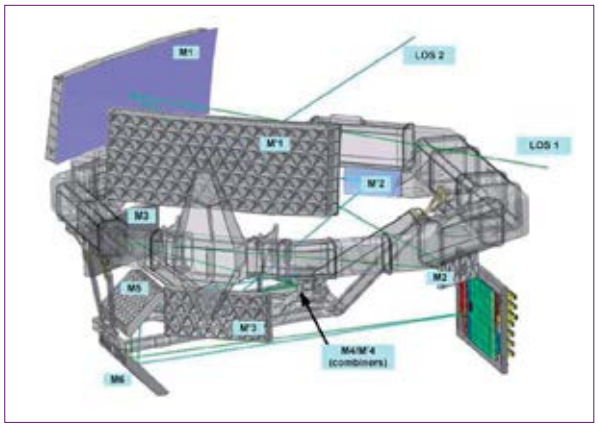


Figure 2 depicts the optical path of both telescopes, which is comprised of six reflectors (M1–M6), while (M5–M6) are shared. Both telescopes share a common focal plane. Line of sight 1 [LOS1] and Line of sight 2 [LOS2] are the optical pathways of both telescopes. Courtesy of EADS-Astrium & ESA. [http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=40129&fbodylongid=1914]

Billion pixel CCD array

GAIA's focal plane consists of 106 highly efficient CCDs with ≈1 billion pixels of resolution.

102 CCDs are dedicated to star detections, using astrometry, photometry and spectroscopy, while the remaining 4 CCDs are used for stability of the telescopic angle (Gare, 2010).

The unique CCD array configuration allows for simultaneously imaging, in wide angle high definition, of numerous objects (Plez, 2011). The array is shown in figure 3 below.

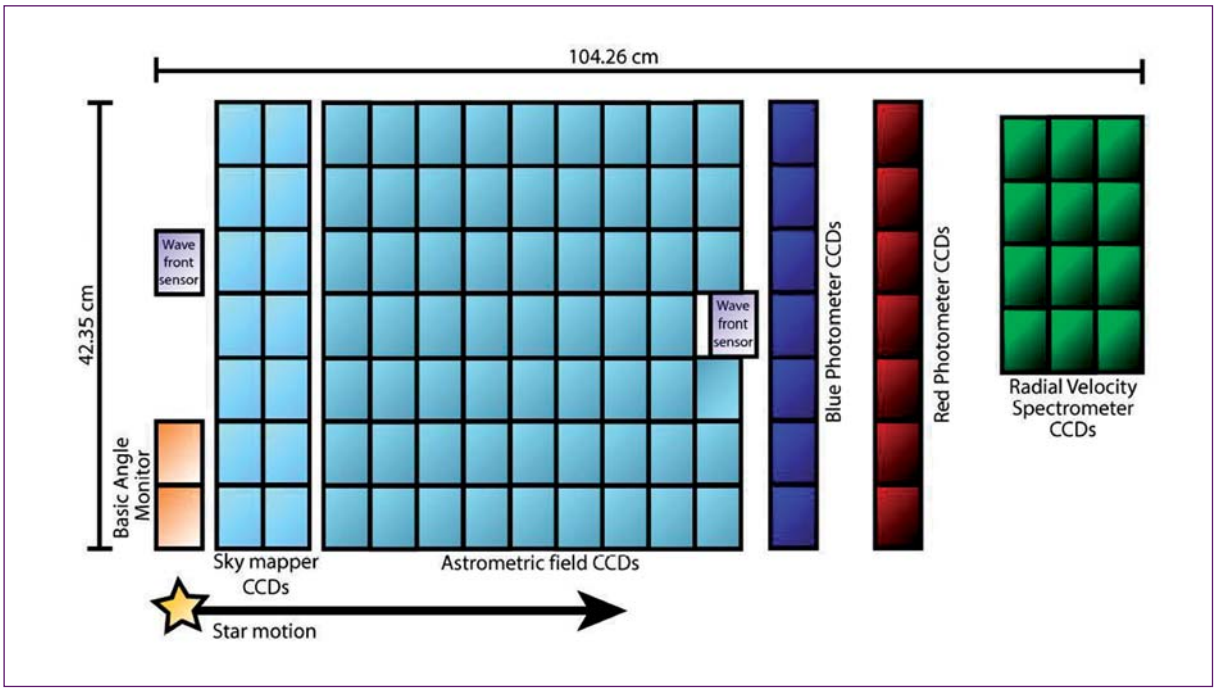


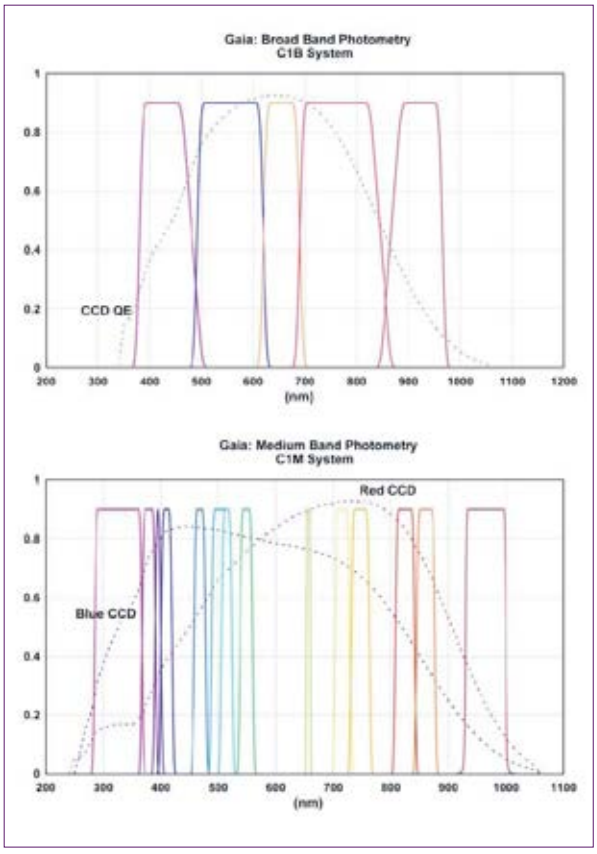
Figure 3 depicts the GAIA common focal plane, comprising a CCD array which features 7 CCD rows, 17 CCD strips, and 106 large-format CCDs, each with 4500 TDI lines, 1966 pixel columns, and pixels of size 10 μm along scan × 30 μm across scan (59 mas × 177 mas). Courtesy of ESA & A. Short. [http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=40129&fbodylongid=1907]

Astrometric data, photometric & spectroscopic data

GAIA's astrometry will tabulate: positions, parallaxes and proper motions of 1 billion of the brightest stars of the Milky Way, with proposed accuracies ≈7–25 μas, down to ≈15 mag, with sub-mas accuracies ≈20 mag. Measurements in densely populated regions ≈3 million stars deg^{-2} will still be accurate (Lindegren et al., 2007).

The astrometric data are compared with low-resolution spectrophotometric data ≈330–1000 nm, using GAIA's radial velocity spectrometer [RVS] instrument, which will collect ≈40 transit spectra per star, during the 5 years mission (Katz, 2009).

Graph 2 is GAIA's proposed photometry curves.

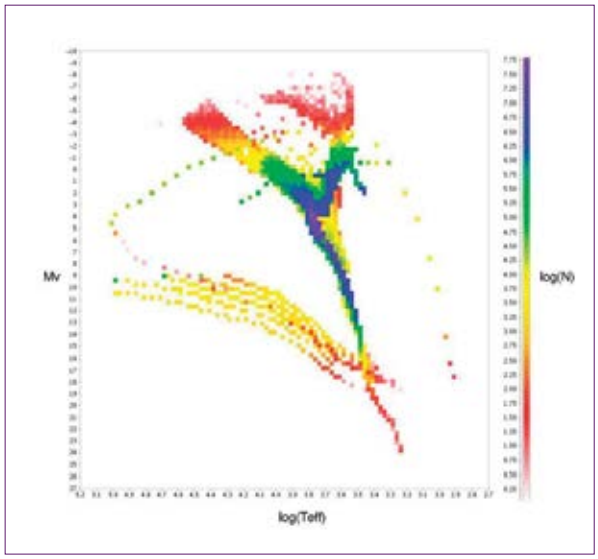


Graph 2 shows proposed broad-band (top) and medium-band (bottom) photometry filters for Gaia. The dashed line corresponds to the CCD response curve. Photometric data ~330-1000 nm. Courtesy ESA. [www.rssd.esa.int/SA/GAIA/docs/info_sheets/IN_spacecraft_and_payload_section.pdf].

GAIA's photometric instrument will be used for astrometric correction, as well as determining: effective temperature, mass, age, and chemical composition, with photometric object densities on the sky ≈750,000 objects deg^{-2} (Katz, 2009).

GAIA's photometry will provide valuable data for chemical-abundance and age determination of the Milky Way stellar populations, over the entire Hertzsprung–Russell diagram (Bruijne, 2009).

Graph 3 is a simulated H-R diagram of GAIA's expected data.



Graph 3 shows the expected density of the GAIA catalogue objects in the different regions of the H-R diagram, for Milky Way stars. Colour scale gives the decimal logarithm of the number of objects. Diagram courtesy Turon et al., [http://arxiv.org/pdf/1202.3645v1.pdf]

General relativity

Normally the effects of General Relativity within our region of the Milky Way are neglected as they are tiny. However, with GAIA's μas resolution the effects of Einstein's general relativity equations will become significant and have to be taken into account during any astrometric calculations. Light bending by solar system objects will affect the results, as well as other stars, and so it must be taken into account, otherwise errors can be ≈1-10 μas for bodies with radii >624 km (Bruijne, 2011).

Hipparcos and GAIA Comparison

The Hipparcos catalogue is currently the most accurate astrometric data and the primary astrometric dataset. However, in order to fully appreciate the increased value the GAIA mission will make, compared to that of Hipparcos, the best method is by comparison.

Table 4 shows a comparison:

Parameter	Hipparcos	GAIA
Magnitude Limit	12 mag	20 mag
Completeness	7.3 – 9.0 mag	≈20 mag
Bright Limit	≈0 mag	≈5-7 mag
Number of Objects	120,000	26 million to V=15 150 million to V=18 1,000 million to V=20
Effective Distance	1 kpc	1 Mpc
Quasars	None	≈ 5 x 105
Galaxies	None	106 - 107
Accuracy	≈ 1 mas	7 μas at V=10 10-20-25 μas at V=15 100-300 μas at V=20
Broadband	2-colour (B & V)	3-colour to V=20 + 1-colour to V=17
Spectro-photometry	None	2 bands to V=20
Radial Velocity	None	1-15 kms-1 to V=16-17

Table 4 provides a comparison table for Hipparcos and GAIA.
Data taken from: Turon & Luri. [http://www.na.astro.it/ESFdistance/Turon.pdf]

GAIA's Objectives

GAIA's primary objective is to study 1% of the Milky Way's stellar population and their distribution, kinematics and physical characteristics (Perryman et al, 2001).

Image 1 provides 3-D simulations of the distribution in the Milky Way, extrapolating the possible results of the GAIA catalogue.

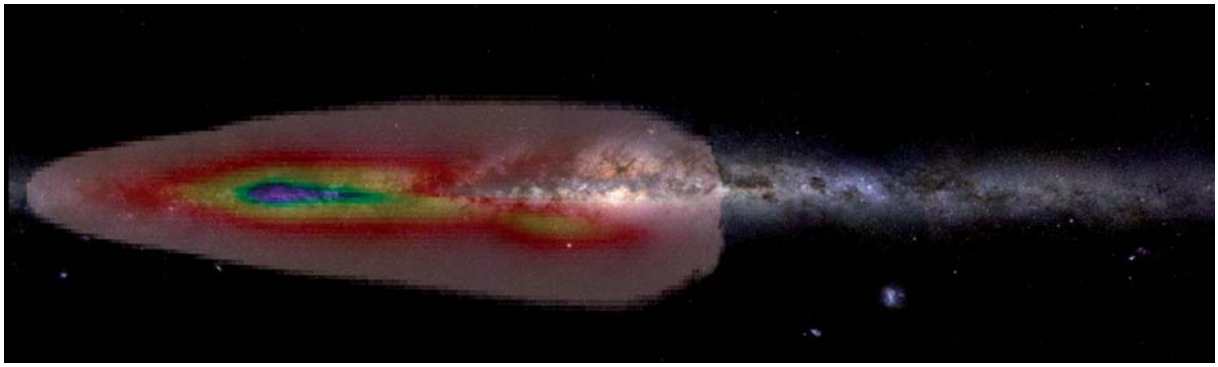
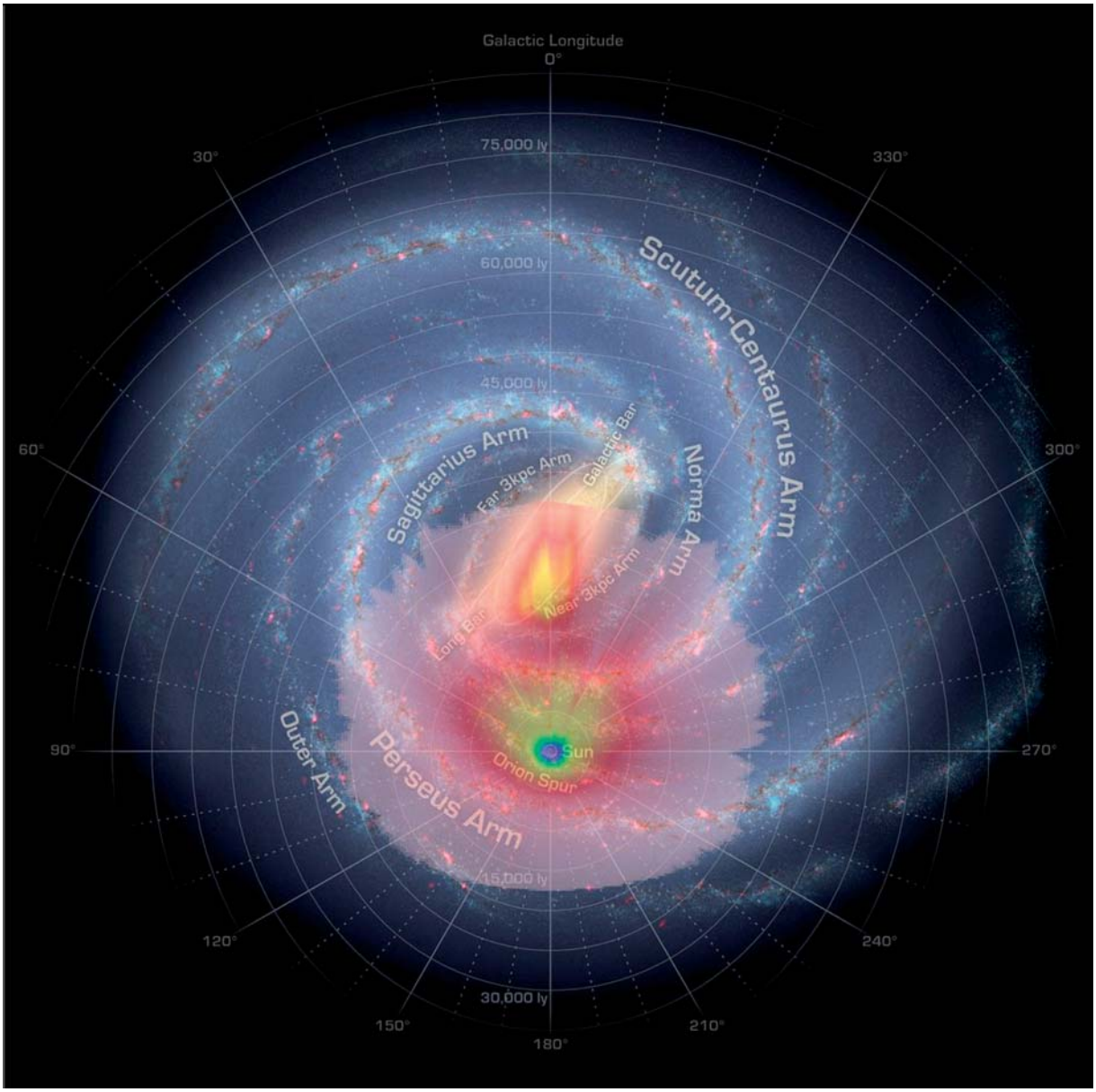


Image 1: 3-D simulations of the distribution in the Milky Way



Simulation of the contents of the Gaia catalogue (GUMS v8), produced by the DPAC-CU2 at the MareNostrum supercomputer. The colours of the overlaid simulation show the expected density of the one-billion stars in different regions of the Milky Way. Top & bottom images are of the Milky Way. Images courtesy Luri & Turon & ESA (Luri & Turon, 2011)

Lastly, other tasks that GAIA will perform include: classification of tens of thousands of extra- Solar planetary systems, a comprehensive survey of 10^5 -10^6 NEOs (near Earth objects), measurements of galaxies in the nearby Universe, with SN1a, and 500,000 quasars, (Perryman et al, 2001).

Epilogue

GAIA's final catalogue will take astrometry to micro-arcsecond resolution, and improve current data by a factor of 50-100 in positional accuracy and by a factor of 10,000 in star counts (Eyer et al, 2012).

Of prime importance is the elucidation of our understanding of the Milky Way galaxy. In particular, astrometric, spectroscopic, and photometric data, in combination, will allow us to improve our knowledge of the following, (Perryman et al, 2001):

- Number of different types of astrophysical objects
- Proper motions & kinematics of stars
- Recalibration of 1st rung distance ladder
- Milky Ways' origin and history
- Chemical evolution and elemental composition of stars
- Dynamics of star forming regions
- Inner dynamics of the bulge/bar, and the disk and halo
- Structure of star clusters and the spiral structure
- Distribution of dust, invisible mass, missing brown dwarfs, and dark matter
- Detection of tidally disrupted debris
- Milky Way rotation curve; accurate mass determination
- Tests of general relativity and cosmology
- Detection of extra-solar planets
- Measure of the disruption of Oort cloud, KBOs[3] & NEOs[4]

Gaia will help astronomers build up a picture of how our Galaxy was born and subsequently evolved. Lastly, GAIA may even find unforeseen things that teach us more about the Milky Way, and indeed the cosmos.

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[1] Two different types of spelling are used: catalog and catalogue, American and English, both are generic.

[2] Derived from the Hubble Space Telescope observations

[3] KBOs: Kuiper Belt Objects.

[4] NEOs: Near Earth Objects.

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Ostrich farming in central Venezuela

Gregorio Dabrowski

Introduction

In scientific terms, ostriches and their relatives are flightless birds belonging to the Order Struthioniformes, divided into the families Apterygidae (kiwis), Casmeridae (cassowaries), Diomaiidae (emus), Rheidae (rheas), and Struthionidae (the true ostriches). The Spanish name for the ostrich, “avestruz”, is also popularly used in South America to refer to the native rheas, which are endemic to many parts of the sub-equatorial region of that sub-continent, where they are also known as “ñandú” (derived from the native Guarani language). The “ñandú”, Rhea americana (Linn., 1758), is found in Argentina, Bolivia, Brazil, Chile, Paraguay, Peru, and Uruguay. The African black ostrich, *Struthus camelus* (Linn., 1758), as the name suggests, is a true ostrich which naturally occurs in Africa.

In 1998, the Venezuelan authorities gave permission for the African black ostrich to be introduced to the country for farming purposes. The first specimens were brought in from an ostrich farm in Curaçao, a nearby insular territory in the Caribbean which forms part of the Dutch Antilles. As a result, 36 ostrich farms became established in Venezuela from the year 1998 onwards. Ostrich farming has become a significant activity in several countries, including Australia, Canada, Chile, China, Ecuador, France, Mexico, Peru, the USA and – more recently – Venezuela. The demand is said to exceed the supply on the markets.

The ostrich is capable of running at speeds of up to 60 – 70 km/hour on land, can reach a height of up to 2.8 metres, an adult weight of 200 kg, and has a life expectancy of 50 years (45 years of which are considered to be productive). In tropical countries, such as Venezuela, the year is divided into a “hot and dry season” and a “humid and wet season”, which affects the egg-laying abilities of the ostriches, and has to be taken into due account for egg production purposes. The eggs themselves weigh 1 – 2 kg each, and the chicks which hatch from them have a mean height of 50 cm, and a mean weight of 800 grams. The commercial production of ostriches is for their feathers (used to make feather dusters and similar), their meat (characterised by its high protein and calcium content, and its low cholesterol and fat levels), and their skins (used to make leather for belts, clothes, handbags, and shoes).

"Ostriches are not for featherbed farmers"

This article gives a summary of the author’s professional experience with the farming and raising of the African ostrich on a commercial farm located in central Venezuela.

The farm and its facilities

The farm, Granja Avestruces La Villa C. A, is located in Villa de Cura, Aragua State, Venezuela, and has introduced intensive management and a high productive performance. All phases of the activity are covered, from breeding to processing of the adult birds.

Breeding

The ostriches intended for breeding purposes are held in trios, 2 males and 1 female, in 10 pens which measure 10 X 20 metres each. The flightless wings have a span of 2 metres, are used during courtship, and as a show of aggressive behaviour (usually against other males). The adult male is black in colour, and the adult female is grey-brown. The eggs are laid each 48 hour period, depending on the climatic conditions and the photoperiod.

Egg incubation

The farm has two incubators and two automatic hatcheries. On being laid, the eggs are stored at a temperature of 15 – 20ºC for 4 days, prior to being placed in the incubator. The incubation period lasts for approximately 42 days, during which the eggs are maintained at a temperature of 35 – 37ºC, and a humidity of 10 – 30%. They are rotated for 90º, 4 – 6 times per diem. The eggs experience a water loss of 13 – 15% during incubation, as is determined by their regular weekly weighing. Candling of the eggs, to detect and eliminate dead and infertile ones, is also done on a weekly basis. They are transferred to the hatcheries when internal pecking is detected, usually 24 – 48 hours before hatching. The temperature of the hatchery is maintained at 1 – 2ºC below that of the incubator, and has a slightly higher humidity. The average hatch/batch is 70%.

On-growing and fattening up

The ostriches are divided into 3 main categories, which are defined as “BB”, “young”, and “adult”. The “BB” ones are kept in a small shed measuring 4 metres in size and 1.2 metres in height (as a fence), provided with all necessary facilities for a 3 month period. The “young ostriches” are handled and managed in the same way as the “BB” ones, but they have more space and higher fences, and are kept for 3 – 10 months. The “adults” require much more space, to enable them to grow to a desired maximum size and weight. Natural well water and commercially available pelleted feeds are provided in all cases.

Above: The author hand-feeding an adult ostrich

Left: Baby ostrich finding its feet on the farm

The composition of the pelleted feeds is as given in the table below:

Characteristics of pelleted feeds for ostriches (Source: Texas A&M University)

Nutrient	Starter	On-growing	Maintenance	Broodstook
Energy	1200	1200	1200	1150
Crude Protein (%)	18.0	17.0	16.0	16.5
Fat (%)	3.0	2.5	2.5	3.5
Linoleic Acid (%)	1.4	1.4	1.4	1.4
Lysine (%)	0.9	0.78	0.75	0.75
Methionine and Cysteine (%)	0.7	0.6	0.55	0.6
Calcium (%)	1.25	1.25	1.25	2.5
Phosphorus (%)	0.9	0.9	0.9	0.75
Available Phosphorus (%)	0.68	0.65	0.65	0.52
Sodium (%)	0.22	0.22	0.22	0.22

Health control

Regular health inspections are undertaken by the qualified resident veterinary surgeon, to check for viral, bacterial, mycotic, parasitic, and other types of possible disease problems. Should treatment be necessary, that is also undertaken by the veterinary surgeon. All of these procedures are in compliance with the legislation introduced in 2005 by the Venezuelan Ministry of Agriculture and Livestock.

Product processing

All aspects of the processing operations are carried out in a separate facility. Following inspection, to guarantee that only healthy birds are sacrificed, the ostriches are euthanised and made ready for the separation of the feathers, meat, and skin. At slaughter, an average ostrich will yield 58% meat, 3 m^2 of skin, and 2 kg of feathers. All of these products are commercialised in trade.

Final observations

Ostrich farming has become a successful productive activity in practice. People should be persuaded to take their heads out of the sand, and prepare themselves for the possibility of eating special presentations of ostrich meat in “fast food outlets”, and in the form of “McOstrich”, “Whopper Ostrich”, and “Ostrich Big Classic”. A single ostrich egg, prepared as an omelette, would be sufficient to feed a family of up to six people at one sitting!

More detailed information, in Spanish, can be obtained from the author’s publications, which are given in the bibliography.

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Author

Gregorio Dabrowski (pictured here with some of his flock) possesses dual Canadian (paternal) and Venezuelan (maternal) nationality. He graduated as a veterinary surgeon (MV) from the Central University of Venezuela in 1996, and then received further post-graduate training in poultry science and production in Egypt and in Venezuela. He decided to specialise in ostrich farming in 1998, and continues to offer professional advice to that productive sector. To date, he has been the author of 15 Spanish-language articles on ostrich farming published in technical journals on agriculture in Latin America. His e-mail is: gregoriodabrowski@hotmail.com.

Interesting Ostrich facts

In Roman times, there was a demand for ostriches to use in *venatio*[1] games or cooking. They have been hunted and farmed for their feathers, which at various times have been popular for ornamentation in fashionable clothing (such as hats during the 19th century). Their skins are valued for their leather. In the 18th century they were almost hunted to extinction; farming for feathers began in the 19th century. At the start of the 20th century there were over 700,000 birds in captivity. The market for feathers collapsed after World War I, but commercial farming for feathers and later for skins and meat became widespread during the 1970s. Ostriches are so adaptable that they can be farmed in climates ranging from South Africa to Alaska.

Ostriches were farmed for their feathers in South Africa beginning in the 19th century. According to Frank G. Carpenter, the English are credited with first taming ostriches outside Cape Town. Farmers captured baby ostriches and raised them successfully on their property, and were able to obtain a crop of feathers every seven to eight months instead of killing wild ostriches for their feathers.

It is claimed that ostriches produce the strongest commercial leather. Ostrich meat tastes similar to lean beef and is low in fat and cholesterol, as well as high in calcium, protein and iron. Uncooked, it is dark red or cherry red, a little darker than beef.

[1] Venatio was a form of entertainment in Roman amphitheatres involving the hunting and slaying of wild animals.

The use of nitrocellulose as an adhesive for alcohol-preserved biological specimens

Simon Moore

Abstract

Despite its chemical instability, nitrocellulose or pyroxylin can be used in solution for the adhesion, mounting, repair and consolidation of alcohol-preserved biological specimens. The 8% solution, once used by histologists for the preparation of larger sized sections, is known as Necoloidine. Its gradual obsolescence in histology and subsequent withdrawal from commercial suppliers' lists means that it now has to be compounded in the laboratory. This paper shows its applications, limitations, hazards, how it can be compounded and a simple but effective test for its adhesive quality. A brief mention is made about using gelatine for adhering formalin-preserved specimens.

Introduction

Those of us who have worked in histology for long enough may recall using a celloidin product known as Necoloidine as an embedding agent for cutting sections of entire small (decalcified) mammals, brains or other organs. With the increase in technology for instant sections, produced by cryo-sectioning, the use and demand for this reagent gradually diminished until it was withdrawn from suppliers' lists, such as BDH/Merck.

According to its label Necoloidine comprises an 8% solution of pyroxylin in a 45:45 w/v solvent mixture of solvent-grade diethyl ether and 96% ethanol. Elsewhere it is sometimes known as Collodion, which is slightly different - a 10% solution in 3 parts ether to 1 of 90% ethanol.

Caveat - despite these synonyms and the fact that the formula of self-compounded solutions is (apparently) identical to the original there are two problems with laboratory-compounded solutions:

1. Commercial Necoloidine is a clear, slightly viscous fluid but the 'home-made' versions are often cloudy despite precautions to ensure that only absolute alcohol (ethanol) is mixed with the ether to provide the solvent for the pyroxylin, even though the formula states that 96% alcohol should be used. The opacity would, theoretically, be caused by the presence of a minute quantity of water.
2. Necoloidine and Collodion have better adhesion than the self-made versions.

This begs the question of how the commercial solution was made up; despite the formulation on the bottle label no one seems to have the answer.

With diminishing stores of Necoloidine, those who use it for the purposes below are becoming increasingly desperate to find either a supplier or an alternative method for adhesion.

Hazards

Pyroxylin is supplied as alcohol-moistened flakes. The alcohol can evaporate if the container is left open in a warm room and this will increase the risk of instability and perhaps explosion or auto-combustion of the nitrocellulose.

Solvent ether is a highly volatile, extremely flammable and powerful solvent. Its vapour can link to a spark and ignite. It has a mildly soporific effect on some (not as powerful as anaesthetic ether).

Figure 1. (right) NFPA hazard label as used in the USA and Canada

Figure 1a. (below) EU hazard (flammability and explosive warning labels)

Absolute ethanol is also highly flammable but has a higher flash point than the ether. Once mixed with the ether, the resulting solution is highly flammable.

There is obviously a risk in the compounding of a Necoloidine/celloidin solution but providing normal laboratory procedures are followed, there should be no problem.

The finished compound can be stored in a laboratory refrigerator to prolong its life. Should the solution become abnormally viscous through evaporation of the solvent or start to get into lumps, it can be re-dissolved by adding an appropriate but unspecified quantity of the solvent.

Related problems

The viscosity of 8% Necoloidine solution is 1.35 times that of water. This was measured by timing the average of ten descents of a lead shot through 20 cms of water versus the same in Necoloidine. It should be maintained at this viscosity, as the solvent will slowly escape over time, the solution will increase in viscosity and may start to become opalescent. Should this occur then the solution must have its normal viscosity restored by the addition of pre-mixed ether-alcohol solvent.

Ethyl alcohol is expensive and isopropanol (propan-2-ol) has been tried as a cheaper alternative but does not provide as effective a solvent as the ethanol. Methanol is being tried and will hopefully provide a cheaper alternative.

Uses

Adhering empty snail shells to small pieces of glass using the 2% and 8% celloidin solutions tested the adhesive tack. The 2% solution was found to have better penetration of tissues than the more viscous 8%, whereas the 8% solution had stronger tack.

The curvature of the shells provided a good test for tangential adhesion, the most challenging and any air trapped in the spire of the shell lifted off any poorly adhered shells within an hour.

Method

For alcohol-preserved specimens, these need to be moist but not wet with alcohol. Some solvent is pipetted onto the areas to be adhered prior to using the celloidin. For a dry shell the application was easier since there was no preserving or other fluid to react with the celloidin.

The shell was placed onto the glass slip and the celloidin was dripped discreetly around the areas for adhesion. For a stronger bond some 8% was also dripped after some 2 % had been administered so that flow around the specimen would be improved for the more viscous fluid.

For both concentrations, a wait of about 10 minutes was required so that the fluid gelled and no longer flowed if the glass slip was tilted. Avoidance of speeding up the process by warming or breathing on it was essential (water vapour is immiscible and will show as a white colloid: figure 3).

The shell and slip were carefully placed into 80% IMS. The small percentage of water in the IMS gels the celloidin, creating an adhesive bond between the shell and glass plate.

Using a spring balance, the adhesion strength was tested after 24 hours of alcohol immersion. For the 2% solution, the maximum achieved strength was found to be 10.2g, whereas the 8% was 25.6g; both readings included the weight of the glass slips.

This is more than adequate for supporting specimens in alcohol although larger and bulkier specimens would require sewing to a pierced glass backplate using nylon monofilament.

For Collodion solutions (10% pyroxylin) the maximum achieved strength was 17.6g.

Figure 2. Successful adhesion of a Cepea hortensis snail shell to glass just prior to immersion in IMS.

Figure 2a. (Right) if the celloidin is left for too long (forgotten) then the solvent will evaporate leaving a wrinkled frill of meta-stable nitrocellulose with zero adhesion!

Figure 3. The author's first attempt (1969) at this technique (right) showing celloidin mixed with water vapour from breathing! The second attempt (left) is better and the salmon ova have stayed on the glass for 40 years at time of writing.

Figure 4. A fluid preservation course attendee using the technique to adhere chiton shells to glass using the 8% concentration.

Other applications

Celloidin solution can also be used as a gap-fill and for repairing specimens. Three examples are shown below. The Lamprey branchial basket is a typical injected vascular dissection that is easily prone to the accidents sustained through movement, including handling. A slight bump on a bench can cause the slightly embrittled and tapering vessels to detach; the example shown is typical but many have detached completely. The "basket" must first be wrapped around a suitable template (polypropylene rod in this instance) and then each break moistened with celloidin solvent, followed by a drop of 2-3% celloidin. After 10 minutes the joint can be gelled in 80% alcohol. During this process the specimen must not be allowed to dry out so preserving alcohol must be pipetted onto the specimen (but not the joins) to keep it moist. Drying out can be disastrous causing the specimen to shrink and distort.

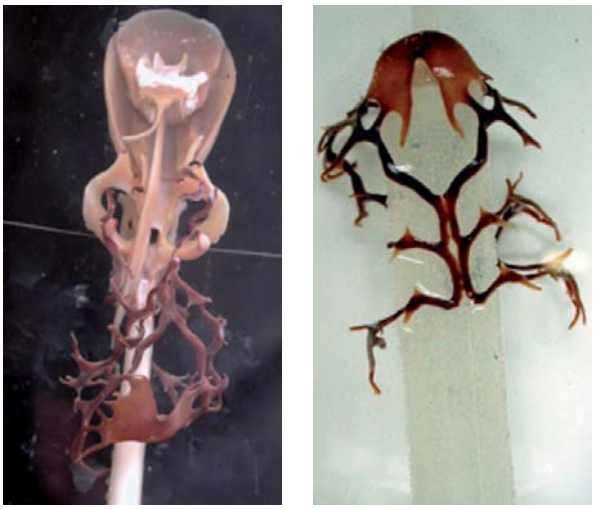


Figure 5. Injected branchial basket dissection from a sea Lamprey – a highly vulnerable specimen that often collapses after years of handling and (right) repaired before remounting in situ, using celloidin. Some parts of the basket were found to be missing.

Once the specimen has been reconstructed, it can be peeled away from the polypropylene rod using a fine steel spatula (no. 46 from Tiranti) and adhered into place on the specimen.

The technique is also useful for re-mounting delicate specimens back onto their glass mounting plates from which they have detached. An example of a flower inflorescence dissection (below) is a case in point. The lower right petal was repaired successfully at first followed by the remaining components including the petals from the main dissection shown lying on the bottom of the jar.

Figure 6. Another fluid course attendee using the technique to repair alcohol-preserved plant inflorescences in 80% IMS. The right-hand illustration shows the specimen at an earlier stage - the lower right petal has been repaired successfully.

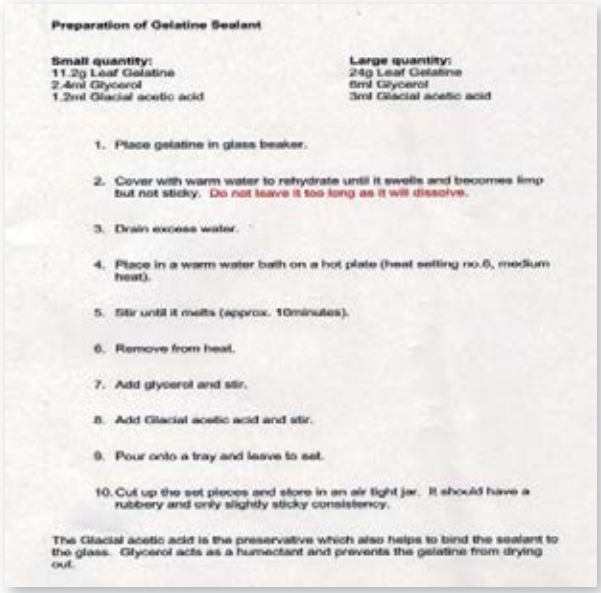
The chameleon (below) was resurrected from a dried-out husk and rehydrated in warm (c. 40°C) 5% Decon-90 surfactant solution over a 24-hour period. Although the body rehydrated successfully the eyes were still sunk in their sockets, so these were carefully cut out and kept in alcohol. Some 8% celloidin (the commercial Necoloidine strength) was pipetted into the eye sockets and left to gel, sealing the eye sockets. Once gelled, the eye levels were tested and a further small amount of celloidin was added to correct the levels and the eyes inserted. These were supported on glass needle fragments during the gelling so that they did not tip to one side.

Formalin preservation

Although it is no longer used as a standard preservative, formalin is occasionally found in jars, sometimes mixed with other preservative agents (glycerine, propylene glycol &c). Preservative concentration formalin is 5% concentration of formalin or 2% formaldehyde, as opposed to fixation strength for fresh material, which is the more usual 10% formalin (4% formaldehyde). The main reasons for formalin as a preservative being subsumed by 70-80% methylated ethanol (IMS) are due to health and safety and that formalin will also denature DNA over time. Celloidin does not work in this instance since the solution is immiscible with a water-based preservative.

A melted preparation of leaf gelatine is used instead (see below) and is applied with a small brush or warmed pipette (leave in beaker of hot water: 50-70°C).

The gelatine is prepared by melting it in a small beaker, within a larger beaker containing hot water (like a *bain-marie*).



Preparation of Gelatine Sealant

Small quantity:
11.2g Leaf Gelatine
2.4ml Glycerol
1.2ml Glacial acetic acid

Large quantity:
24g Leaf Gelatine
5ml Glycerol
3ml Glacial acetic acid

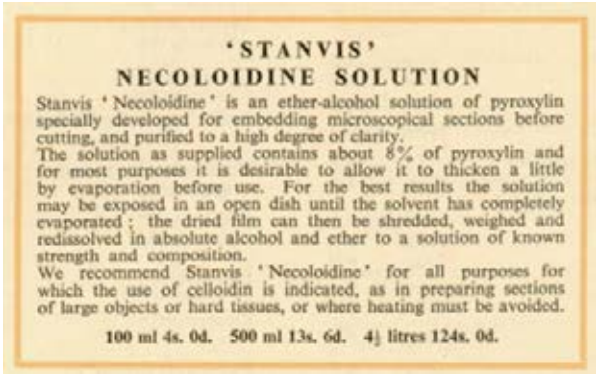
1. Place gelatine in glass beaker.
2. Cover with warm water to rehydrate until it swells and becomes limp but not sticky. Do not leave it too long as it will dissolve.
3. Drain excess water.
4. Place in a warm water bath on a hot plate (heat setting no.6, medium heat).
5. Stir until it melts (approx. 10minutes).
6. Remove from heat.
7. Add glycerol and stir.
8. Add Glacial acetic acid and stir.
9. Pour onto a tray and leave to set.
10. Cut up the set pieces and store in an air tight jar. It should have a rubbery and only slightly sticky consistency.

The Glacial acetic acid is the preservative which also helps to bind the sealant to the glass. Glycerol acts as a humectant and prevents the gelatine from drying out.

Figure 7. A newly rehydrated chameleon whose eyes had sunk in their orbital cavities – the eyes were cut out, then mounted onto a semi-gelled 'cushion' of 8% celloidin and then supported with glass needles during the gelling of a second layer of celloidin to seal the eyes into place.

Conclusions

This technique has been used successfully on specimens over a 40 year period and, as can been seen, has many applications. Trying to find some commercially prepared solution of Necoloidine is still not possible. If supplies run out or someone cannot find a way of improving the compounding from pyroxylin flakes, an alternative adhesive will have to be found.



'STANVIS'
NECOLOIDINE SOLUTION

Stanvis 'Necoloidine' is an ether-alcohol solution of pyroxylin specially developed for embedding microscopical sections before cutting, and purified to a high degree of clarity.
The solution as supplied contains about 8% of pyroxylin and for most purposes it is desirable to allow it to thicken a little by evaporation before use. For the best results the solution may be exposed in an open dish until the solvent has completely evaporated; the dried film can then be shredded, weighed and redissolved in absolute alcohol and ether to a solution of known strength and composition.
We recommend Stanvis 'Necoloidine' for all purposes for which the use of celloidin is indicated, as in preparing sections of large objects or hard tissues, or where heating must be avoided.

100 ml 4s. 0d. 500 ml 13s. 6d. 4½ litres 124s. 0d.

Necoloidine solution as described in the 1963 British Drug Houses catalogue. By 1994 the price had increased to £10.40 per 500ml. At the same rate of inflation, this would cost £55 today.

Suppliers

Artist/sculptor spatulas from Alec Tiranti Ltd.
www.tiranti.co.uk enquiries@tiranti.co.uk

Tel: 020 7380 0808 (London) and 0845 123 2101 (Thatcham, Berks)

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Treasure Island – riches from guano

Alan Gall, IST Archivist

According to crime writer P. D. James, the motives for murder are the four Ls: love, lust, lucre and loathing.[1] When Henry Jones struck Thomas Foster three times with an axe during a riot on Navassa Island his reason was most definitely loathing – a hatred fuelled by the horrors of guano mining.

Guano is not so well-known these days. It once provided the world's finest manure and there were fortunes to be made by individuals and countries. Peru's economy depended on the stuff and the USA created The Guano Islands Act of 1856 to secure new sources. Britain protected its interests by monopolising the supply of Peruvian guano.

The formation of significant deposits is a long process. Sea birds congregate in large numbers at certain remote sites, leaving their droppings. Accumulating undisturbed over many centuries, this excrement can form layers as deep as 150 feet thick. If the climate is dry, soluble compounds remain mostly untouched and conditions around the coast of Peru are ideal for the most beneficial compositions of guano.

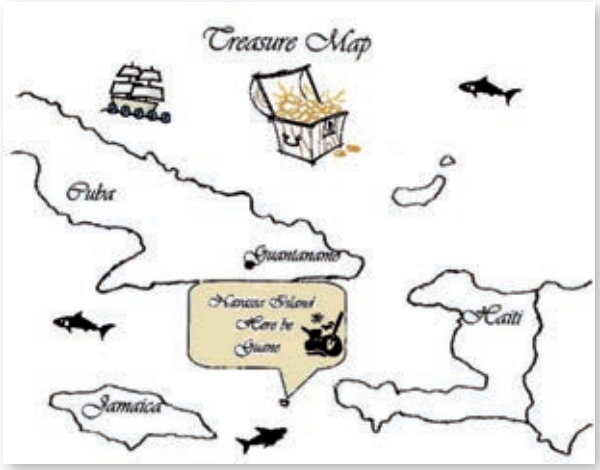
Introduced into England in 1839, guano usage amounted to some 200,000 tons per annum over the following thirty years. What makes it so useful as a fertiliser is the phosphate and nitrogenous matter content. A process employed by the fertiliser company Ohlendorff[2] in the late 1800s consisted of treating guano with a small proportion of sulphuric acid, followed by drying to a powder. The resulting "dissolved guano" then contained a guaranteed nitrogen content of 9% (expressed as ammonia) and 20% of soluble phosphates. Table 1 compares one of the best Peruvian sources, the Chincha group of islands, with the low nitrogen content version found on Baker's Island in the Pacific Ocean. Climate accounts for the massive comparative difference in soluble organic content.

Table 1. Figures taken from C. W. Vincent (c.1870).
Values are the averages of a small number of samples.

Component	Peruvian Chincha guano %	Baker's Island guano %
Water	13.67	10.00
Organic matter and ammonium salts	52.05	9.20
"Earthy" phosphates	22.78	75.15
Alkali salts	9.67	-
Sand and silica	1.83	0.80
Nitrogen	13.61	0.50
Total phosphoric acid	13.78	34.80
Soluble phosphoric acid	3.34	0.37

Preston E. James gives some interesting figures for one of the Chincha islands. It had been previously estimated that in one "relatively small area" there were 5,600,000 birds, needing at least a thousand tons of fish per day. This population of birds would create over 50,000 tons of guano per year.

The climate that so favours guano deposits around the coast of Peru was disrupted by abnormal conditions at the time of an El Niño event in 1925.[3] Preston James describes the results as surpassing "the traditional seven plagues of Egypt" and notes that between 1918 and 1925 the total rainfall at Trujillo, in northwestern Peru, amounted to only 1.4 inches. In one single month, March 1925, 15.5 inches fell. The fish moved away seeking cooler water and millions of birds starved to death.



What's the worst job you've ever had?

Guano digging would probably rank high on any list of undesirable occupations. So unpleasant, in fact, that those undertaking the work generally fell into one of three categories: the desperate, the duped or the forcibly recruited.

It was the desperate, the black Americans with poor prospects, who signed contracts in Baltimore with the Navassa Phosphate Company "for the business of assisting in loading of vessels with cargo". This disarming statement was followed by the more alarming: "... and agree to devote their whole time and services in such labour as they may be directed to do ..." and: "... should they fail to obey the orders and instructions of said Navassa Phosphate Company, or its agents, or refuse at any time to labour, they shall forfeit all claims for wages and compensation which may be due to them."

To chip away at the meagre wage of $8 per month, the company deducted a fixed fee for "medicines and medical attention". But they also imposed a daily fine on the sick and injured, as well as docking their wages for the duration of the incapacity.

Anyone considered unfit to continue labouring faced the total loss of all wages with the added financial burden of being forced to pay for passage back to the US.

As if these terms were not bad enough, food and accommodation turned out to be very poor and could only be improved by buying, at inflated prices from the company shop, a few little luxuries like rented bedding and something edible. On top of the foul nature of digging out guano, physical punishment for minor rule infringements rounded off the employment package.

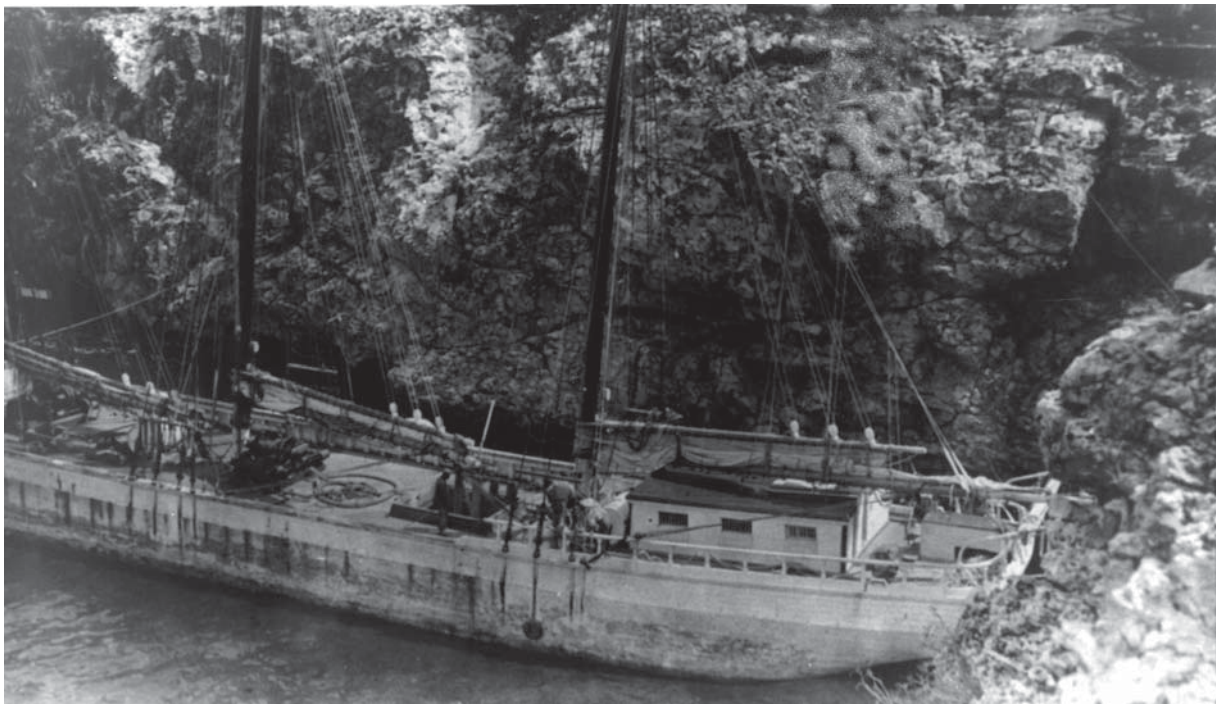
The incident that sparked off a riot occurred on 14 September 1889. One of the managers, Charles Roby, caused the simmering pot of resentment to boil over by kicking one of the labourers. Moments later, Roby was brought down with the aid of a metal pole and relieved of his gun. In the fracas that followed, five of the overseers died (one of them later, from injuries), including the distinctly unpopular Thomas Foster who was despatched with a hatchet.

Navassa Lighthouse 1938
(Courtesy of Lighthouse Digest)

In response, the US authorities sent a vessel to bring everyone back to the port of Baltimore. Three of the rioters faced hanging but their sentences were later commuted to terms of imprisonment when investigations revealed the barbaric working conditions. Despite the bad press, the company continued with its exploitation. The Spanish-American war intervened in 1898 and the guano-diggers left the mines for good.

Let there be light

The birds were left in peace until 1916 when work began on a monumental undertaking, the tallest lighthouse that the US had yet built. Standing 162 feet tall and made of concrete, its construction was made difficult by the lack of a harbour.



A schooner close to cliffs at Navassa Island delivering supplies
(Courtesy of Lighthouse Digest)

Vertical cliffs from 9 to 15 m high surrounded the island and so all materials brought in by ship were hoisted to the top.

Shown above is a ship in position for unloading and gives an idea of the dangers. Even fresh water arrived by boat since the island had none of its own. Supplying the lighthouse staff must have been an expensive business, a problem that found a solution in 1929 when advances in technology allowed the light's operation to be fully automated. Later on, developments in ship navigation systems made the lighthouse redundant and since 1996 it has been inactive.

What birds can do, humans can do better

Despite its name suggesting otherwise, the Native Guano Company, of London, did not deal in bird droppings. The fertiliser on offer came from treating water borne human waste by what the company called "the ABC method", a process endorsed and promoted by the influential chemist William Crookes (known to physicists for the Crookes Tube).

Patented in 1868, ABC stood for Animal charcoal, bovine Blood and Clay, a mixture used to help remove solids and deodorise the separated liquid. There were plenty of competitors with different techniques, but at the time no one knew that successful sewage decomposition requires bacterial action and so they only looked at chemical treatments.

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Thanks to Tim Harrison of Lighthouse Digest.

Notes

1 P. D. James, *The Murder Room* (London: Faber and Faber, 2010).

2 Ohlendorff & Co became the Anglo-Continental Guano Works and operated a factory at Victoria Docks, London.

3 During an El Niño event, warm water moves southwards from the equator. It forms a layer over colder water and usually dissipates in a short time. In 1925 considerably more of the heated seawater arrived along the Peruvian coast. El Niño comes from Spanish for "The Child" (Christ), since it generally happens around Christmas time (every few years).

4 The company charged 50 cents for each lost working day, whatever the reason for absence. This fee was described as a payment for boarding – a fine by another name.

Biofloc technology trials on a tilapia farm in Thailand: towards the production of a better fry

Carlos Conroy

Introduction

A generally accepted definition of aquaculture is the production of various animal and plant species in aquatic environments, much as agriculture covers a similar activity in terrestrial environments. The latest data available indicate that global aquaculture production has increased at an annual rate of 8.9% since 1970, compared with an annual growth rate of 1.2 – 2.8% for capture fisheries and for terrestrial meat production over that same period (Avnimelech, 2012).

Avnimelech (2012), in his Preface, correctly describes aquaculture in the following terms: "Unlike terrestrial agriculture of plants or animals, the aqua culturist does not see the fish", obliging "production to be facilitated by the determination of biological, chemical, and physico-chemical processes in the water". Citing recently published sources, he estimated that the anticipated (or required) global aquaculture production, expressed in millions of metric tons (MT), will be 120 – 150 in 2025, and 210 in 2050, compared with 61 produced in 2010. Tilapias, including the many species and their hybrids which are suitable for aquaculture purposes, now occupy third place in the global production of edible fresh water fish. In addition, certain tilapia species possessing euryhaline characteristics are being increasingly farmed in suitable coastal and estuarine localities in the world.

Several technological advances, including those in genetics and nutrition, have led to the wider use of tilapias in aquaculture. An international research project, initiated in the Philippines in 1988 as "Genetic Improvement of Farmed Tilapia" (GIFT), has enabled a strain of Nile tilapia *(Oreochromis niloticus)* to become available for practical purposes. Data reported by Lutz (2006) indicate that the use of the GIFT strain produced 7 – 36% savings in the breakdown costs of production, when evaluated against locally used strains in Bangladesh, China, the Philippines, Thailand and Vietnam.

Environmental concerns are leading to increasingly significant limitations on water usage being placed on the commercial use of the aquatic environment, alongside the rising costs of the operations. Further concerns refer to the future availability of important ingredients, and their costs, for the manufacture of feeds used by the aquaculture industry. Such considerations are obliging the industry to develop and apply more efficient measures to comply with world market demands for attractive, high quality, nutritious, safe, and socially acceptable farmed fish products.

Increasing attention is being given to the use of novel practices such as biofloc technology (BFT) to achieve that goal. BFT uses selected beneficial microorganisms (e.g. certain autotrophic and heterotrophic bacteria, unicellular algae) as low cost natural sources of food for the farmed species, together with a parallel boost to the immune response of the farmed fish against certain diseases which negatively affect them under conditions of their culture in captivity. The latest advances in BFT applied to productive aquaculture worldwide have been comprehensively compiled and reviewed by Avnimelech (2012).

Of the many countries in which tilapia farming has become of commercial and productive importance, Thailand is a good example. In the year 2003, that activity there commenced with a production of more than 100 000 m.t. to satisfy

Figure 1: Map of Thailand showing its geographical location in S.E. Asia

Figure 3: Typical feeding tanks

Figure 2: View of tanks used in the biofloc trials

its internal domestic consumption, and that has now been extended to the exportation of selected tilapia products to the international markets (Fitzsimmons, 2006). The author was invited to undertake some preliminary studies on the possible application of BFT to tilapia fry production on a commercial site in Thailand, and this contribution very briefly reports on the initial findings of those studies.

Background

The trials were conducted during the period June – September 2012 in the tilapia fry production facilities of a farm located in a tropical area of southern Thailand (Figure 1), near to the town of Petchburi, where a mean ambient temperature of 34°C prevails all year round. The 3 separate field trials proposed used fully lined plastic tanks measuring 15 x 3.8 metres, with a depth of 0.90 metres. These tanks are normally stocked at a density of 3 – 6 fish/cubic metre, and for these trials they were stocked at a density of 3.5 – 5 fish/cubic metre. The facility produces sexually reversed fry with an individual mean weight of 0.38 g and a total body length of up to 3 cm., for sale to other tilapia farms, or for use in the company's own on-growing production sites, up to the market size of the adults (unit weight: 350 g - 1 kg, according to the type of intended use). This process is normally achieved in cycles of 21 days.

The purpose of the trials was to evaluate the efficacy of an experimental biofloc system on the survival rates of sexually reversed fry of the GIFT strain of Nile tilapia (Oreochromis niloticus), by means of the use of a commercially available brand of probiotic (based on autotrophic microorganisms). The physico-chemical characteristics of the water were: pH 7.9 – 8.2, temperature 27 – 31°C, hardness >100 ppm, ammonia 0 – 3%, nitrite 0%, N:C relationship 20:1, and having a natural "green" colour. Artificial feed was provided 8 times per day in the form of a commercial pelleted shrimp feed (protein content: 37%), to which a natural masculinising hormone had previously been mixed. Each trial was made over a period of 21 days. Figures 2 – 6 illustrate aspects of this process.

Findings and discussion

Traditional practices in Thailand lead to a survival rate of approximately 55% per batch/production cycle. In these present trials, and during which no antimicrobials were used, the sexually reversed tilapia fry raised in the biofloc system had a mean survival rate of 80%/batch/cycle.

The initial conclusions drawn from these very preliminary experimental trials indicate that the use of BFT is a positive step forward in commercial tilapia fry production in Thailand. The benefits of the use of probiotics include the

Figure 4: Daily sampling of the sexually reversed tilapia fry


Figure 5: Preparation of the feed containing probiotic


Figure 6: A typical sexually reversed tilapia after exposure to biofloc technology

provision of non-pathogenic strains of microorganisms which exclude the growth of potentially pathogenic bacteria, and limit the effects of those latter on the fish. In addition, they favour the environment by utilising the available nitrogen sources from the faeces and the food, thereby reducing the risks of high ammonia and nitrite levels in the water, which could be toxic to the fry.

The practical application of BFT appears to be a potentially valuable contribution towards improving commercial tilapia fry production in Thailand. These very preliminary observations will be followed up by further more detailed experimental studies to be undertaken, in order to obtain more evidence to support the initial conclusions which have been reached.

Acknowledgements

The author thanks his father, Prof. David Conroy, FIScT, and his mother, Dr. Gina Conroy, for their comments and assistance in the presentation of this article. Prof. Sergio Zimmerman provided most helpful technical advice and support in the execution of these preliminary field trials. He also wishes to thank his Thai colleagues, for their enthusiastic cooperation, friendship, and hospitality.

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Understanding cleanroom microflora

Tim Sandle

Figure 1: Operator in a cleanroom (© Tim Sandle)

Introduction

There has been very little published information relating to the "typical" microorganisms recovered from cleanrooms or clean environments. This can cause difficulties for the pharmaceutical manufacturer when assessing the results and range of "microflora" recovered from environmental monitoring activities. Microorganisms are found in pharmaceutical ingredients, water for pharmaceutical use, the manufacturing environment, intermediates, and in finished products. Microbiologists are frequently required not only to count the number of "colony forming units" (cfu) but also to identify the contaminants in order to assist in product investigations and environmental monitoring excursions. Although there is no direct reference to this activity in current Good Manufacturing Practices (GMP), the United States Pharmacopeia (USP) chapter <1116> addresses establishing the normal microbial flora and using microbial identification to assess the effectiveness of the cleaning and sanitization program and to investigate the source of microbial contamination, especially when environmental monitoring action levels are exceeded.[1]

This article examines some of the typical microorganisms that can be recovered from cleanrooms, their origins, and the importance of this information for microbiologists.

What are cleanrooms?

The pharmaceutical manufacturing environment is based around a series of rooms with specially controlled environments. These are termed "cleanrooms." A cleanroom is a specially designed room in which the concentration of airborne contamination is controlled[2], and which is constructed and used in a manner to minimize the introduction, generation and retention of particles inside the room, and in which other important parameters, such as pressure, temperature and humidity are controlled [3]. Cleanrooms are certified to meet the requirements of the International Organization for Standardization (ISO) in the international cleanroom standard ISO14644 and are operated to meet the requirements of either the EU GMP or the FDA guidelines.

What is environmental monitoring?

Cleanrooms and clean areas are assessed through an environmental monitoring program. The purpose of microbiological environmental monitoring is to assess the cleanliness of pharmaceutical (sterile and non-sterile), hospital pharmacy units and medical device manufacturing environments. Environmental monitoring involves the collection of data relating to the numbers and types of microorganisms present on surfaces, in the air, and from people. In addition, nonviable particle counting--a physical test--is undertaken in conjunction with viable monitoring.[4]

Figure 2: Operator loading an active air-sampler (© Tim Sandle)

Microbiological monitoring is undertaken using a range of different air- and surface-counting methods:

a. Active air-sampling: volumetric air-sampler

b. Passive air-sampling: settle plates

c. Surface samples: contact (RODAC) plates and swabs

d. Personnel samples: finger plates and gown plates

In constructing an environmental monitoring program, it is important to be aware of the limitations of monitoring. The methods deployed, for example, are highly variable in terms of collection efficiency. In relation to the recovery of microflora, there are a number of variables that will affect the types of microorganisms recovered, or indeed whether microorganisms are recovered at all. These variables include:[5]

- Monitoring methods[6]
- Location of the monitoring sample
- Types of agars
- Whether agars contain disinfectant neutralizers (and the appropriateness of the neutralizer)
- Incubation temperature
- Incubation time
- Identification method

These variables are important, although they are not explored further in this article.

Contamination sources within cleanrooms

There are many sources of contamination within cleanrooms, and to an extent, these will depend upon the design and use of the cleanroom. The atmosphere contains dusts, microorganisms, condensates, and gases. People in clean environments, are the greatest contributors to contamination, emitting body vapours, dead skin, microorganisms, skin oils, and so on.

In relation to the human body, one square centimetre of a hand surface has an average of 10,000 microorganisms, and other parts of the body, for an equivalent surface area, can harbour over 30 million bacteria. The average person sheds 1,000,000,000 skin cells per day of a size 33 µm x 44 µm x 4 µm (a rate of 30,000 to 40,000 dead skin cells shed from the surface of the skin every minute), of which approximately 10% have microorganisms on them[7]. There are, on average, four microorganisms per skin cell. This is important, because the majority of microorganisms in cleanrooms are suspended in the air, carried on rafts of skin.

The rate of particle deposition varies according to speed and activity. For example, when stationary, people generate approximately 100,000 particles of 0.3 µm or greater; if someone is walking slowly (at two miles per hour), they will shed around five million particles. Whereas, if someone is walking briskly (at five miles per hour), they will shed around 7.5 million particles, and whereas, at a very brisk pace, the number shed increases to around 10 million particles[8]. These figures show the importance of slow, steady movements within cleanrooms.

The particles released from people via their mouth and noses are minute liquid droplets that are extremely contaminated with microorganisms. These different particle sources are controlled through personnel wearing suitable cleanroom clothing and wearing this clothing correctly[9]. Where cleanroom clothing is worn, the number of microbe-carrying particles will reduce 20-fold.

The second greatest contamination source is from air[10]. Unfiltered and uncontrolled air contains a high number of particles. For example, the ambient air outside in a typical urban environment might contain as many as 35,000,000 particles per cubic meter (of a size 0.5 µm and larger in diameter)[11]. Within cleanrooms, physical controls include the use of unidirectional airflow units, and the isolation of the operator through the use of barriers, such as isolators and restricted access barrier systems (RABS), which act to separate the filling area from the operator.

The third most important source of contamination in cleanrooms is water. Water is a concern because it can be both a contamination source and a vector of contamination, in that water droplets are easily spread. Water is controlled through the use of pharmaceutical-grade water of a low bioburden (purified water or Water for Injection (WFI), depending upon the application) and through keeping areas clean and dry, then through appropriate cleaning and disinfection practices.

With the fourth source of contamination, equipment poses a risk in relation to the way that it is introduced into the cleanroom. This can range from trolley wheels, which are not correctly sanitized, to cardboard used to hold reagents, to non-sterile items in critical areas. Control is achieved through minimizing the amount of packaging that enters a cleanroom and by using sterilized material where possible, such as gamma-irradiated sterile disposable material within critical zones, and through effective cleaning and disinfection practices[12].

The sources of contamination are summarized in the diagram [13].

Figure 3: Diagram showing cleanroom contamination

Cleanroom microbiology

In considering cleanroom microbiology, the main source is people. Considerable research since 2005 has been dedicated to the types and variations of microorganisms in relation to people. This is in relation to the human microbiome. A microbiome is the totality of microbes, their genetic elements (genomes), and environmental interactions in a particular environment[14]. The human body contains over 10 times more microbial cells than human cells, however, because bacteria are 10-100 times smaller than human cells, the entire microbiome weighs about 200 grams (7 ounces)[15]. It has been calculated that a human adult houses about 10^{12} bacteria on the skin, 10^{10} in the mouth, and 10^{14} in the gastrointestinal tract.

In addition to the term microbiome, the terms microflora or microbiota are also used. However the distinction is made, the human microbiome or microbiota is the aggregate of microorganisms that resides on the surface and in deep layers of skin, in the saliva and oral mucosa, in the conjunctiva, and in the gastrointestinal tracts. They include bacteria, fungi, and archaea. Some of these organisms perform tasks that are useful for the human host. However, the majority have no known beneficial or harmful effect. Those that are expected to be present, and that under normal circumstances do not cause disease, but instead participate in maintaining health, are deemed members of the normal flora. The alternative and commonly used term “microflora” is, in technical terms, a misnomer, since the word root “flora” pertains to plants, and biota refers to the total collection of organisms in a particular ecosystem.

The microbial ecology of the human body is complex, and many of the species of microorganisms that form the microbiota are unknown[16]. However, understanding has been considerably advanced through genotypic microbial identification techniques (such as analyzing species based on 16s rRNA genes present in samples of lyzed microbial DNA). There is a considerable diversity of species and variation between different locations on the body and across individuals over time[17]. This is represented in the diagram below:

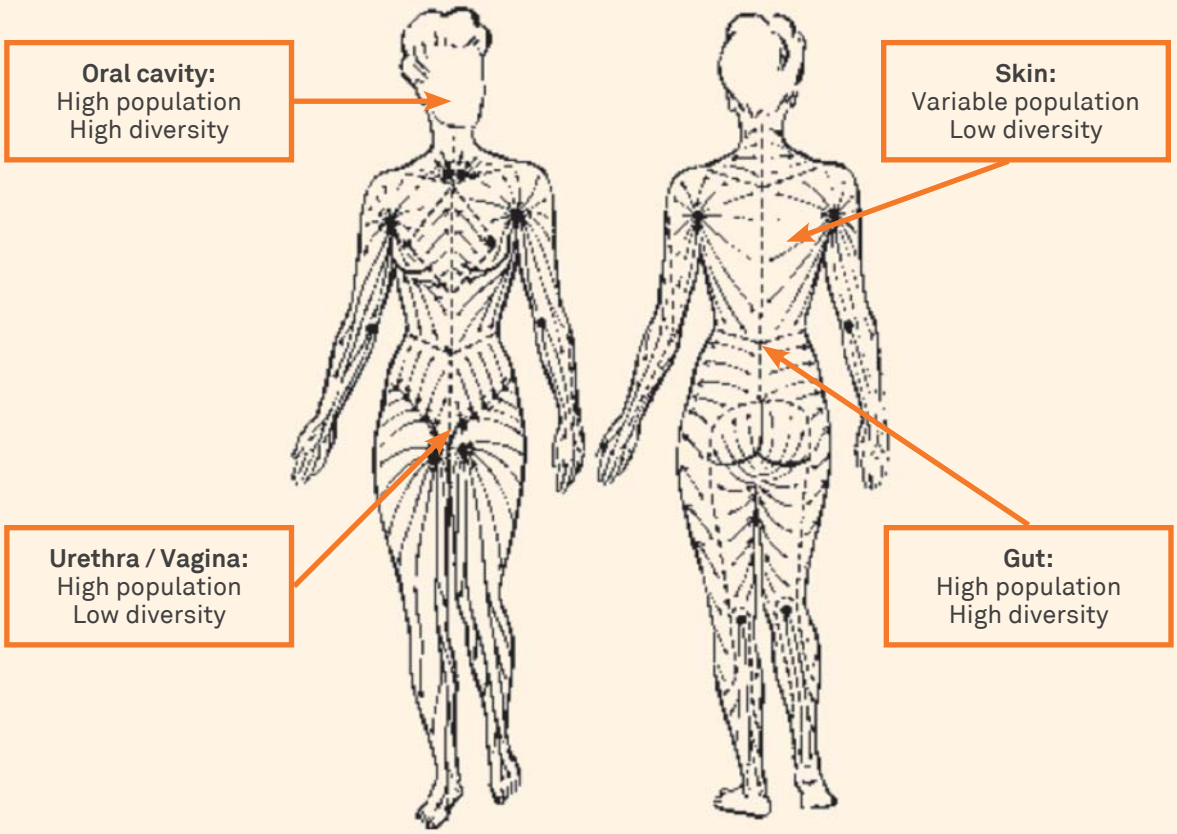

Figure 4: Diagram showing microbial recovery from the human body (© Tim Sandle)

In terms of the range of different microorganisms recovered, these are approximated in the chart below:

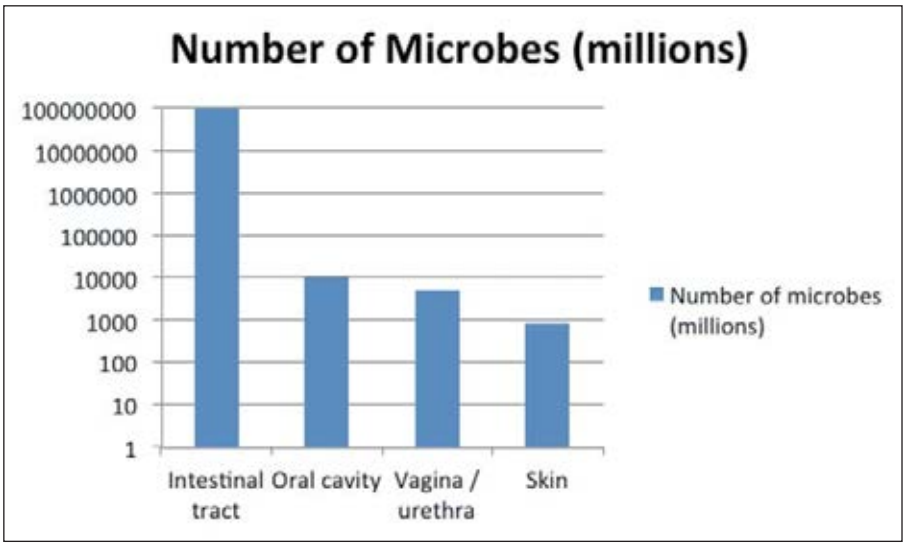

Figure 5: Chart showing microbial density from different parts of the human body [adapted from wilson (2008)][18]

The chart above, based on rough approximations, indicates the variation in terms of the numbers of microorganisms across and within the human body. Similarly, the complexity of the microbial community varies depending upon different body sites. This relates to whether a particular part of the body has the conditions conducive to microbial growth and survival (nutritional and physiochemical requirements). Here, Liebig's law of the minimum (which is, the total yield of an organism is determined by the nutrient present at a concentration that will limit the growth of a particular species) and Shelford's law of tolerance (which relates to the non-nutritional factors governing growth, such as pH and temperature, where different species require different conditions for survival and growth) must be met. Other factors affecting the ability of an organism to become established include biological factors, such as the production of antimicrobial compounds, and mechanical removal factors, such as saliva, urine, or skin shedding.

Microorganisms on and within the human body are normally found as microcolonies, that is, aggregates of microorganisms that are often enclosed within a microbial polymer (sometimes these may form larger structures called biofilms). With the skin, however, as epithelial cells are continually being shed, many microbial communities on the external surface are rarely stable.

The main parts of the body and the primary microorganisms recovered are examined below. Due to the focus upon cleanrooms, the greatest focus is afforded to the skin microbiota. The general descriptions relate to healthy adults. It is likely that microbiota vary, to an extent, by:

- Age
- Host genotype (genetic relatedness of individuals)
- Gender (for example, males have a higher density of bacteria on their skin than females, which may be linked to increased sebum and sweat production).

Human gastrointestinal tract

It is estimated that 500 to 1,000 species of bacteria live in the human gut. The typical species are [19, 20]:

Bacteroides fragilis, Bacteroides melaninogenicus, Bacteroides oralis, Lactobacillus, Clostridium perfringens, Clostridium septicum, Clostridium tetani, Bifidobacterium bifidum, Staphylococcus aureus, Enterococcus faecalis, Escherichia coli, Salmonella enteritidis, Klebsiella sp., Enterobacter sp., Proteus mirabilis, Pseudomonas aeruginosa, Peptostreptococcus sp., and Peptococcus sp.

Eyes

The conjunctival floras have a much lower variety compared with other parts of the human body. This is because the lachrymal glands continuously secrete, keeping the conjunctiva moist, while intermittent blinking lubricates the conjunctiva and washes away foreign material. Tears contain bactericides such as lysozyme, so that microorganisms have difficulty in surviving the lysozyme and settling on the epithelial surfaces. The common species include *Staphylococcus epidermidis* and certain coryneforms such as *Propionibacterium acnes.* Other species are: *Staphylococcus aureus, Streptococci, Haemophilus sp.,* and *Neisseria sp..*

Oral

The mouth harbours a diverse, abundant, and complex microbial community. This highly diverse microflora inhabits the various surfaces of the normal mouth. Bacteria accumulate on both the hard and soft oral tissues in biofilms[21]. Bacterial adhesion is particularly important for oral bacteria. Oral bacteria include streptococci, lactobacilli, staphylococci, corynebacteria, and various anaerobes in particular bacteroides. Predominant examples include *Streptococcus mutans* and *Streptococcus sanguinis*[22].

Skin-based microorganisms

Human skin represents the most extensive organ of the human body, whose functions include protecting the body from pathogens, preventing loss of moisture, and participating in the regulation of body temperature[23]. The adult human is covered with approximately 1.8 square meters of skin, weighing 4.2 Kg (without blood[24]). The skin is composed of an outer epithelium (epidermis) and an inner dermis, made up of epidermal, connective, nervous and muscular tissues.

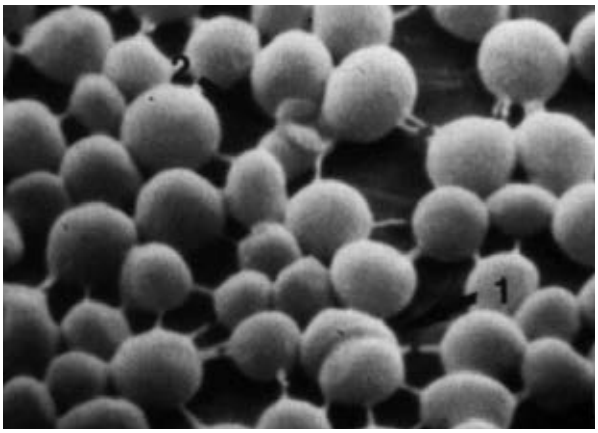

Figure 6: Electron micrograph of staphylocci bacteria (Source: University of Maryland, www.life.umd.edu/classroom/bsci424/pathogendescriptions/Staphylococcus.htm.)

The temperature of the skin varies, depending on the anatomical location, covering the range 25-37°C, with the warmest area under the arms (at around 36.6°C.), and the coolest area being the fingers (at around 29.5°C). It thus encourages the growth of mesophilic bacteria. The pH of the skin varies between neutral and alkali, across different regions, with the forehead having a pH of around 4.8 and under the arm at pH 6.9.

The variation between people is far less when compared to studies of the gut microbiota, the density and composition of the normal flora of the skin varies with anatomical locale. The high moisture content of the axilla, groin, and areas between the toes supports the activity and growth of relatively high densities of bacterial cells, but the density of bacterial populations at most other sites is fairly low, generally in 100's or 1000's per square cm. Most bacteria on the skin are sequestered in sweat glands. Therefore, when considered as an ecosystem, the skin supports a range of microbial communities that live in distinct niches. Hair-covered scalp lies but a few inches from exposed neck, which in turn lies inches away from moist hairy underarms, but these niches are, at a microbial level, as distinct as a temperate forest would be compared with savanna and tropical rain forests. Studies characterizing the microbiota that inhabit these different niches are beginning to provide insights into the balance between skin health and disease[25].

The estimate of the number of species present on skin bacteria has been radically changed by the use of 16S ribosomal RNA to identify bacterial species present on skin samples directly from their genetic material. Previously, such identification had depended upon microbiological culture upon which many varieties of bacteria did not grow and so were hidden to science. From such analysis, it has been estimated that there may be around 1,000 species upon human skin from 19 phyla, although a recent study found a lower number of bacteria. The study of twenty skin sites on each of 10 healthy humans found 205 identified genera, 19 bacterial phyla, with most sequences assigned to four phyla: Actinobacteria (51.8%), Firmicutes (24.4%), Proteobacteria (16.5%), and Bacteroidetes (6.3%) [26]. The skin flora is different from that of the gut, which is predominately Firmicutes and Bacteroidetes[27].

The reason that Gram-positive bacteria predominate is because the skin is generally a dry environment, and any fluids present on the surface generally have a high osmotic pressure. Thus Gram-positive bacteria (especially the Staphylococci and Micrococci) are better adapted for such environments, not least to being resistant to desiccation. Due to variations in temperature and areas of higher sweat production, there are some areas of the skin with higher moisture content, especially occluded regions where sweat does not easily evaporate (such as toe webs). This leads to some variation of the microflora and to variations in numbers, for occluded areas have higher densities than dry areas.

Table 1 below summarizes the physical properties of the skin in relation to microbial survival:

Factor	Effect
Temperature	Allows growth of mesophiles, prevents growth of thermophiles or psychrophiles
Low Moisture	Prevents the growth of many species, especially Gram-negatives
High Osmolality	Prevents the growth of many species, especially Gram-negatives
Low pH	Prevents the survival of many species
Oxygen Concentration	Prevents survival and growth of anaerobes, except in hair follicles where oxygen concentration is low. Here, some anaerobes or microaerophiles will grow.
Nutrient Availability	High

Table 1: Physical properties of skin and the effects on microorganisms

The next table looks at areas of the body in relation to microbiota:

Region	Important Environmental Determinants	Effect on Microbiota
Forehead	Many sebaceous glands.	High population density. Dominated by Propionibacteria and some Corynebacteria. Main species: P. acnes, P. granulosum, S. hominis, S. capitis, S. epidermidis, M. luteus, M. lylae, Koc. Varians, C. minutissimum.
Scalp	High density of sebaceous glands; abundant hair traps moisture; a warm and moist environment.	High numbers of propionibacteria, staphylococci and micrococci. Species include: P. acnes, P. granulosum, S. hominis, S. capitis.
Axillae	Many sebaceous glands. Partially occluded, therefore increased moisture, temperature, and pH.	High microbial density. High numbers of moisture requiring corynebacteria, fungi and Acinetobacter spp. Main species: P. acnes, P. avidum, C. minutissimum, C. xerosis, Brevibacterium spp., S. epidermidis, S. saprophyticus, S. aureus, M. luteus, E. coli, Klebsiella spp., Proteus spp., Enterobacter spp., Acinetobacter spp.
Perineum	Occluded: increased moisture and temperature.	High microbial density. High numbers of moisture requiring corynebacteria, fungi and Acinetobacter spp. Main species: S. epidermidis, S. hominis, S. aureus. Occasional intestinal organisms.
Toe Webs	Occluded: increased moisture and temperature.	High microbial density. High numbers of moisture requiring corynebacteria, brevibacteria, fungi and Acinetobacter spp.
Arms and Legs	Few sebaceous glands, dry regions.	Low microbial density, mainly staphylococci and micrococci. Main species: S. epidermidis, S. hominis, P. acnes, M. luteus, Koc. Varians.
Hands	No sebaceous glands, exposed, low water content.	Mainly Staphylococci; Corynebacteria; a few Propionibacteria.
Soles of Feet	Absence of hair follicles and glands. High moisture due to shoes and socks.	Species include: S. hominis, S. haemolyticus; S. warneri, S. capitis, S. epidermidis, M. luteus, M. lylae.

Table 2: Regions of the skin and the types of bacteria recovered

The total number of bacteria on an average human has been estimated at 10^{12}. Most microorganisms are found in the superficial layers of the epidermis and the upper parts of hair follicles.

The common skin flora are usually nonpathogenic, and either commensals (which are not harmful to their host) or mutualistic (offer a benefit [28]. However, in relation to pharmaceutical manufacturing, the presence of such organisms remains problematic. The potentially pathogenic Staphylococcus aureus is found on the face and hands in individuals who are nasal carriers. This is because the face and hands are likely to become inoculated with the bacteria on the nasal membranes. Such individuals may auto-inoculate themselves with the pathogen or spread it to other individuals or foods.

There are three main ecological areas: moist, dry and sebaceous. Propionibacteria and Staphylococci species were the main species in sebaceous areas. In moist sites on the body Corynebacteria, together with Staphylococci dominate, although some Gram-negative bacteria will be present. In dry areas, there is a mixture of species, but b-Proteobacteria and Flavobacteriales are dominant. Ecologically, sebaceous areas had greater species richness than moist and dry ones. The areas with the least similarity in species between people were the spaces between fingers, the spaces between toes, axillae, and umbilical cord stump. The areas with most similarity are beside the nostril, nares (inside the nostril), and on the back.

The distribution of main bacterial groups is shown in the diagram below:

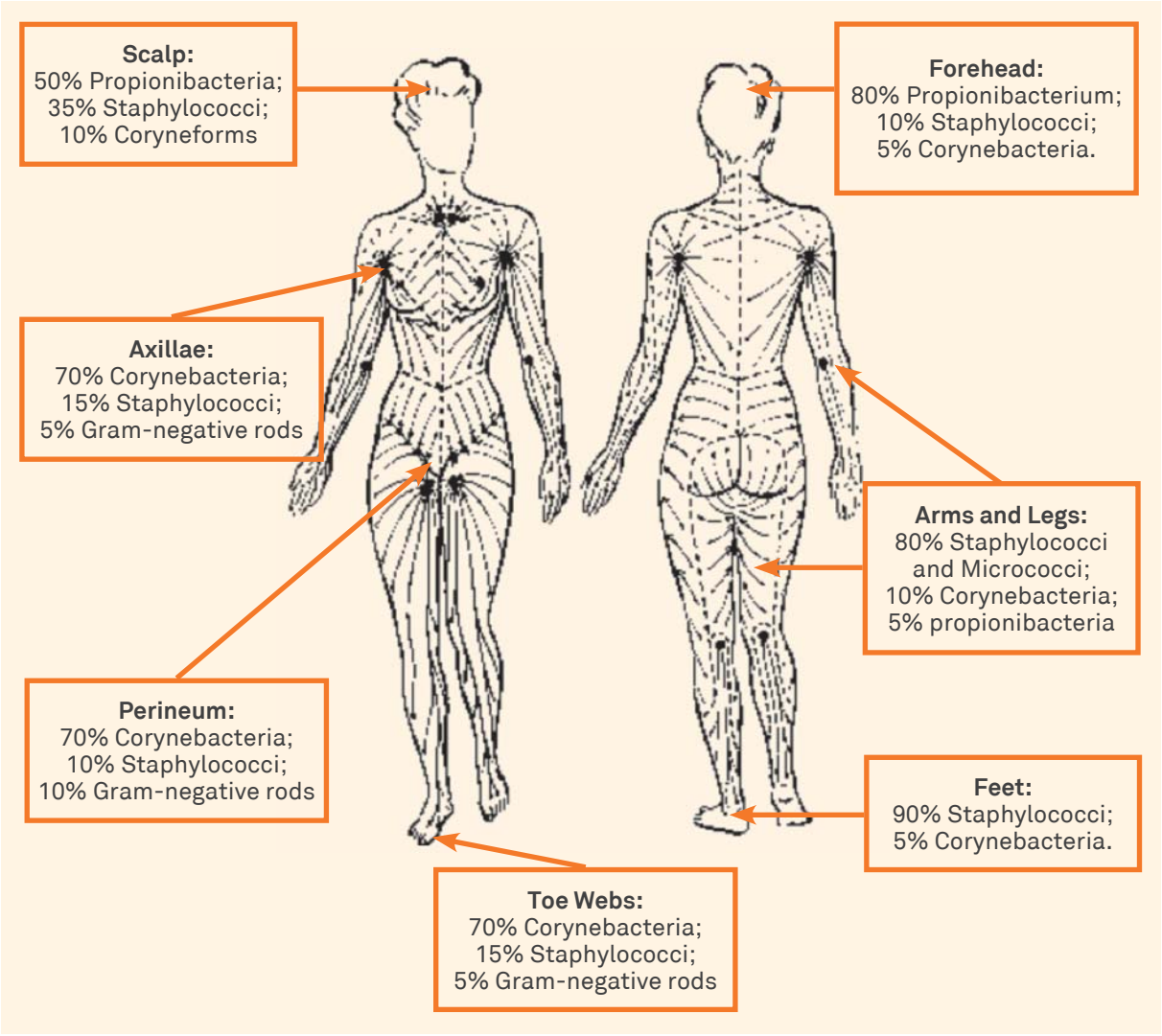

Figure 7: Types of bacteria found on the human body (© Tim Sandle.)

The most frequent species according to genetic studies are:

a. Bacteria include *Staphylococcus epidermidis, Streptococcus mitis, Propionibacterium acnes, Corynebacterium spp.,* and *Acinetobacter johnsonii.*

b. Fungi include yeasts such as *Candida albicans, Rhodotorula rubra, Torulopsis* and *Trichosporon cutaneum,* dermatophytes (skin, living fungi) such as *Microsporum gypseum, Trichophyton rubrum* and nondermatophyte fungi (opportunistic fungi that can live in skin) such as *Rhizopus stolonifer, Trichosporon cutaneum, Fusarium, Scopulariopsis brevicaulis, Curvularia, Alternaria alternata, Paecilomyces, Aspergillus flavus* and *Penicillium species.*[29]

In terms of further analysis, the skin microorganisms found in the most superficial layers of the epidermis and the upper parts of the hair follicles are Gram-positive cocci (*Staphylococcus epidermidis* and *Micrococcus spp.*) and *Corynebacteria,* such as *Propionibacterium spp.* Levels of fungi can be lower, because staphylococci and propionibacteria produce fatty acids that inhibit the growth of fungi and yeast on the skin.

The surface of the skin is an aerobic environment, and anaerobic bacteria do not tend to grow or survive. Microareophilic and anaerobic bacteria, like *Propionibacterium* are able to survive in hair follicles.

Why do microorganisms survive in cleanrooms?

It can be difficult to understand, especially for the nonmicrobiologist, as to why microorganisms will survive in a cleanroom. The survival of microorganisms in cleanroom environments is dependent upon a number of different factors. The influence of these factors varies depending upon the species (for example, the extent of water activity required) and the combination of factors involved. Such factors include[30]:

- Temperature
- Available water
- Concentration of organic compounds
- Concentration of hydrogen ions
- Concentration of inorganic compounds
- Concentration of particles in the air
- Redox potential
- Pressure
- Light intensity
- Geographical location and habitat

In considering why particular microorganisms might have survived in a cleanroom, it is important to understand survival mechanisms[31]. To survive in the cleanroom environment, microorganisms adopt different survival strategies. Some microorganisms do not need high concentrations of organic or inorganic material in order to sustain their metabolisms and survive in the harsh environments of cleanrooms. An example is the *Pseudomonas* species that exhibit strong physiological variety[32].

The adoption of environmental strategies, such as a minimal utilization of energy to support the microbial metabolism, results in microorganisms taking on very different forms to laboratory cultures. This is one of the reasons why some argue that environmental isolates (or "wildtypes") should be included in the assessment of microbiological culture media, in the validation of microbial methods, and in challenging disinfectant efficacy. This inclusion is challenged by others who argue that any environmental isolate, once grown on microbiological culture media, becomes a laboratory culture like any other[33].

The effect of the environment causes a number of problems in pharmaceutical manufacturing. Examples of such problems include the formation of biofilms, endospores, and the predominance of viable non-culturable species. With biofilms, the low nutrient conditions often reduce the size of the microbial populations and promote adherence to surfaces in aqueous environments. An example of a survival strategy in nutrient-depleted environments is the formation of endospores. The presence of spores poses problems for disinfectant efficacy[34].

What are common cleanroom microflora?

The description of the human microbiota does not necessarily predict the types of microorganisms found in cleanrooms. This is due to the variations relating to:

a) Cleanrooms
   - Cleanroom types and uses
   - Grade, temperature and humidity
   - Geographical location
   - Gowning requirements
   - Certain locations of the body are more likely to release organisms than others

b) Microbial identification method

c) Phenotypic or genotypic

d) Databases [size, orientation (clinical or industrial)]

e) Periodic reclassification of microorganisms

f) Limitations of EM methods [35]

g) Culturability (some research suggests that less than 10% of bacteria found in cleanrooms are culturable)[36]

h) Seasonality and time of sampling [37]

There have been very few studies of pharmaceutical cleanroom microflora published in recent years. The only significant new research paper is that by Sandle (2011) [38].

Findings from Sandle's study and older historical studies show:

- An association between the microorganisms commonly found in cleanrooms and those that are transient to (short-term or long term-residents on) human skin[39, 40].
- In addition, other types of microorganisms present in cleanrooms, such as Bacillus spp.[41], are those present in soil. Such microorganisms may be transferred into the cleanrooms via personnel, dust, and material transfer[42, 43].
- Occasional, low-level incidences of microorganisms resident within the human body can also be detected.
- In lower-grade cleanrooms, where there is a water source, some microorganisms associated with water systems will be detected (albeit often in relatively low numbers; otherwise the cleaning and sanitization regime may be considered to be ineffective)[44].

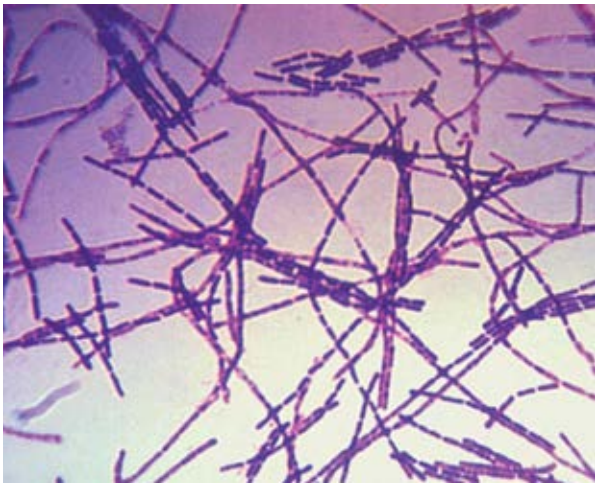

Figure 8: Gram-stain of a *bacillus spp.* (Source: creative commons library)

The vast majority of bacteria isolated from cleanrooms are mesophilic aerobic or facultatively aerobic bacteria. Common species include [45].

- *Micrococcus spp.*
- *Staphylococcus spp.*
- *Corynebacterium spp.*
- *Bacillus spp.*
- *Aspergillus spp.*
- *Pencillin spp.*

With the genera *Staphylococcus* and *Micrococcus*, many of the species are indigenous to humans.

What is the Value of Identifying and Characterizing Microflora?

The value of identifying microflora can help with the formulation of corrective and preventative actions (CAPA) as the species will provide important information about the likely origin. There are also concerns, in relation to non-sterile products, when the potential for the organism to survive in a process or to cause spoilage of the product is taken into account [46]. Trending microflora also helps to assess the efficiency of cleaning and disinfection regimes. A further reason would be in the event of a sterility test failure or possible product contamination event, for there may be an identifiable link between personnel or the environment to the contamination incident.

Conclusions

This paper has discussed the human microbiome and cleanroom microflora and has drawn links between the two. The review, which has considered recent literature, indicates that the microbial diversity observed in cleanrooms is much broader than previously realized.

Knowing the normally recovered types of microorganisms can be used to provide important information about contamination origins, which, in turn, can provide important information about people, disinfection regimes, air handling systems, and other forms of cleanroom control.

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Haldane Gwilt Cotsworth and his arc lamp

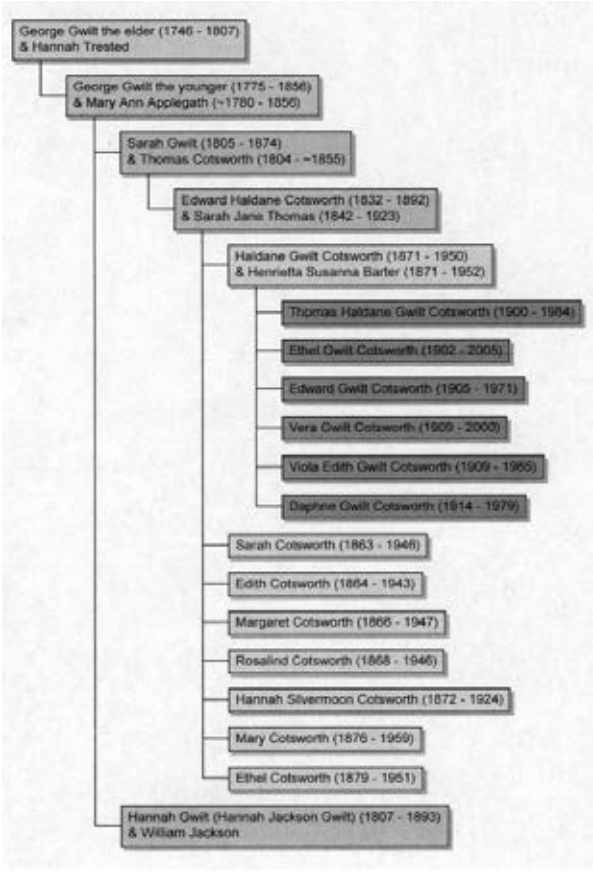
Alan Gall, IST Archivist

Introduction

From the time of George Gwilt the elder to the present day, the middle name of Gwilt has been bestowed on numerous descendents. Sarah Jane and Edward Haldane Cotsworth respected this tradition by baptising their son Haldane Gwilt on 19 February 1871. He was the brother of Hannah Silvermoon Cotsworth and the grandnephew of amateur astronomer Hannah Jackson Gwilt, about whom further details can be found in the Winter 2011 issue of this journal.

Funds were in short supply at the Cotsworth household. To pay for her son's railway apprenticeship, Sarah Jane obtained a grant from the Henry Smith Charity. Haldane then spent ten years at the Swindon locomotive works of the Great Western Railway (GWR), five years indentured to the chief engineer and the rest in other capacities. The training he received was wide-ranging; covering chemistry, electrical engineering and mechanical engineering. While at Swindon he observed the shortcomings of arc lamps caused by poor control of spark-gap length as the carbon rods were consumed. He then set about designing a system to automatically adjust the rods, resulting in a number of patents. Commercialisation of the arc lamps was put into the hands of a company promoter called Arthur Ormsby, but the Syndicate that he set up failed dismally after only a short time.

Haldane gained experience in academia by lecturing part-time at the North Wiltshire Technical School while still working for the GWR. After a short spell in private practice and a teaching post at Battersea Polytechnic, he moved north to head electrical engineering at the newly built Wigan and District Mining and Technical College, remaining there until his retirement.



A simplified family tree showing the links to George Gwilt the elder

The Cotsworths

George Gwilt the elder and his sons Joseph and George junior were all architects and accumulated considerable wealth. Remarking on this affluence and reflecting on his own reduced financial circumstances, Edward Haldane Cotsworth wrote in 1886 to his wife: "My Mothers Grandfather Gwilt was originally a working mason and left his two sons £50,000 each." At the time of writing, he was struggling to earn ten shillings per week.

The Cotsworths, August 1918

Edward made the voyage from England to Australia when the time at sea generally exceeded one hundred days. There he met an Irish girl, Sarah Jane Thomas. Sarah and Edward were married on 19 April 1862 at Christ Church, St Kilda, Melbourne. Shortly after the birth of their daughter Sarah in 1863 the family made the long trip back to England and over the next sixteen years another six daughters were added. Their only son, Haldane, was born 13 January 1871, with the census for that year following eleven weeks latter. From this record we can see that Edward claimed his profession to be a land surveyor and that whatever his income, he managed to employ a domestic servant. This would change. Ten years later the tally of children had increased from five to eight, with Edward now described as a retired bookseller at the age of 48, and minus a servant.

Living in Devon

The birthplaces of Edward's children indicate a great deal of movement. Eventually, in 1880, they settled at a house on Ringmore Road, which runs alongside the mud flats of the River Teign estuary at the village of Shaldon, then in the Parish of St Nicholas. Across the river stood Teignmouth, linked by a toll bridge that held the record as the longest wooden bridge in England when opened in 1827. Picturesque it might have been at Shaldon, but conditions were primitive. Edward put his name to a petition in 1882, a year after the Teignmouth Local Board had absorbed Shaldon with a promise to provide drainage, water and gas. These facilities were slow in coming as the Teignmouth Board was in debt at the time of the merger. Shaldon residents claimed that there had been cases of typhoid fever caused by the open sewer system although the Board denied this. Later on, some of the Cotsworth girls contracted an illness with fever as a symptom and Edward (then living away from home) was concerned it might be typhoid.

Along with sanitation, Shaldon also lacked a suitable school for a bright young lad like Haldane to attend. There must have been money available for his education as he gained a place at St James's Grammar School, Teignmouth. This establishment, close to the School of Art[1] on Orchard Gardens, was variously referred to as the Teignmouth Grammar School or just "The Grammar School", not to be confused with the Teignmouth Grammar School built later on Exeter Road. For much of Haldane's time there, the school came under the rule of headmaster Augustus Wooldridge Godby, a young teacher with a Cambridge MA.

Back at home, Edward started coughing up blood and also had some problems with what we would call tinnitus (ringing in the ears). The dryer climate of Australia gave the prospect of some relief and as the weather in Tasmania offered lower summer temperatures than the mainland he set sail for Hobart in 1884, leaving Sarah Jane and the children.

Tasmania

A series of letters[2] written by Edward from Tasmania over the period 1884 – 1887 tell of his struggles to earn a living, mainly as a photographer. They also reveal his wish to be reunited with Sarah and the children, and the dawning realisation that it would never happen. Torn between the desire to see his family and the need to protect them from the poor prospects in the colony, he seesawed between the possibilities. One letter suggests he might cash in some shares, brave the English winters and set up shop in London, but perhaps his health will suffer. In other letters one sentence tells them to come, the next to stay put. Money was a major problem: for settling debts at home should he return, or for transport and support if the family decided to emigrate.

With little expectation of a successful ultimate outcome, Edward decided to apply for assisted passage that would enable his wife and children to join him. It happened that subsidised voyages were available from the Immigrant Bounty Scheme but he needed to act quickly as the grants were coming to an end.

Edward secured tickets for his wife and six of the daughters (issued 4 October 1886) and separately for Haldane and Rosalind (issued 15 November 1886). The puzzle of why Edward arranged for tickets in two separate lots is explained in a letter dated 2 October 1886:

> *My Dear Sarah,*
> *With my utmost endeavour I was unable to pay more than £18 to emigration so had to knock out Haldane and Linda [Rosalind] but if possible before they close will add their names tho I hardly expect any of you will avail yourselves of it ...*
>
> *Mr Palmer lent me £5 but Mr Parker with whom I have (until the last fortnight) been living with for nearly a year would not lend me the other £8 for a few weeks altho he has £50 or 60 in savings bank.*

Edward ended the letter with: "I hope Haldane will keep a total abstainer and not take to smoking as the latter has a very weakening tendency and I do not think he has any too much stamina."

In the event, the family did not leave Shaldon and the "Bounty" records show that Edward had his deposit returned.

On the railways

At the age of fifteen and three-quarters, on 7 October 1886, Haldane began an apprenticeship with the Locomotive and Carriage Department of the Great Western Railway at Swindon. Under the terms of the Indenture, as a "premium apprentice" he was bound for five years and required to pay £50, half at the start and half the following year. To put this sum into perspective, his allowance in the first year amounted to 10d (pre-decimalisation pence) per day, equivalent to working 1200 days to earn back the original expenditure.[3] But this represented a wise career move as Haldane was apprenticed to William Dean, Chief Locomotive Superintendent, and took full advantage of a grant from the Henry Smith Charity that covered the cost.

Apprenticeship completed, on Monday 24 August 1891 Haldane began work at the GWR chemical laboratory on Bristol Street, Swindon, as an assistant analyst. The lab had been set up in 1882 at the instigation of William Dean who had been keen for some time to establish a department for material testing. Space simply could not be found within the complex of GWR buildings until a vacated school building on the opposite side of Bristol Street, facing the works, became available.

Some explanation for the role of chemistry in running a railway is perhaps necessary. Before widespread standardisation, materials from different manufacturers varied considerably and purchasing decisions were made on the basis of evaluating samples. In the very early days, independent analysts provided test results on which to assess the suitability of a particular product. As the volume of testing increased so did the economic argument for employing full time chemists. Unsuitable water could cause great damage to boilers, inferior steel might lead to tracks being replaced after only a short service life, poor quality oils would fail to lubricate sufficiently; a few of the good reasons for laboratory staff. Crewe station led the field with the appointment of E. Swan as the first railway chemist in 1864.

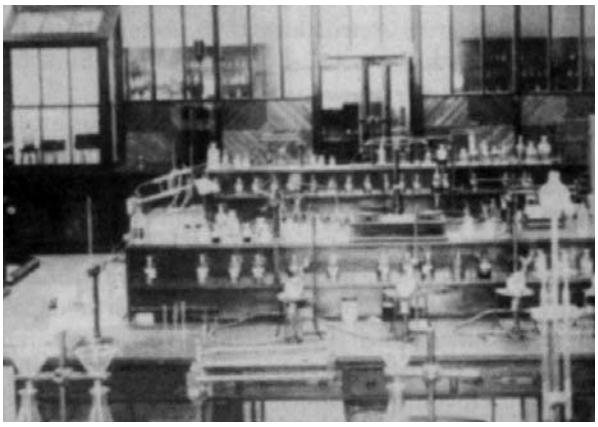
Someone who visited the laboratories very shortly before Haldane started work there was the journalist William Mitchell Acworth, collecting material for his 1889 book *The Railways of England*. Making reference to the mechanical test room he had seen at the workshops in Derby, Acworth wrote: "Let us here notice the chemical laboratory, which is an equally indispensable part of a great locomotive establishment." And in describing the need of chemical analysis went on to say: "As for steel, it is a matter of common knowledge that a trifling percentage of phosphorous, or a few grains too much of carbon, means a brittle, and may at any moment mean a broken, crank-axle, with all its possible consequences."

The death of Edward Cotsworth

Ten months after Haldane's move to the laboratory came the news that his father had died in Hobart on 2 May 1892 at the age of 60. Family legend says that the demise of Edward prompted Hannah Jackson Gwilt to make out her will. She must have been quick off the mark as the will was signed on the same day (16 June) that Haldane wrote a letter from Swindon to his mother, with expressions of grief, presumably having only just heard about the death.

As the main beneficiaries, the Cotsworths were to receive Hannah's house in Wimbledon, called Moonbeam Villa, and cash sums. In a codicil dated 15 May 1893 Hannah replaced Rosalind Cotsworth with Haldane as an executor. Further, she revoked all the benefits previously bequeathed to Rosalind. The story behind this is that Rosalind had described her great aunt as an old snob (or something similar) and the comments were reported back to an unforgiving Hannah.

Edith Cotsworth, Haldane's sister, set sale for Hobart on 11 June 1892. Given the date, it is unclear if she knew of the death beforehand. Her voyage was scheduled to take 90 days on the RMS Doric, the same ship that had carried Edward



The Swindon laboratory of the GWR in 1883 (Bleasedale Collection, Science and Society Picture Library, Science Museum, London)

Haldane's great aunt Hannah Jackson Gwilt, 1884 (Courtesy of the Cotsworth family)

away from his family eight years before. Haldane let his mother know that he could spend a week at Shaldon with her: "I have a very good suit of black which I think will do to wear. I have had a band put round my hat and coat sleeve."[4]

Further-education & lecturing

During Haldane's spell as an assistant analyst, he broadened his knowledge by taking classes in electrical engineering at The Merchant Ventures School in Bristol. It is likely that encouragement to attend this particular institution came from his employers since The Society of Merchant Venturers was one of the founders of the GWR. Haldane's attendance can be dated to 1893 as one of his notebooks has survived. Two pages with the date 20 October 1893 describe the calibration of a galvanometer and in November he made measurements of resistance with a Post Office Box. At some point in his early career he was awarded the City and Guilds Full Certificate in Electric Light and Power.

The following year, Haldane started teaching in the evenings at the North Wiltshire Technical School, Swindon, giving classes in practical chemistry and in electrical engineering. About this time he was a founder member of the New Swindon Junior Engineering Society that organised lectures given at the GWR Mechanics' Institution. The first published paper covered a lecture given by Mervin Herbert Story-Maskelyne FRS, grandson of the Astronomer Royal, Nevil Maskelyne (1732-1811).[5]

The Junior Engineering Society met fortnightly on Wednesday evenings. At one meeting on 14 March 1894, Haldane assisted W. F. E. Seymour's lecture on copper by explaining the Elmore refining process.[6] William Frederick Earl Seymour had started his GWR apprenticeship a few months before Haldane. His father John was master of the ship SS Seine that embarked on a cable-laying trip for the Brazilian Submarine Telegraph Company between 30 October 1889 and 15 January 1890. Young William accompanied the expedition, making copious notes in his diary.[7]

In September 1891 he completed his apprenticeship and went working for the South Australian Railways in Adelaide, returning to England and the GWR in 1893. Once back, he joined Haldane in the chemical laboratory, transferring to the engineering section a year later as Ironwork Inspector. The Government appointed him as Inspector of Factories and Workshops in 1900.

The arc lamp

Haldane moved from the Bristol Street laboratory to the GWR drawing office, taking up his new position as a draughtsman on Monday 11 March 1895. In December that year the provisional specification for "Improvements in the Striking and Regulating Mechanism of Arc Lamps" arrived at the patent office. Haldane recorded his address on the application as 14 Station Road, a house not far from the GWR laboratory. By this time his salary had increased to 31 shillings per week but the yearly increments seem to have ceased after January 1894 and he resigned on 3 July 1896.

Advertisement c. 1899 (Courtesy of the Costworth family)

In the archives of the Great Western Trust is a patent A-Z lined book bearing the title "The GWR Mechanics Institution New Swindon Junior Engineering Society 1893 List of Members". This record gives the names and addresses of members from 1893 to 1896, and in the back is a list of the Society's officials with William Dean as the President.

Haldane served as a Committee Member for the first two years and in 1895 he was elected as Chairman. His predecessor in the Chair was A. E. Leader and he resumed his role as a Committee Member in 1896 when T. C. Davison took over as Chairman.

(Information from the Great Western Trust Museum and Archive at Didcot Railway Centre).

By the time of submitting the complete patent specification on 29 August 1896, Haldane had moved to Moonbeam Villa at 125 Merton Road, London, on the corner of Pelham Road.[8] He then set up a workshop, grandly described as the "Experimental Works". The address for this works is given as 125 Merton Road on a letterhead of 9 August 1899 but also as Pelham Road on a draft prospectus dated 8 December 1898. Since a piece of land on the opposite side of Pelham Road came with the house, a possibility is that he used it to build a place for his development of the lamp. Haldane also rented modest space in a large office block at 109 Victoria Street, Westminster, next to the Army & Navy Co-operative Society's stores.

About ten years before Slingo and Brooker published the first edition of their popular text *Electrical Engineering for Electric Light Artisans and Students* (1890), the arc lamp provided the sole means of illumination apart from burning something easily combustible like gas, oil or candle wax. The first instance of domestic lighting by electricity is claimed by Colonel Rookes Evelyn Bell Crompton who illuminated two rooms in his house with small arc lamps "about Christmas 1879".[9] Generally, the intense light given out by arc lamps made them unsuitable for normal indoor use but appropriate for searchlights and the illumination of large areas.

Arc lamps function by passing an electric current along two carbon rods that have an adjustable gap between them. In the jargon of such devices, they need to "strike" and this is accomplished by having the end faces of the rods meeting each other. The resistance to current is high at the imperfect interface and heating results. Incandescence follows as the rods are drawn apart to an optimum distance. Clearly, some means is needed to move the rods during striking and then maintain a suitable spacing as they burn away. Apart from the quality of the rods themselves, how well the mechanism copes with these requirements determines how constant the intensity of light will be. Other features of good design help prolong the life of carbons.

Haldane's system of regulation followed established principles. Like those found in competing versions he used a "striking" electromagnet and a higher resistance shunt electromagnet to adjust the rods. With the rod ends touching, the dc current passes through the rods via the "striking" electromagnet that is connected to one rod and causes it to move apart from the other. As the gap size increases, so does the electrical resistance in that part of the circuit and more current re-directs through the shunt. This electromagnet acts in the opposite direction so bringing the carbons back into position. The exact mechanical arrangement for achieving these adjustments distinguished one design from another.

A big drawback of the arc lamp is the need to regularly replace the carbon rods. Haldane's patent (number 17832, dated 1896) aimed to make lowering and raising the lamp from a ceiling position easier. The proposed operation used a pneumatic system – just like attaching the lamp to a bicycle pump handle. With the air inlet partially throttled, the lamp would descend slowly and could be returned by hand because the air valve was designed to open on the upstroke. However, the introduction of the incandescent light bulb (starting to make its mark after 1880) sounded the death-knell for arc lamps as a means of domestic illumination.

R. E. B. Crompton, the man who installed an arc lamp in his dining room, worked with Edmund Pochin at the Arc Works in Chelmsford. The Crompton-Pochin arc lamp was available by 1900 and so were many others, such as the Siemens "Band" arc lamp and the Brockie-Pell lamp. Haldane's version did receive favourable reports and the best of these were used in sales literature.

Meanwhile, on the domestic front

Haldane decided to get married. It is presumed that he met his future wife Henrietta Susanna Barter locally while working at the GWR as she lived in Swindon. Because of the hard times caused by Edward's absence from home, Sarah Jane had developed an aversion to matrimony. In fact, none of her daughters did marry and Haldane decided to keep his union with Henrietta quiet at first. Only after the birth of his son Thomas Haldane Gwilt on 15 August 1900 did he decide to confess. A letter written about a year after the marriage broke the news: "I feel that I cannot put off any longer from you the fact that I have been married some time since I left home, more especially as I have now a little boy". There is a suggestion in the letter that some rift had occurred between Haldane and his mother, which would explain why he left home originally.

The Syndicate

Haldane had sufficient confidence in his arc lamps to believe in a sound business future. What exactly went wrong during the next few years may have been due to competing designs from other manufacturers, or the fact that the patents and their exploitation were passed over to a company promoter called Ormsby. Under what circumstances Haldane knew Arthur Ormsby is not known although the fact that this gentleman lived less than three-quarters of a mile from the Cotsworth household on Merton Road is suggestive. Under Ormsby, plans to promote the lamps and entice investors were put in motion.

Sitting in the middle of the Thames near Hampton Court is a piece of land a little over 400 m long and less than 80 m at its widest. Once called Walnut Tree Island, it became Tagg's Island, named after local builder Thomas Tagg who opened a hotel

The "Cotsworth" Arc Lamp and Electric Lighting Syndicate, Limited.

109, VICTORIA STREET, WESTMINSTER, S.W.

Best Workmanship.

No Clockwork.

Steady Burning.

Cannot Get Out of Order.

Nothing to Wear out.

Very Efficient.

FACTORY TYPE.—The above type of lamp has been specially designed for the purpose of efficiently lighting Goods Yards, Docks, and other large areas where work has to be carried out during the night time. The mechanism is the same as in our standard type. If desired the lamp may be fitted with globes instead of wells, as shown in the accompanying illustration, at the same price.

COMPLETE WITH GLOBE AND ASH TRAY.

	£ s. d.	£ s. d.
5 to 15 Amperes.		
100 hour lamp		4 10 0
18 "		5 0 0
32 " (double carbon)	PRICES ON APPLICATION.	

Clear Ground or Opal Globes supplied.

N.B.—When trimming the Carbons should be left ⅛in. apart.

From Price List of "Cotsworth" Arc Lamps and Accessories, c.1898 (Courtesy of the Costworth family)

there in the early 1870s. The Syndicate, perhaps more specifically Arthur Ormsby, chose the island to host a big promotional event in 1898. Food, drink, music and bright lights were provided for assembled guests, journalists, and officers of the soon to be incorporated company.

The Surveyor and Municipal and County Engineer of 1 July 1898 reported: "... over seventy press men and gentlemen interested in electric lighting, together with several of the fair sex, assembled at the invitation of Mr. Arthur Ormsby of Merton Park ..."

From the programme of 20 June 1898 can be seen the tempting range of refreshments and musical entertainment. Naturally, the bright lights were provided by the Cotsworth arc lamp, which The Surveyor described as illuminating the whole of the island after 9.30 in the evening. Current to power the lamps came from batteries made by the Electric Power Storage Company of Millwall, housed in electric boats operated by the Immisch Electric Launch Co Ltd.

When persuading prospective investors to part with money, it didn't harm to have titled gentlemen amongst the directors. In the case of the Syndicate, a notable director of the company was retired Major-General Sir John William Campbell, baronet. But was Sir John a bit of a Jonah? In 1908, appearing in court to give testimony in a fraud case against some fellow directors of a slate quarry business, he admitted that many of the companies with which he had been connected were failures and had been wound up, saying "but that was ill-luck".[10]

Also associated with the Syndicate were Colonel William Saurin Brooke, Sir Charles Bradley Pritchard, Robert Logan and Charles George Lumley Cator. It was intended to have Brooke, Pritchard, Logan and Ormsby as the first directors but the exact makeup is not known since the company didn't file the obligatory paperwork. However, some documents submitted to Companies House show that Sir John Campbell and an engraver called A. Gascoine were included.

Arthur Ormsby occupied an office in a building near to The Strand called Arundel House and this was used as the Syndicate's registered office. On company price-lists, and other literature, 109 Victoria Street appeared as the firm's address. In return for Haldane's patents, three English and one German, he was guaranteed the job of Electrical Manager for five years at a salary of £200 per annum and a share holding. The main products were to be the 100-hour enclosed arc lamp, the 40-hour double carbon lamp and a photographic printing lamp. Haldane signed over the patent rights on 25 March 1899.

PROGRAMME

Gage's Island, Hampton Court.

June 20th, 1898.

With Mr. A. Ormsby's Compts.

Programme of Music.

Part I.

Part II.

GOD SAVE THE QUEEN.

Menu.

Ormsby expected to do very well out of the deal. The Articles of Association dated 22 March 1899 fixed Ormsby's selling price at £16000: £3000 in cash and £13000 as shares. This was moderated by a later agreement to the payment of £6000: £2000 in cash and £4000 in shares. The cash element was to be paid at a rate of 50% of all capital received from investors after the first £1000's worth of shares were sold. Records found so far do not reveal if Haldane was due to receive any of this cash bonanza and, strangely, Ormsby's name does not appear on the list of shareholders made up to 9 August 1899. Haldane and his wife-to-be are recorded with a holding of 500 shares each. Indications are that sufficient investors could not be found.

At the beginning of 1900, the Syndicate changed registered office from Arundel House to 25 Victoria Street but failed to submit a company return for that year. The Registrar of Companies responded by threatening the directors with fines. Since four consecutive letters sent to the same address on Victoria Street were returned marked "gone away" the persistence turned out to be somewhat futile. In the absence of any replies, the company was officially struck off on 9 December 1902.

Prestwich and Burt

Both before and during the time of the Syndicate, Haldane completed a number of electrical installations for customers inside and outside the capital. Haldane even did a quotation for equipping the family home with electric lighting. But with hopes for the arc lamp's success dashed, it was time to consider a new direction. After two years (1896-1898) of working for himself and one year as manager and consulting engineer to the Syndicate, he needed a job.

Towards the end of 1899 an opening became available at the Kingston on Thames based electrical and mechanical engineers Prestwich and Burt. The position was Chief Draftsman and during the brief time that Haldane spent there, he designed a line of automatic lathes, knowledge certainly gained during his time at the railway. Acworth, previously mentioned, observed similar machines in action at the Swindon works: "Close by, a second boy looks on while a copying lathe reproduces, with a scrupulous accuracy that the most skilled hand-turning could never hope to rival, the thickenings and taperings of the oval-shaped handle of a platelayer's pick."[11]

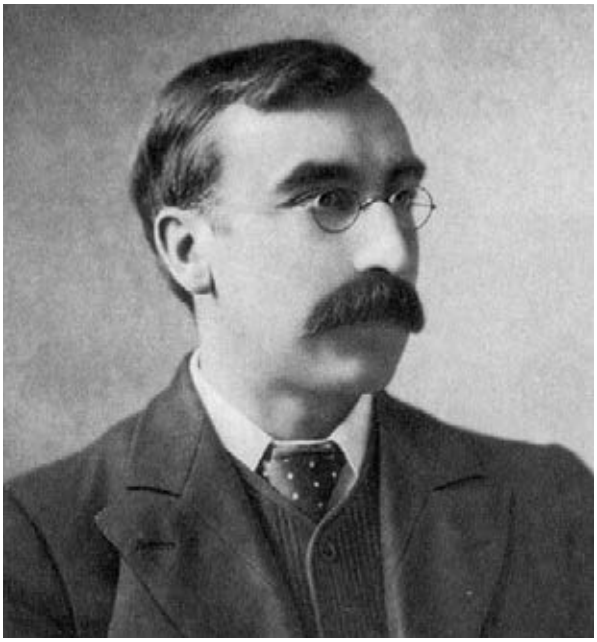
Ernest Prestwich and Lesie Burt had jointly patented a semi-mechanical system for the regulation of electrical current to lamps and motors. Haldane's expertise in this area would have been of considerable use to the firm, but a career in lecturing beckoned.

Battersea Polytechnic Institute

The predecessor of the University of Surrey, Battersea Polytechnic Institute, opened on 8 January 1894 in premises on Battersea Park Road. In the previous year, Sydney Herbert Wells had been selected as Principal and he also headed one of the six departments: Mechanical Engineering and Building Trades. Into this department came Haldane Cotsworth in 1900 as Superintendent of the workshops and as an assistant lecturer. We might suppose that Haldane and Sydney Wells got on well together as both were good practical engineers and neither had a university education.

When Haldane applied to join the Institution of Mechanical Engineers in December 1901, Wells acted as the main sponsor. Haldane became an Associate Member (AMIMechE) the following year.

Battersea Polytechnic Institute soon after 1899 (Courtesy of the University of Surrey)



Sidney Herbert Wells, Principal of Battersea Polytechnic Institute 1893-1907 (Courtesy of the University of Surrey)

Although both male and female students attended the Polytechnic, interaction between the two sexes, such as merely talking to each other, was actively discouraged. By modern standards, the general level of discipline imposed at that time seems extreme and more reminiscent of a strictly-run secondary school. To illustrate the point, anyone talking in the library would end up in front of the Principal.

The Polytechnic catered for work-related instruction but Sydney Wells had aspirations to run courses with a higher academic status and the 1896/97 prospectus offered tuition for degrees awarded by the University of London.

Lecturing at the Polytechnic allowed other work to be undertaken. When the London General Omnibus Company changed from horse-drawn vehicles to motorised buses during 1903-1904, Haldane acted as an examiner for the drivers. He also devised a syllabus for motor engineering classes to be run by the Kent Education Authorities.

By the time that Haldane finished testing bus drivers for their skill in negotiating London's streets, a new college building had opened in Wigan. The college Governors needed someone with suitable experience to head electrical engineering. Haldane applied, was offered the post, and set off for the north allowing time to settle-in before taking up his duties in November 1905.

The move to Wigan

The christening of Edward Gwilt Cotsworth at St Michaels & All Angels, Swinley, Wigan, on 12 August 1906, places the family near the town centre at 44 Avondale Road. Shortly after this they moved to a semi-detached house at Gathurst, a leafy suburb next to the village of Shevington. The immediate area consisted of little more then a few dozen houses, a pub and an explosives factory, all along the road from Shevington to Orrell. It did, however, enjoy the convenience of two major transportation systems: The Leeds and Liverpool Canal, and Gathurst Station on the Wigan to Southport line. The canal's towpath provided a direct route into Wigan by foot, bicycle or horse and the train's 2½-mile journey made the town only 5 minutes away.

One of Haldane's colleagues at the college, Ernest Brooks Naylor, lived about a quarter of a mile northwards on Gathurst Lane. E.B. Naylor BSc MSc (later FIC and FCS) headed chemistry and had also started at the same time, in 1905. Born in Bolton and a graduate of Owens College, University of Manchester, he had taught at Burnley School of Science and the Technical School at Widnes before the appointment at Wigan. Along with Haldane's next-door neighbour, John Dalton Reid, Naylor was a founder member of the Gathurst Golf Club (which celebrates its centenary this year) and captain for the years 1917 to 1926. There is no record that Haldane took up the sport.

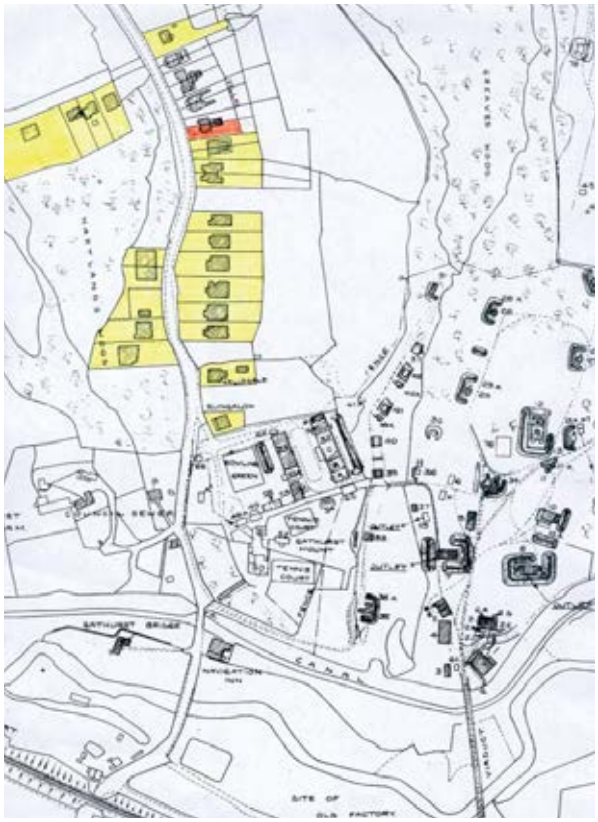
Several doors up lived Alfred Worswick at a house called Woodlands. The involvement of this neighbour with the early aviation industry would undoubtedly have been of great interest to the Cotsworths. Alfred Worswick formed Motorplanes Ltd in 1910 to exploit his research on aeroplane construction. A field near to Woodlands housed a hanger, mechanics workshop and a carpentry shop. Several monoplanes were constructed but it seems that none were capable of flight because of low power to weight ratios. The business was auctioned on 24 May 1911, by which time Worswick had moved away from the area.

Perhaps a less welcome local feature was the Roburite explosives works further down Gathurst Lane, towards Gathurst Station. German chemist Carl Roth had invented an explosive claimed to be 25% stronger than dynamite yet safer for storage and handling. J. P. Cundill[12] describes Roburite as essentially a mixture of ammonium nitrate and chlorinated dinitrobenzol[13], often combined with other constituents. The prospectus of the Roburite Explosives Company in 1887 claimed the combustion products to be virtually odourless, a view not shared by the miners of the Park Lane Collieries, Wigan, who went on strike because of the (claimed) obnoxious fumes.

Haldane at Gathurst around the time of World War One (Courtesy of Cotsworth family)

Ernest Brooks Naylor (1877-1942), Head of Chemistry Department, Wigan and District Mining and Technical College (Courtesy of Gathurst Golf Club)

From left to right: Daphne, Viola (Peggy), Vera (Corrie), Edward, Ethel, Henrietta, Haldane and Thomas
Photo taken in 1918
(Courtesy of the Cotsworth family)



A map showing Gathurst Lane in the 1960s. Marked orange is Haldane's house. The houses in the yellow areas were built later. Also shown are the explosives processing sheds and storage magazines surrounded by earth banks, although many of them were constructed after Haldane left the area.

Harris Bigg-Wither, the General Manager of the Roburite works at the time of Haldane's residence, has an interesting connection with the history of literature. His grandfather, of the same name, is the only recorded person to have proposed marriage to Jane Austen. She initially accepted, then on further reflection declined.

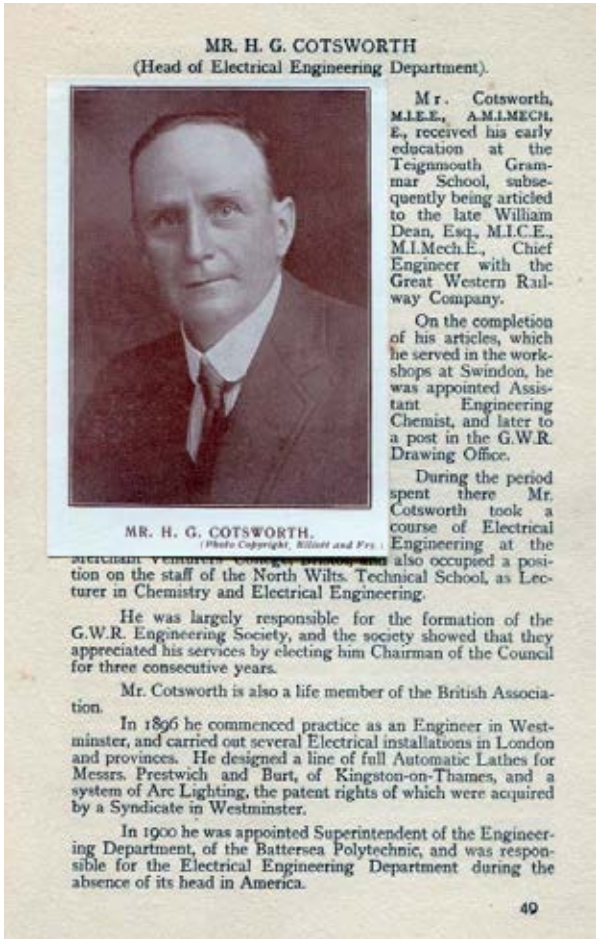
Before moving house again, there were further births. Twins Viola Edith Gwilt Cotsworth (known as Peggy) and Vera Gwilt (known as Corrie) were born in 1909. Haldane and Sarah Jane's last child, Daphne Gwilt, followed on 30 July 1914, just two days after the start of World War One. When their eldest son Thomas reached the age of 18 he became eligible for conscription. Fortunately for him, war ended a few months later, and he did not enter military service.

Twins Viola and Vera dressed as mill girls, c. 1914 (Courtesy of Cotsworth family)

Wigan and District Mining and Technical College (WDMTC)

The first directory for Wigan, published by J. Worrall in 1869, notes: "In the Western district of the Lancashire coal field there were ninety-nine collieries in 1867, of which seventy-seven were around Wigan, and other pits have opened since."

Despite the prominence of the industry, attempts at running a local school of mining had not been altogether successful. Indeed, in the very year of Worrall's statistics the committee managing the school decided on its closure. Attempts to run classes in mining and other technical subjects had begun in 1858 when 50 students were enrolled for the first session at the Wigan Mining and Technical School. The Mechanics Institute on King Street provided the classrooms, and tuition continued in a small way until the death of the first master. At this point came the decision to close but intervention by the Science and Art Department[14] reversed this. Not until 1883 did the school have its own building and this took the form of purely temporary accommodation.



MR. H. G. COTSWORTH
(Head of Electrical Engineering Department).

MR. H. G. COTSWORTH.

Mr. Cotsworth, M.I.E.E., A.M.I.MECH. E., received his early education at the Teignmouth Grammar School, subsequently being articled to the late William Dean, Esq., M.I.C.E., M.I.Mech.E., Chief Engineer with the Great Western Railway Company.

On the completion of his articles, which he served in the workshops at Swindon, he was appointed Assistant Engineering Chemist, and later to a post in the G.W.R. Drawing Office.

During the period spent there Mr. Cotsworth took a course of Electrical Engineering at the [illegible] also occupied a position on the staff of the North Wilts. Technical School, as Lecturer in Chemistry and Electrical Engineering.

He was largely responsible for the formation of the G.W.R. Engineering Society, and the society showed that they appreciated his services by electing him Chairman of the Council for three consecutive years.

Mr. Cotsworth is also a life member of the British Association.

In 1896 he commenced practice as an Engineer in Westminster, and carried out several Electrical installations in London and provinces. He designed a line of full Automatic Lathes for Messrs. Prestwich and Burt, of Kingston-on-Thames, and a system of Arc Lighting, the patent rights of which were acquired by a Syndicate in Westminster.

In 1900 he was appointed Superintendent of the Engineering Department, of the Battersea Polytechnic, and was responsible for the Electrical Engineering Department during the absence of its head in America.

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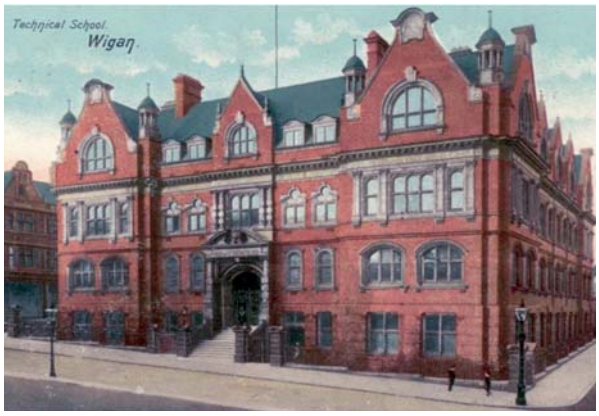
Mr H. G. Cotsworth, a photograph from the WDMTC Students' Magazine of 1920 (Courtesy of the Cotsworth family)

On a hot July afternoon in 1900, the Countess of Crawford witnessed the fixing of a memorial tablet to a building under construction that two and a half years later she would officially open as the Library Street premises of WDMTC. The site had previously been the location of one of Wigan's many slaughterhouses and dwellings grouped around Gaskell's Yard and Crispin's Court. Appropriately for a mining college, clearance of the area exposed the entrance to an ancient coal pit, covered by a large flat stone. One previous resident remarked that he had always wondered why the kitchen, located at that particular spot, was always damp.[15]

The Institution of Mining Engineers was founded as a federation of local and regional institutes on 1 July 1889. One of the constituent bodies, the Manchester Geological and Mining Society, had been formed in 1838 and Haldane joined, probably around the time of the First World War. Because of this affiliation he became an Associate Member of the Institution of Mining Engineers (AMIMinE), a qualification also attained by colleagues at Wigan, George Farmer and Colin McLuckie. Haldane did not keep up this membership. His business card from later years shows only MIEE and AMIMechE.

Electrical engineering at Wigan

A number of courses were developed during Haldane's headship. There was what would develop into the National Certificate and Diploma in Electrical and Electronic Engineering, administered by The Joint Committee (acting for the Department of Education & Science, the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers[16]). For electricians a course of instruction provided the route to a City and Guilds of London certificate in the subject of electrical installations. Haldane also prepared students for the engineering degree awarded by the University of London.



Wigan and District Mining and Technical College on Library Street, built 1903 (Courtesy of Ron Hunt and wiganworld.co.uk)

An article in the *Wigan Observer* of 13 April 1935 entitled "Presentation to Wigan College Departmental Chief" speaks of a cheque presented to Haldane, marking 30 years of service to the College. Actual retirement is not mentioned in the report but as he was approaching the age of 65 it can't have been far off – Ernest Naylor retired at age 60 in 1938.

A directory listing for 1924 shows that Haldane no longer lived at Gathurst. The new address given, at 107 Dicconson Street West, had the convenience of a short walk to work, although it offered a rather less picturesque view en route. This would remain his residence until he died at the age of eighty on 5 March 1950.

Mr Ormsby's last fling

Arthur Ormsby's old business associate Sir John Campbell, ever one to indulge in a new business venture, proposed a search for buried treasure in South America. So the story went at the time, in 1767 Jesuits at Sacambayn, Bolivia, buried a hoard of treasure worth an estimated £11,000,000. In return for funding, Sir John offered Ormsby a return of £20,000 if half a million pounds worth could be recovered. Others had tried previously and the new expedition fared no better. This failed attempt, in about 1911, forced Ormsby into bankruptcy and when Sir John died in 1915 his estate was worth less than £70.

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Further reading

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Acknowledgements

My thanks go to Haldane's grandchildren for the substantial amount of information and many illustrations used in this article:

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Peter Foulsham, son of Vera

Sylvia Hogarth, daughter of Daphne

Daphne Hough, daughter of Ethel.

Thanks also to:

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Peter Rance, Chairman of the Great Western Trust

Jim Walls, historian of Gathurst Golf Club for details of Ernest Naylor.

Research costs funded by SDA Electronics Ltd, Salford.

Notes

1 Haldane's sisters attended the School of Art with great success in their examinations.

2 Originals held by the Cotsworth family.

3 The payments to apprentices increased in each year. In Haldane's 5th year he received 2 shillings and six pence each day.

4 Letter dated 16 June 1892, Haldane to Sarah Jane Cotsworth.

5 Nevil Maskelyne was famously involved with the problem of determining longitudinal position at sea and his opposition to John Harrison's clocks (which finally solved the problem). See Dava Sobel, *Longitude* (London: Fourth Estate, 1996).

6 A recently invented electrolytic method of depositing copper.

7 See http://atlantic-cable.com/CableStories/Seymour/events_1889_10_30.html

8 Renumbering of the houses along Merton Road around the year 1900 changed number 125 to 153.

9 Colonel R. E. Crompton, "The Development of Electric Lighting", in Edward Malloy (ed.) *Practical Electrical Engineering*, Vol. II, Revised Edition (London: George Newness, n.d.), 393-403 at 397.

10 *The Times,* 17 June 1908.

11 W. M. Acworth, *The Railways of England* (London: John Murray, 1889), 277.

12 Lieutenant- Colonel J. P. Cundill, *A Dictionary of Explosives,* 2nd Edition (London: HMSO, 1895).

13 In modern terminology, 1-chloro-2, 6-dinitrobenzene.

14 A government department based at South Kensington, London.

15 *Manchester Guardian,* 26 September 1904.

16 The Institution of Electrical Engineers and the Institution of Electronic & Radio Engineers merged in 1980. The combined body is now the Institution of Engineering & Technology.

Appeal for information

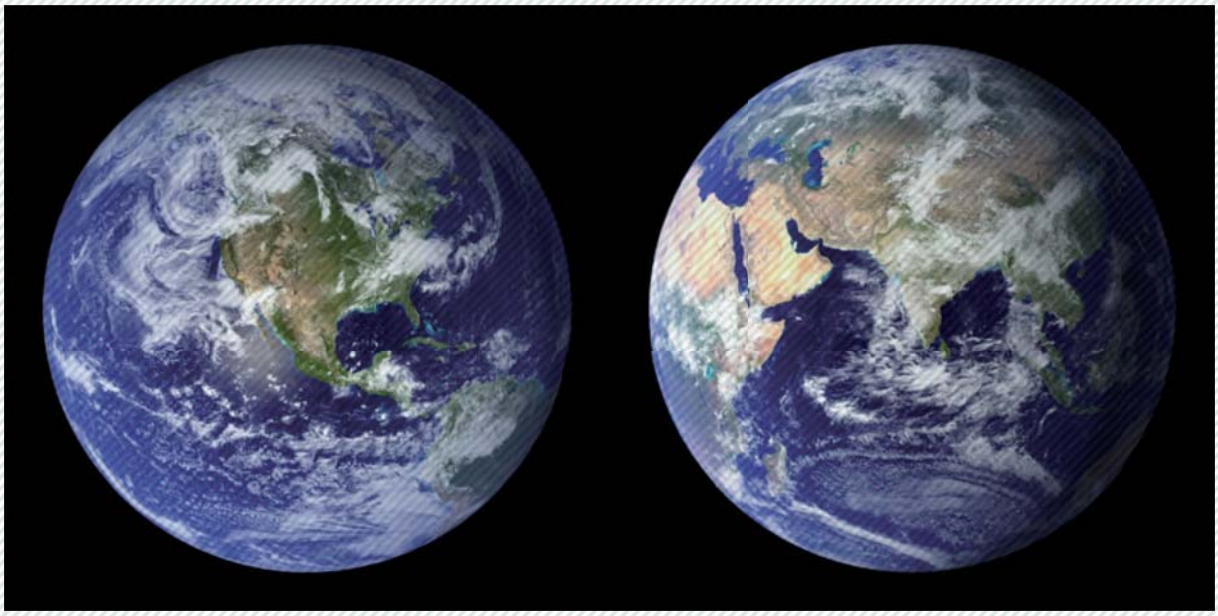
IST Archivist, Alan Gall, is researching the history of Philip Harris. The company started in 1817 as a Birmingham based surgical instrument supplier that expanded to include the manufacture of scientific equipment and pharmaceuticals. It is probably best known to IST members for its activities in the educational sector, helping to develop materials for the Nuffield science courses. Associated with Philip Harris, historically, are the laboratory suppliers Kernick & Sons Ltd, Scientific Supplies Company Ltd and The Northern Media Supply Ltd.

If any readers wish to share memories or have information on any of the above firms, including pictures suitable for illustrations, please get in touch.

alangall@hotmail.com

Management and conservation of marine microbial resources for sustainability of marine microbiology and biotechnology

Olumide Adedokun Odeyemi



Only 29 per cent of the world surface is land. The rest is ocean, home to the marine life forms. The oceans average four kilometres in depth and are fringed with coastlines that run for nearly 380,000 kilometres.
(Image courtesy of Wikimedia commons and NASA)

Introduction

The advent of biotechnology in the 21st century revolutionised the entire field of life and natural sciences. It has led to various scientific discoveries and breakthroughs with academic, medical, agricultural, environmental and industrial benefits. Biotechnology is a broad field of science that involves various disciplines such as biochemistry, microbiology, molecular biology, genetics and chemical engineering (Odeyemi, 2011).

Marine microbiology and biotechnology is the deliberate manipulation and utilization, complete or partial, of marine micro and macro organisms for the production of goods and services for mankind (Odeyemi, 2013). Advancement of marine biotechnology from a global perspective does not only depend on manpower, infrastructures, funding, equipment, management and conservation of marine microbial resources. It also depends on biological systems required and utilized. Biological systems

such as microorganisms, plants and animals are essential for a successful marine microbiology and biotechnology. There is therefore a need to adequately preserve these systems.

This paper tends to explore microbial culture collections as a key tool in management and conservation of marine microbial resources in sustaining marine microbiology and biotechnology. An effective management and conservation system for marine microbial resources can only be achieved through conscious or deliberate study of marine microbial diversity, determination and documentation of microbial species abundance in the marine ecosystem and appropriate storage facilities in the form of culture collections of all isolated microorganisms; especially those with medical, industrial and environmental importance. This will therefore entail proper segmentation of the microbial resources based on their source and relative importance. One outcome of this vital step in management and conservation of marine microbial resources is the potential of developing vaccines, probiotics and bioactive metabolites from these microbial resources and their use in conserving marine ecosystems.

Microbial diversity of marine ecosystems

More than 70 per cent of the earth is occupied by oceans, thus making the earth a "blue planet" (Bowler et al., 2009; Glöckner and Joint, 2010). According to Bhatnagar and Kim (2010) the ocean is the "mother" of all forms of life both in terrestrial and aquatic ecosystems. Odeyemi (2013) stated that more than forty per cent of the inhabitants of the world live and obtain their livelihood from coastal regions of the oceans.

The various biological and chemical processes in the oceans have been attributed to the metabolic activities of marine microorganisms, which suggests that microorganisms inhabiting the ocean carry out more than half of the primary biological production. Quantitatively, 1 mL of sea water contains on average over 10^5 bacterial cells, making it a bio resource centre due to the fact that global oceans contain more than 3.6×10^{28} cells (Sogin et al., 2006). Researchers worldwide have opined the diversity of marine microbes in various biogeochemical cycles in the sea.

Marine microorganisms are those found living, metabolizing and surviving in a marine environment. Such marine environments also include low salinity regions such as estuaries, brackish water and deep sea containing seawater that is hypersaline. Survival of these microorganisms in these low or hypersaline environments has been attributed to the presence of various enzymes. These forms of life are broadly grouped into marine bacteria, marine viruses, archaea and Protista.

Marine microbiology and biotechnology

The discipline in natural sciences that has effectively helped to utilise and to study microbial diversity in marine ecosystems is marine microbiology and biotechnology. Marine microbiology is the study of marine microorganisms that are too small to be seen with the naked eye, while marine biotechnology involves deliberate manipulation of marine living organisms for the production of goods and services for the benefit of humanity. Marine microbiology and biotechnology is still an emerging field when compared with other aspects of microbiology and biotechnology as more discoveries are still undergoing. Biotechnologically, numerous bio products from marine microbial resources are increasingly being developed with a global market estimate of over € 2.7 billion as at 2010 with annual growth rate of 5–10% (Børresen et al., 2010).

Sustainability of marine microbiology and biotechnology

Marine biotechnology or blue biotechnology (blue, as it is the colour of the sea) is of great potential that can significantly contribute to food security and environmental sustainability. Creation of jobs and wealth are all part of the outcome of marine microbiology and biotechnology. Because marine microbiology and biotechnology involve the use of marine microorganisms and other forms of marine life, the management and conservation of those microbial forms of life which are both cultivable and uncultivable under laboratory conditions are of great importance. The most acceptable means of managing and conserving microbes is the establishment of functional culture collection centres.

Marine microbial resources centres

Microbial culture or resource centres are important because they are libraries of living organisms just like reference book libraries (Danielle et al., 2010, Dilip et al., 2005; Caktu and Turkoglu, 2011). They provide microbial materials needed for advancement of microbiology and biotechnology globally due to richness in microorganisms with past, present and future potentials. Microbial resource centres also preserve microorganisms (Uruburu, 2003; Waites et al., 2001). Primarily, microbial resource centres collect, maintain and distribute bacteria, viruses, virions, and fungi for research or industrial purposes. Professor Frantisek Král established the first culture collection centre in the world in 1890, located at the German University of Prague (Czech Republic). He made use of his experience in the glass-making industry producing laboratory

glassware and later worked as technician at the Institute of Hygiene of the German University of Prague (Caktu and Turkoglu, 2011). Microbial culture collection centres currently number more than 568 from one single collection in 1890. There are 262,884 strains and 38,004 species of different microorganisms from 57 culture collections originating from 29 countries and regions (WDCM, 2013).

Conclusion

Information regarding microorganisms deposited in culture collection centres is just as valuable as the deposited microbes. These living libraries are needed in the maintenance, understanding and utilisation of microbial resources in order to advance microbiology and biotechnology. Microorganisms isolated from marine environments with medical, pharmaceutical, food and industrial potential need to be preserved accordingly for the advancement of marine microbiology and biotechnology.

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Some reminiscing from an old technician on past routes to IST Fellowship

Derek Sayers

Those of us of a certain age are bound to say that the technical qualifications of today are nowhere near as useful as those of a bygone age when the IST first began in 1954. Personally I do not think this is true. I believe that the difference is what is being taught. Since the 1970s successive Governments have geared education to more theoretical and less to practical applications. Whereas good background knowledge of a subject is necessary, equally I believe in many cases this is useless without good practical experience. When I left my grammar school a great many years ago, I could read a circuit diagram and knew what a resistor looked like on paper, but had never actually seen or held one. I knew nothing about the colour banding and had never soldered anything. Today I was surprised when my son-in-law told me he did not know what a screwdriver is used for!

I joined the Science Technologists Association (STA) in 1954 just before it became incorporated and changed its name to the Institute of Science Technology (IST)[1]. In those days, when working as a student/junior technician in a University, the only qualification available was that issued by the STA/IST. The initial course, what the medical technicians at the time called the "intermediate", was a necessary qualification to be employed as a technician. It involved being taught a number of subjects by Chief Technicians in the evenings. They consisted of three nights a week and one afternoon for three years.

I was at University College London. However, my evening classes were held at Imperial College, Kings College, Queen Mary College (Mile End Road), The Polytechnic (Regents Street) and University College. In any one week I could be at three of these venues!

The subjects covered were mainly practical although some background theory was also taught. I was working in the Physiology/ Pharmacology departments so as well as being taught practical physiology I was also taught the following subjects:-

- Histology (felt necessary as part of the physiology course)
- Photography (Photographing apparatus and also making lecture slides)
- Woodwork
- Metalwork (including lathe work, welding and working with plastics)
- Glassblowing (making and repairing laboratory glassware)
- Physics (mainly theory)
- Electrics and Electronics (including soldering)
- Chemistry (mainly theory)
- General laboratory design (including care of equipment and benches etc.)

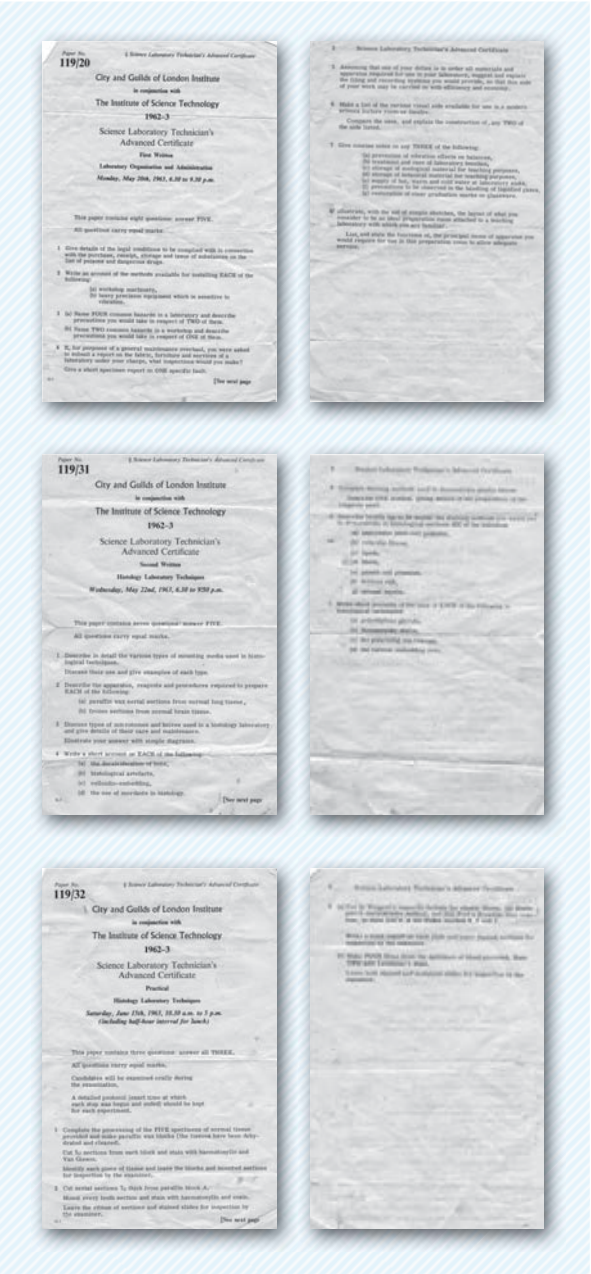
If you passed the Examination at the end of the third year, you were a "Jack of all Trades" something at the time believed necessary to be a good technician. After finishing the course I had to do my National Service in the Army; in fact I did three years as a regular and studied Medical Technology and Medical Entomology at the Royal Army Medical College.

To become a Senior Technician you had to complete a further two year IST/City & Guilds course in your specialised subject and a course in Laboratory Management. At around the time I left the Army in 1960, the IST had joined with the City and Guilds to produce the "119 Course".

Clearing out my loft recently I came across my old examination papers (see illustrations) and thought that it might be interesting to make a comparison with examinations of today.

Back then the course for Laboratory Management also included studying English, and how to communicate, both by writing and verbally. There was not a final examination in this but I suppose if you could not write your answers in decent English and give good account of yourself in the Oral examination, you could fail. This Course also included the design of laboratories and lecture rooms and also procuring equipment advice. This was especially helpful for me in later life when I did become a Laboratory Manager.

[1] The "and" was not added until a few years ago



At the time my special subject was histology, which I studied once a week in the evening at Hammersmith Hospital. The tutor was the Chief Technician, Mr Hamilton, who was one the finest tutors I have ever met, and in later life I have always tried to emulate him. At the end of his course he called us all together and announced that everyone, with the possible the exception of myself, should pass the examination. Perhaps it made me try that much harder just to prove him wrong. I passed the exam!

You will notice that the practical examination was six and a half hours long with a break of 30 minutes for lunch. The same examination papers were used throughout the country. However, it was later realised that because in some parts the syllabus was not well defined and that the level of teaching varied, students at some venues might be at a disadvantage if a single standard pass mark was set. To overcome this they decided that the average mark of students at any one venue would be the pass mark. This meant a possibility that only 50% of the students would pass. In my case there were eight taking the Histology Practical, where two of them were mature students who had worked in histology for some years. It was more than likely that they would get a very high mark in the practical and hence produce a high average and a pass mark that would eliminate the rest of us. Fortunately they both misunderstood one of the questions and did not complete the staining technique required. This lowered their marks and allowed me to scrape through.

Back in those days the award of Fellowship of the Institute was particularly hard to obtain and only an elite few would go along to become Fellows. The membership back then was very high but came from a narrow and focused band of science disciplines. In those earlier years Fellows amounted to about only 1% of the IST membership. The route to Fellowship was either by a dedicated thesis/dissertation, an examination or in rare instances by time-spent experience. The latter was really only open to those few older technicians who had gained a great number of years' experience before moving on to a senior management position and therefore no longer did much practical work, thus making an examination or thesis/dissertation inappropriate. In my case in 1982 I did a dedicated thesis after three years research work and an oral examination on my thesis.

2013

Today the entry requirements for Fellowship are suitably extended to reflect our technical diversity and our wider professional standing. We have not had that single examination route for many years as it became impossible to fairly set and mark a generic paper, especially for both such a broad membership that now embraces many disciplines, and in particular also for our growing members outside the UK. However, we still follow what we strongly believe are exacting standards for what is our highest membership grade, by now offering a number of alternative routes to Fellowship. We assess all applications for Fellowship through a Fellowship Panel, which is made up of existing Fellows. For example, in support of an applicant's nomination the panel:

Will strongly consider the publication of substantive articles in the IST's Journal. We now actively encourage article submissions as a route toward Fellowship.

Will also consider the submission of a thesis completed for qualifications such as PhD, MSc, MPhil etc. that demonstrate sufficient technical knowledge and significant technical application, and that where possible it can be suitably adapted for publication in the IST's Journal.

Similarly the panel will accept technical papers and publications where the applicant is the author or the co-author.

The panel will also consider a suitable number of separate publications where the applicant is mentioned in the "Acknowledgments" as giving valuable technical assistance.

The IST Executive will on occasions nominate and award a special Fellowship to those who have done a considerable amount of work in promoting the Institute. In certain cases this could be an Honorary Fellowship.

Fellows of the Institute are elected by the IST Executive on the recommendation of a Fellowship Panel, which comprises at least 3 IST Fellows of good standing in an appropriate discipline. In support of each application the Fellowship Panel will consider a range of factors such as qualifications, professional work experience, length of service, supervisory ability and contribution to the technical application of science and/or technology.

We are strongly encouraging our members who have technical experience gained over a number of years of responsible work, and who are able to demonstrate individual achievements relating to the technical application of science, technology and/or to their related technical management in their chosen discipline, to consider Fellowship.

This is the most senior class of IST membership and indicates a very high level of technical achievement and an outstanding contribution to the technical profession.

Derek C.J Sayers
FIScT, FInstLM, FRMS
IST Fellowship Officer

Research news

Four UK cities could be abuzz with insects after urban flower meadows are planted to encourage insect pollinators.

Wildflowers will be planted in the meadows in Bristol, Edinburgh, Leeds and Reading this summer as part of a three year, £1.3M research project which forms part of the BBSRC-supported Insect Pollinators Initiative.

University scientists are planting flower meadows in the cities' parks, playing fields and schools to examine how pollinating insects are affected by urbanization.

The scheme is part of the Urban Pollinators project led by the University of Bristol with academic partners at the Universities of Leeds, Reading and Edinburgh.

Last summer, the scientists successfully created flower meadows in several sites across the four cities in collaboration with local councils. These meadows are being re-sown this year, and a further five new meadows are being created in each city.

The scientists are sowing two different types of meadow: annual meadows containing a mix of native and non-native plant species which flower for one year, and perennial meadows which have only native species and are slower to establish. Flowers being planted include cornflowers, poppies, oxeye daisies, meadow buttercups and red campion.

As well as being beautiful to look at, the meadows provide pollen and nectar for pollinating insects and act as 'wildlife corridors', allowing insects and other invertebrates to thrive.

Professor Jane Memmott of Bristol's School of Biological Sciences who is leading the project, said: "Urban areas have the potential to support large numbers of insect pollinators. However, many cultivated plants do not provide suitable forage for them. Sowing meadows like these that contain nectar- and pollen-rich plant species increases the provision of foraging resources for bees and other pollinating insects in urban areas.

"Replacing traditionally planted areas with flower meadows can also have economic benefits as wildflowers are less expensive for councils to replace than cultivated plants."

As well as investigating how planting such meadows can improve conditions for insect pollinators, the scientists have also been quantifying these pollinators and their interactions with flowering plants in 180 different locations across the four cities, including parks, gardens, allotments, churchyards and cemeteries. Dr Katherine Baldock of Bristol's School of Biological Sciences who is co-ordinating the project, said: "Simultaneously sampling a range of urban habitats in this way will enable us to compare the value of different types of urban habitats for insect pollinators and identify habitat 'oases' for pollinators in urban areas."

The Urban Pollinators project works in partnership with local councils and wildlife trusts. Together with Bristol City Council›s Meadow Bristol project, it won the 2013 Mayor›s Bristol Genius Award in May 2013.

The Urban Pollinators project is one of nine projects under the UK Insect Pollinators Initiative (IPI), funded jointly by the Biotechnology and Biological Sciences Research Council (BBSRC), the Department for Environment, Food and Rural Affairs (Defra), the Natural Environment Research Council (NERC), The Scottish Government and The Wellcome Trust.

Researchers from the BBSRC-funded Institute of Food Research (IFR) have successfully produced bioethanol from waste paper, as part of efforts to turn waste into valuable products.

To increase the sustainability of biofuels, there is currently a drive to turn away from deriving them from food crops, such as corn and sugarcane. Bioethanol derived from the waste products of agriculture and the food chain is more attractive as this avoids competition with food crops, reduces food waste and lowers the carbon footprint. Achieving this on a commercial scale needs to overcome a number of hurdles, which the Biorefinery Centre on the Norwich Research Park working on.

Sugars are the starting point for the production of bioethanol, and are readily obtainable in large quantities from food crops such as sugar beet, corn and wheat. In agri-food waste however the sugars are effectively locked away in the structure of the plant material – mostly in the form of lignocellulose. Lignocellulose gives plant cells walls their rigidity and resistance, but this makes them harder to convert into biofuels. For most agri-food waste a pre-treatment is needed to break open these structures, reducing the overall economic viability of the process.

However waste paper, particularly shredded paper that cannot be recycled, has effectively been pre-treated, with much of the lignocellulosic structure broken down.

Now researchers at IFR have for the first time produced high concentrations of bioethanol from waste paper that match the yields obtained from first generation biofuels.

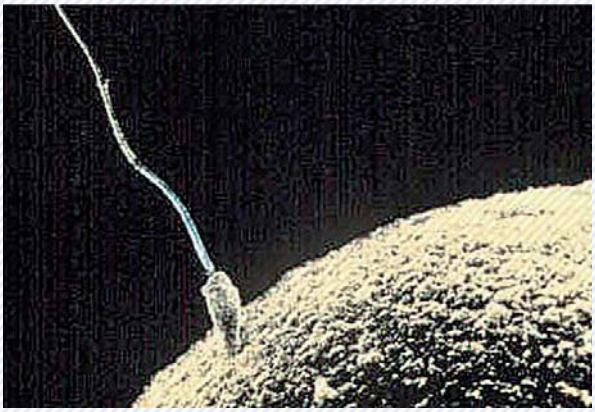
Achieving this saw the team overcome a number of obstacles. Paper absorbs water and becomes difficult to mix. A specialised pilot bioreactor able to mix the material needed to be used. Adding the paper in batches also allowed digestion to occur, preventing the material from becoming too thick.

Ethanol conversion is a two-step process. Enzymes are used to break down the complex carbohydrates (saccharification) to simple sugars that yeast ferments into ethanol. Semi-simultaneous saccharification and fermentation was used. After an initial enzyme treatment, further saccharification feeds sugars into yeast fermentation simultaneously. This, along with the mixing and the batch addition of paper waste keeps the bioreactor working steadily and a final ethanol yield of 11.6% – as high as that in current commercial biofuel production and higher than any other reported yields from paper or paper pulp waste streams.

The researchers believe that there is considerable room to improve on this figure, by optimising batch addition regimes and the initial enzyme concentrations (which are low to reduce input costs). Different yeast strains may convert sugars to ethanol more efficiently, for example heat-tolerant yeasts may be better suited the exact conditions in this set-up. The researchers are working with the National Collection of Yeast Cultures, a BBSRC-supported National Capability based at IFR, to investigate this.

These initial findings relate to pilot scale experiments, and to be viable the system must work on the industrial scale. Scaling up must be economically viable, taking into account things such as the energy needed for the crucial agitation of the paper material. However, with over 12 million tonnes of paper waste being generated annually in the UK alone, there is great potential to divert this into a new sustainable source of fuel or higher value chemicals.

Research shows how females choose the 'right' sperm



NERC funded scientists at the University of East Anglia (UEA) have revealed how females select the 'right' sperm to fertilise their eggs when faced with the risk of being fertilised by wrong sperm from a different species.

Researchers investigated salmon and trout, which fertilise externally in river water. The two species occasionally hybridise in the wild, but since hybrid offspring become reproductive dead-ends, females of both species are under selection to avoid hybrid fertilisations, and instead promote external fertilisation by their own species' sperm.

Findings published in the journal *Evolution* show that when eggs from each species are presented with either salmon or trout they happily allow complete fertilisation by either species' sperm. However, if eggs are given a simultaneous choice of both species' sperm, they clearly favour their own species' sperm.

Lead researcher Professor Matt Gage, from UEA's School of Biological Sciences, said, "The salmon-trout system is ideal for studying sperm-egg compatibilities because we are able to conduct controlled fertilisation experiments and measure sperm behaviour under conditions to which the gametes are naturally adapted. Although we found almost 100% interfertility between salmon and trout sperm and eggs, when we mixed equal amounts of sperm from both species together, we found that sperm from their own species won 70% of the fertilisations.

"Since we are conducting in vitro fertilisations without interference or control from males or females, this provides clear evidence that eggs favour the sperm of their own species, but only when given a choice."

The team then went on to investigate what mechanisms allow female eggs to encourage the right sperm to fertilise by examining two key components of reproduction in female fish - the egg, and the ovarian fluid that coats the egg. Ovarian fluid is a protein-rich solution that bathes the eggs and is released at spawning - but little has been known about its function.

Professor Gage said, "We ran further sperm competition trials but this time we rinsed eggs of their ovarian fluid and then added back either their own fluid, or that from the other species. Remarkably, we found that the egg itself plays no significant role in promoting fertilisation precedence by their own species' sperm. Instead, it is actually the ovarian fluid that controls which species' sperm wins the fertilisations, which was very unexpected. If we put salmon ovarian fluid onto salmon eggs, then salmon sperm win, but if we put trout ovarian fluid onto eggs from that same salmon female, trout sperm now win."

The researchers then used video tracking analysis to analyse how salmon and trout sperm behave in ovarian fluid.

"We found that activating sperm in ovarian fluid makes them live about twice as long as in river water. Importantly, both species' sperm also switch from swimming in tight elliptical circles in river water, to swimming in straightened trajectories in ovarian fluid. This behaviour allows sperm to navigate towards the egg by following a chemical cue.

"So what we're seeing is that ovarian fluid gives a specific chemical signal to the sperm of its own species, causing changes in the way their tails beat, so that they swim in a straighter trajectory, and therefore guided more effectively towards the site of fertilisation."

To establish that this was the mechanism which promoted fertilisation precedence by their own species' sperm, the research team ran a final experiment in which they measured sperm migration across a membrane permeated with tiny pores mimicking the single entrance into the egg. They found that many more sperm swam through the membrane into their own ovarian fluid, compared with numbers crossing into the other species' ovarian fluid or water.

"These findings allow us to establish that females have indeed evolved mechanisms of 'cryptic choice' at the intimate level of the sperm and egg. The results also give us a valuable insight into why female salmon mate so promiscuously - typically being fertilised by eight, and up to 16, males in one nest. By promoting sperm competition, females provide their eggs with greater choice, allowing ovarian fluid to avoid potentially hybridising sperm, and instead encourage fertilisation by the right sperm."

The research was funded by the Natural Environment Research Council (NERC) and collaboration between UEA, the Norwegian Institute for Nature Research and the Institute of Zoology.

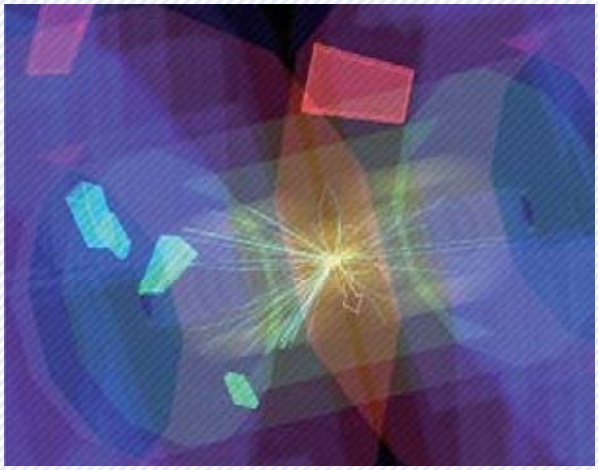
Now you can hunt the Higgs Boson for yourself using a new app!

Physicists spent years tracking down the elusive Higgs Boson particle using the 27km long Large Hadron Collider at CERN as part of the world's largest science experiment and now you can have a go at finding it for yourself – using technology that fits into the palm of your hand. A new smart-phone app called 'Collider' allows you to play games, watch high energy particle collisions streamed from the Large Hadron Collider and hunt for the Higgs Boson and the good news is - it's all free.

The app, in Android and iOS versions, is now available.
(http://collider.physics.ox.ac.uk/)

Collider was developed by a PHD student at Oxford University, Chris Boddy and University of Birmingham graduate Tom McLaughlan using funding from Science and Technology Facilities Council public engagement awards.

Tom said: "I'm really impressed with how well received Collider has been so far, and so soon after release. I've only heard good things from people, and everyone talking about it comments on how cool it is that anyone can find a Higgs Boson on their phones. I hope that in the coming weeks and months that many more people get to experience Collider, and learn a thing or two about the physics being done at the LHC!"



Screenshot of the app in action
(Credit: University of Oxford)

Comments from some of those who've used the app so far include:

"Fantastic educational tool and great design. Very easy to use app and allows you to really understand the science being done at the LHC!"

"A great app that's easy to use. It makes understanding high energy physics within reach for anyone!"

Wee-powered phones

Claiming a world-first, scientists from Bristol Robotics Laboratory, have used urine to produce electricity to charge a mobile phone. The urine is passed through microbial fuel cells and, so far, enough power has been generated to enable the phone to make a brief phone call, send text messages and browse the Internet.

Screenshot of the app in action
(Credit: University of Oxford)

"We are very excited as this is a world first, no-one has harnessed power from urine to do this so it's an exciting discovery. Using the ultimate waste product as a source of power to produce electricity is about as eco as it gets," said Dr Ioannis Ieropoulos from UWE Bristol, at the Bristol Robotics Laboratory.

"The beauty of this fuel source is that we are not relying on the erratic nature of the wind or the sun; we are actually re-using waste to create energy."

The team developed a microbial fuel cell to convert energy. Live microorganisms inside the fuel cell process the urine to produce electricity.

The research team is now working on scaling up the electricity output from Microbial Fuel Cells. They believe that the technology has the potential to be installed into domestic bathrooms, producing electricity to power showers or lighting as well as mobile phones.

The Engineering and Physical Sciences Research Council (EPSRC) funded the project alongside the Gates Foundation and the Technology Strategy Board. The EPSRC also provided fellowship funding to Dr Ieropolos for the work.

New AHRC film looks ahead to the 2014 WW1 commemorations

In August 2014, candlelit vigils will be held across Britain to mark the centenary of the outbreak of the First World War.

With the anniversary just a year away, a new film by the Arts and Humanities Research Council (AHRC), is shining a light on a fascinating research project that reveals how long-forgotten comic strips from 1914-18 contributed to the origins of modern international popular culture – both military and civilian.

Professor Jane Chapman and her team of researchers at the University of Lincoln are uncovering comics from the UK, Europe, Commonwealth countries, the USA, and exploring their unique depiction of epic events of the First World War and their influence on the public consciousness and cultural heritage.

Examining attitudes to war as expressed through comics strips, as well as the various national, political and social tensions they conveyed, the researchers are uncovering the kind of views that comics offer in specific aspects of world war history. These sources can show a unique form of insight into depictions of heroes, enemy and victims.

Amateur cartoon artists in the trenches had to beg and borrow paper; iodine and paintbrushes, normally used by medics for wounds, were sometimes used to create comic strip colour. Professor Chapman adds: “these popular communications were the armed forces’ Great War equivalent of today’s mobile phone citizens’ journalism’.

Professor Chapman says: ‘The harsh realities of trench warfare create a poignancy of humour through pain: ordinary people, including soldiers were producing their own newspapers, and some were creating early comic strips when they were surrounded by suffering and death threatened.”

An amateur newspaper from the trenches, produced as citizen journalism in 1918: the artist changes opinion about the War experience after he receives his de-mob notice. Courtesy of the Australian War Memorial.

The AHRC ‘s film offers a glimpse ahead to 2014, which will see Professor Chapman and her teams curate a major exhibition of WW1 comics at the Cartoon Museum in London, and a further on exhibition on WW2 comics follows in 2015.

New support for innovation within the arts announced

New support has opened up for arts projects exploring the possibilities of digital technology in Britain, with new backing for big data and research projects through the Digital R&D fund for the Arts in England (opens in a new window) and the launch of the Digital R&D Fund for the Arts in Wales (opens in a new window).

The Digital R&D fund for the Arts in England, which opened for applications in 2012, has announced two additional application streams.

The first, Big Data (Funding Opportunity), will provide funding to consortia of arts organisations working with a technology partner and a research partner who wish to investigate Big Data to improve or implement new business models within the arts sector.

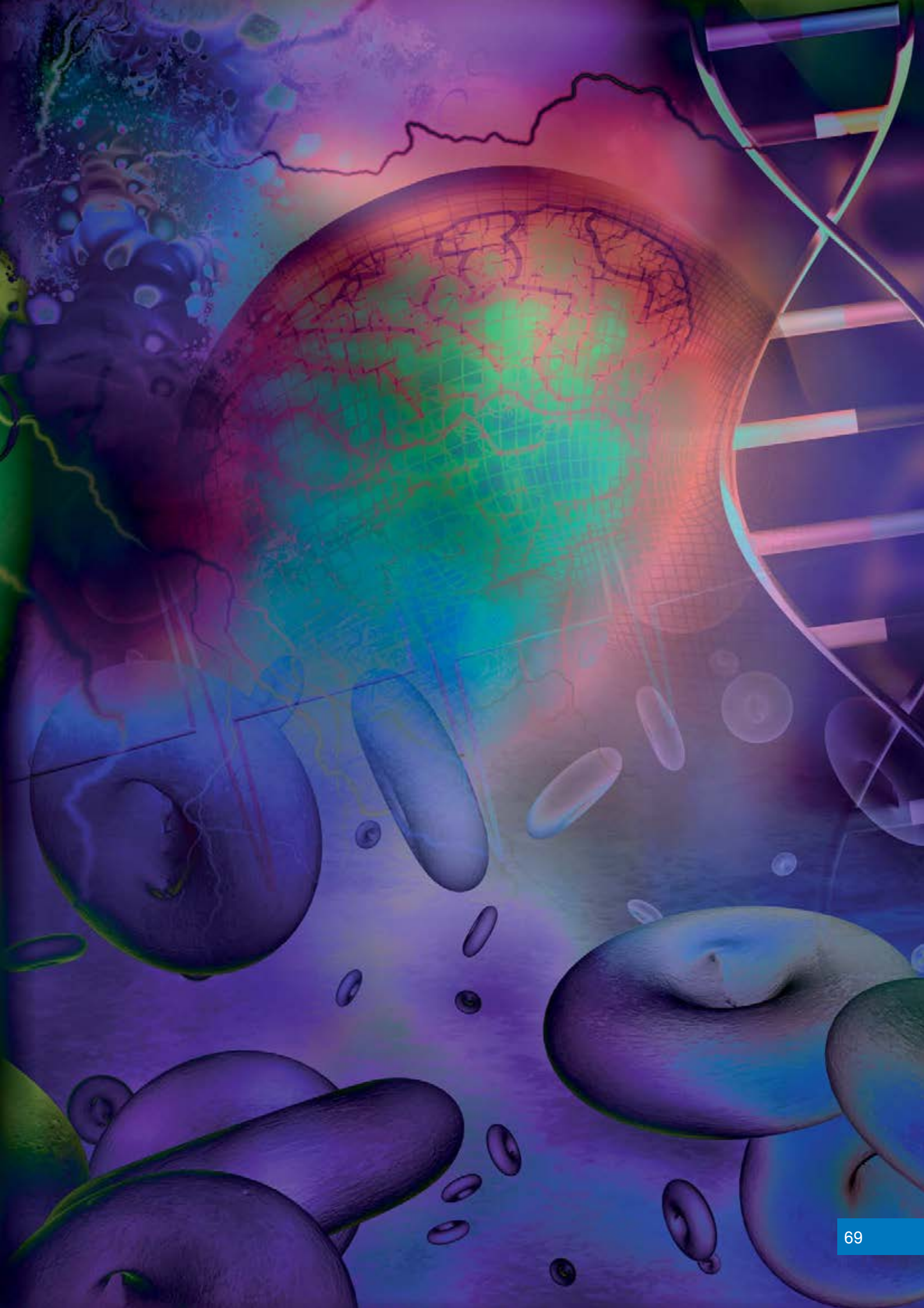
Big data is a term used to describe large sets of data often used to understand an organisation's audiences and enhances their decision-making processes. The importance of Big Data and what changes are needed within the arts and culture sector to harness its potential were discussed in a recent report from Nesta and Arts Council England: Counting What Counts. The report's findings have influenced the instigation of the call for big data projects to apply to the fund.

The second, Research+ (Funding opportunity), is to support existing art and digital collaborations by providing research funding for projects that have just begun or are underway and are currently not being supported by the Digital R&D fund for the Arts in England. Working with a researcher will allow funded projects to gain insights into the impact and successes of their work. The knowledge that researchers acquire through collaborating with arts and technology partners on funded projects will go on to benefit the wider cultural sector when learning is shared by the fund.

Jon Kingsbury, Nesta's director of Creative Economy programmes, said: "'Big Data' is a buzz-phrase at the moment, but we believe that there are fantastic opportunities for arts organisations to use their data better to generate revenue. This new call encourages arts organisations to co-operate with each other to find new forms of value from their information."

Professor Andrew Prescott, AHRC Leadership Fellow for Digital transformations comments: "'Big Data' is more usually associated with science projects like the Large Hadron Collider but is becoming increasingly important in arts and humanities. The servers holding family history data are among the biggest on the planet, while artists are starting to use big data to create new types of scientific visualisation. Movies, TV, Facebook, and Twitter: all these everyday activities are producing data on a vast scale, which offer new opportunities and challenges for researchers in all disciplines. Big data is one of the most exciting areas in which artists, humanities scholars and scientists are beginning to find common areas of interest."

Simon Mellor, Executive Director, Arts and Culture, Arts Council England, said: "Nearly one year on from the launch of Digital R&D Fund for the Arts we have been able to widen its offer to give more organisations the opportunity to work together to use data to make themselves more sustainable.This is great news for the sector as a whole as we'll all benefit from sharing the learning which is coming out of this work."



What makes an effective teacher of science and technology?

Kevin Fletcher

Introduction

Teachers of science and/ or technology, as teachers of most other subjects, are asked to undertake a number of tasks. The most obvious of these is to teach. This duty, however, may be only a small part of the whole spectrum of duties teachers are asked to undertake, and even then, there are numerous other tasks that must be completed before classroom delivery takes place.

The following discussion arises out of my experience of Teacher Training and uses some of the resources employed in "teaching teachers how to teach". First, we need to consider what sort of qualities a teacher might reasonably be expected to have:

Qualities of an effective teacher

An Effective Teacher should at least be:

A Good Communicator	Committed
Approachable	Creative
A Good Listener	Enthusiastic
Helpful	Responsible
Patient	Honest & Trustworthy
Knowledgeable	Accurate and Precise
Organised	A Role Model
Confident	Supportive
Observant	Dependable

This, of course, is not an exhaustive list but it seems to encompass most of the qualities that teachers are expected to have when students are asked to suggest the ones that a "good teacher" should possess (always a worthwhile exercise with your learners; to produce a checklist for yourself and see how closely you match up to their idea!) (or not, as the case may be....)

The teacher as a communicator

The role of any teacher also includes the need to be a good communicator and to liaise with a number of individuals/ organisations. These might include

The Effective Teacher
Management
Other Colleges/Universities
Administrators/Office Staff
Caretakers/Cleaners
Course Team
Learning Support Staff (Technical Support Staff)
Other – Subject teaching Staff
Awarding Bodies
Employers/Parents

Taking these various qualities and the ability to be a good communicator and liaison-officer, there are still further duties and roles to fulfil in order to be an effective teacher.

The roles of teacher can include:

Organising Yourself
- Keep up-to-date with science and technology
- Increase knowledge
- Maintain enthusiasm and positive outlook
- Ensure speech is easy to understand
- Be punctual and well presented
- Be fully prepared
- Attend staff training
- Be patient and keep a sense of humour

Organising your Subject
- Review / design science and technology syllabuses
- Prepare schemes of work
- Organise lesson content
- Prepare teaching material
- Assess subject content and delivery
- Organise revision for exams

Organising Delivery
- Choose teaching materials
- Vary teaching methods
- Mark efficiently and quickly
- Marks constant standard
- Keep up-to-date
- Assess methods used
- Clear away after practical work

Student Employer / Parent Liaison
- Encourage supportive role at home/work in science and technology
- Discuss student progress
- Discuss student progression

THE EFFECTIVE TEACHER

Your Employer
- Know site rules
- Supervise examinations
- Attend team meetings
- Support colleagues
- Organise displays/open days
- Liaise with schools and industry
- Marketing

Managing the Course
- Order stock and budget monies
- Enter students for examinations
- Enrol students
- Keep registers
- Organise visits to science technology establishments
- Reserve rooms and equipment

Pastoral
- Counsel or arrange counselling
- Profile progress
- Discuss needs
- Discuss progress
- Discuss progression
- Maintain discipline
- Write references

Managing Student Work
- Organise a sensible programme for assessment
- Prepare class exercise and homework
- Design assignments
- Test and record progress
- Provide framework for notes

Conclusion

I hope this article will have raised awareness about what makes an Effective Teacher of Science and/ or Technology. I purposefully did not explain at the start of this discussion what an effective teacher actually is. Rather I have left it until the end, when I have offered ideas for consideration about the qualities teachers are supposed to have, the communication and liaison skills expected of them and also after listing a few of the more well known roles and responsibilities.

In short, and in my humble opinion, an effective teacher should be all of these things and more if they are to be effective in terms of passing on knowledge to their learners in the most efficient way possible.

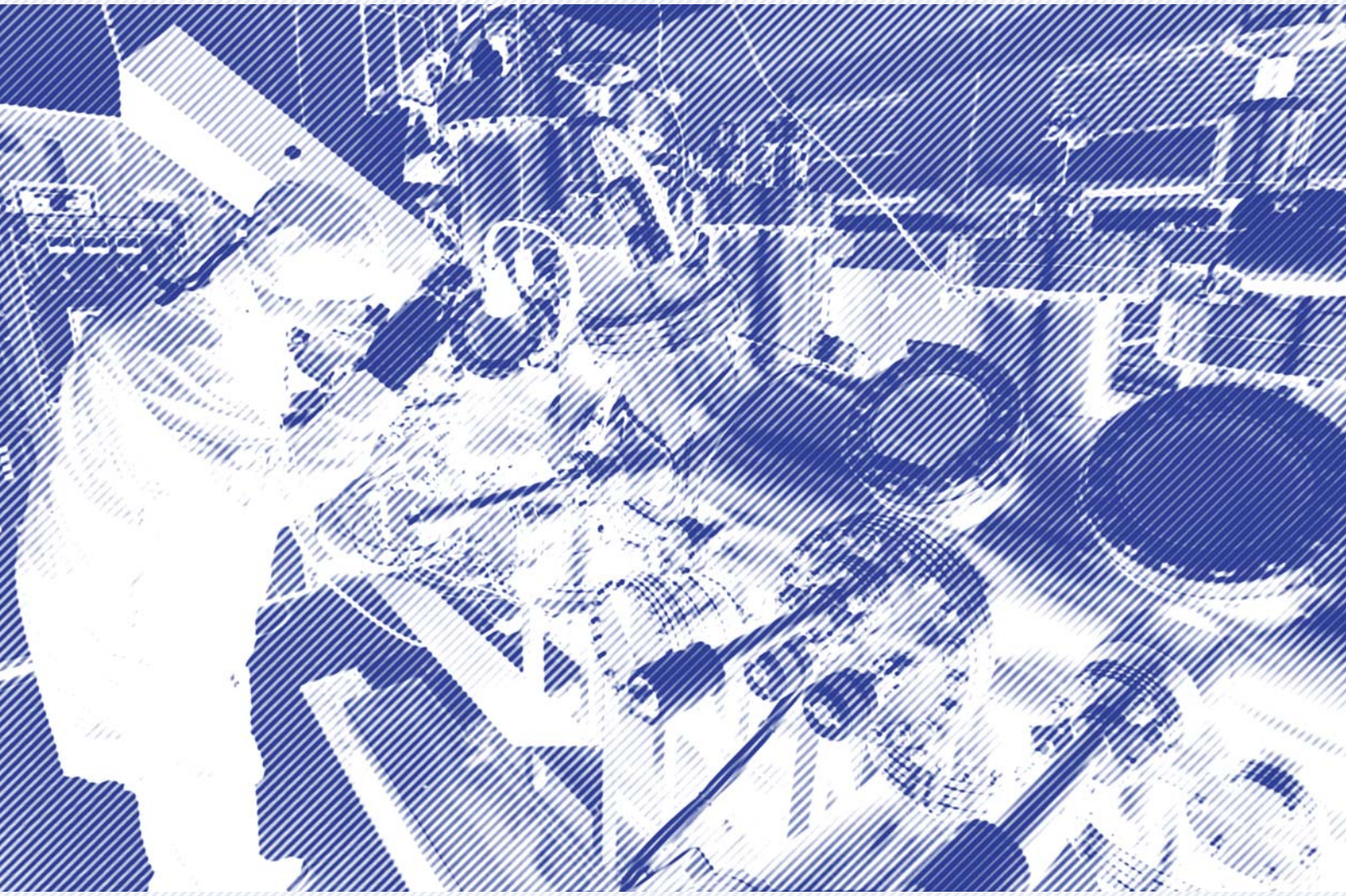
Acknowledgement

I freely acknowledge that I have used and adapted some of the resources and information that I have been furnished with or have created while delivering Initial Teacher Training Courses at Goole College. Some of these resources have been developed by colleagues in the Teacher Training Team, and have evolved over a number of years and I acknowledge their use/ adaptation here.

Author

Kevin Fletcher,
BA, BSc(Hons), AdvDipEd, MA, MEd, MEd, Cert IT & Comp, FIfL, EurProBiol, CBiol, MSB, MIScT, QTLS.

Unionlearn with the TUC



All too often in the UK, technicians are characterised in industry as carrying an "oily rag", somehow of less value than graduates and professionals. In fact the UK has far too few technicians compared to similar countries. The German economy for example places much greater value and status on technician skills within their successful manufacturing sector. Technicians do vital jobs, often in high tech industries and with little support and without oily rags. The Gatsby Foundation (funded by Lord Sainsbury) has contracted with unionlearn to help unions to encourage their technician members to gain Registered Technician status.

This is why unionlearn is running a two-year project aimed at promoting trade union support for technician registration. As representatives of individuals in the workplace, professional registration is an area of natural and significant interest to trade unions as it enables the technician workforce to gain recognition of their skills and knowledge as well as:

- Improved employment prospects
- Status as a professional
- Career development
- Recognised transferable skills
- Greater earning potential

Unionlearn is the learning and skills arm of the Trades Union Congress (TUC). Its primary aim is to help unions promote learning and skills in the workplace through its network of Union Learning Representatives (ULRs) and grants from its Union Learning Fund. Unions provide an unrivalled reach to millions of workers across all sectors and are in a unique position to be able to promote the benefits of technician registration to their members and the wider workforce, through Union Representatives and Union Learning Reps (ULRs).

Unionlearn will help unions build relationships with professional bodies and form social partnerships with key organisations including both the Science Council and Engineering Council. We will be developing a toolkit for Union Representatives which will provide information on how to promote registration in the workplace and support members through the process.

For further information, please contact Lauren Usher on: lusher@tuc.org.uk, 02070796930

Tom Wilson, unionlearn director said:

"Unionlearn recognises the fact that the UK faces a major skills gap and that the expansion of the technician class is vital to boost growth in the economy and to ensure that the UK remains competitive in a global market. This two year project aims to promote the professional standing of technicians, recognising the valuable contribution they make both to the economy and to our lives more broadly."

Terry Croft MBE, Chair of the Institute of Science & Technology said:

"I warmly welcome this joint TUC / Gatsby initiative. Unilearn will undoubtedly enhance the efforts made by other bodies and institutions to recognise how important the professional technical community is to all sectors in the UK. The IST fully supports this initiative to encourage technicians everywhere to gain Registered status."

The future demand for highly skilled technicians

The overall skills requirements of the future UK economy have been calculated at 13.5 million expansion and replacement demand job opportunities by 2020.[1]

Of these 1.5 million will be SET job opportunities, including technicians at all levels. About one third of the SET job opportunities will need to be filled by technicians offering a higher skill level. The demand predicted out to 2020 is for 450,000 highly skilled technicians. Many opportunities will be filled by aspiring professional technicians. Hence, promoting and developing the *professional technician* framework will make a significant contribution to helping UK plc 'close the gaps'.

Three key issues continue to fuel the demand. These are spreading sector demand, replacement of less skilled roles with higher skilled ones and the lack of females, particularly higher skilled females, in many areas of SET employment.

The demand for highly skilled technicians continues to diffuse into ever widening sectors.

Those with the biggest growth requirements are perhaps surprisingly now in traditionally people orientated businesses such as media and publishing and business services. The construction and certain manufacturing industries continue to fuel the demand for higher level technical skills, with several other expecting to follow their trend.

The Royal Academy of Engineering estimate in their 2012 report, Jobs and Growth: the importance of engineering skills to the UK economy, that there will be a requirement for more than 100,000 STEM graduates per annum for the period 2012– 2020 and that this will not be met by newly graduating STEM students who currently number only about 90,000 per year. In fact the gap will be much wider than this because a significant proportion of STEM graduates will ultimately choose to go into non-STEM occupations. It is estimated, for example, that currently 26% of all engineering graduates don't go on to enter the engineering profession.

[1] Professional technician: The future Delivering growth through skill, creativity and innovation – Technician Council Report 2012

Memberships & Registrations

December 2012 – June 2013

New Members

Mem. No	Name	Grade
T14901	Mrs J L Phipps	MIScT
T14902	Mr I O Obano	MIScT
T14903	Miss C Nichols	MIScT
T14904	Mr T J Pitman	MIScT
T14905	Mr K Arnold	MIScT
T14906	Mr D Haylock	MIScT
T14907	Miss Z Hill	MIScT
T14908	Mr A G McKillen	Assoc IScT
T14909	Mr O P Eboigbe	MIScT
T14910	Mr G O Akhile	MIScT
T14911	Miss K Chamberlain	MIScT
T14912	Mr R Bottomley	MIScT
T14913	Mrs S Taylor	MIScT
T14915	Mr B Harvey	Assoc IScT
T14916	Ms S Holden	MIScT
T14917	Mr S M Haynes	MIScT
T14918	Mr P D Ieren	Assoc IScT
T14919	Dr J Bates	MIScT
T14920	Mr E S Agbongiague	Assoc IScT
T14921	Dr L J Hollands	MIScT
T14922	Mr M J Thresher	MIScT
T14923	Dr B R C Saer	MIScT
T14924	Mr J Chittock	MIScT
T14925	Mr N R Smith	MIScT
T14926	Mr P Farran	MIScT
T14927	Mr D P Jackson	MIScT
T14928	Mr E S Novughakpo	Assoc IScT
T14929	Dr E A Pinto	MIScT
T14930	Mr T Williamson	MIScT
T14931	Mrs C A K Nwagboniwe	MIScT
T14932	Mr O S Egbeyale	MIScT
T14933	Mr J P Richards	MIScT
T14934	Mr Lister	MIScT
T14935	Mr A Grundy	MIScT
T14936	Ms H Norbertczak	MIScT
T14937	Mr J K Beresford	MIScT
T14938	Ms N Fox	MIScT

Mem. No	Name	Grade
T14939	Ms Estelle Asmodelle	FIScT
T14940	Miss J A Porter	MIScT
T14941	Mr C G Stock	MIScT
T14942	Mrs R E Roberts	MIScT
T14943	Mrs Papaemmanouil	MIScT
T14944	Mr M Smiga	MIScT
T14945	Mr R F Truswell	MIScT
T14946	Mrs A P Lane	MIScT
T14947	Mr R I Kangley	MIScT
T14948	Mr G J Nicholson	MIScT
T14949	Mr I Igharo	MIScT
T14950	Mr A McFarlane	MIScT
T14951	Miss C M Sutcliffe	MIScT
T14952	Miss J V Walker	MIScT
T14953	Miss N J Price	MIScT
T14954	Mrs C A Hart	MIScT
T14955	Mrs Y Stephenson	MIScT
T14956	Mr A W Fairburn	MIScT
T14957	Ms N J Kennerley	MIScT
T14958	Mr M Imafidon-Idiaghe	MIScT
T14959	Ms A Michalik	MIScT
T14960	Mr R J Webb	MIScT
T14961	Dr S Collins	MIScT
T14962	Mrs I Asadova	MIScT
T14963	Mr G S Humphreys	MIScT
T14964	Mr G Blunt	MIScT
T14965	Dr L Hetherington	MIScT
T14966	Mr A P Ham	MIScT
T14967	Mr P D Mason-Smith	MIScT
T14968	Ms V A Strzelczyk	MIScT
T14969	Mr O A Agboola	MIScT
T14970	Mrs B Eboh	MIScT
T14971	Mr A Abela	MIScT
T14972	Ms F Y Jacobs	MIScT
T14973	Mr R V Stacey	MIScT
T14974	Mr T Turton	MIScT
T14975	Mr A M Oyetayo	Assoc IScT

Mem. No	Name	Grade
T14976	Mr G Martinic	FIScT
T14977	Mr D Jones	MIScT
T14978	Mr M Holley	MIScT
T14979	Miss Johnson	MIScT
T14980	Miss S Curl	Assoc IScT
T14981	Ms B Czajkowska	MIScT
T14982	Dr J K Deans	MIScT
T14983	Mr D Finn	MIScT
T14984	Mr I A Imonifegwo	Assoc IScT
T14985	Mr C B Birchall	MIScT
T14986	Mrs K Brown	MIScT
T14987	Mr E A Owhere	MIScT
T14988	Mrs M O Okon	MIScT

Total 87

Upgraded Members

Mem. No	Name	Grade
T14957	Ms N J Kennerley	FIScT
T14594	Mr M R Levi	FIScT
T14851	Mr C Gouveia	FIScT
T14800	Mr O A Odeyemi	FIScT
T13901	Mr T Madziva	MIScT

Total 5

Reinstated Members

Mem. No	Name	Grade
T13901	Mr A A Adefiranye	MIScT
T14348	Mr K Olatokun	MIScT
T14400	Mr K J Padley	MIScT
T14405	Mr C H A Hormeku	MIScT
T14716	Mr V M Botelho	Assoc IScT

Total 5

Higher Diploma

Mem. No	Name	Grade
T13901	Mr T Madziva	MIScT

Total 1

Science Council Registrations

Mem. No	Name	Grade
T14845	Dr J Thirumalai	FIScT RSci
T14789	Mr R Conte	MIScT RSciTech
T14846	Mr S A Martin	MIScT RSci
T14804	Mr G Turner	MIScT RSci
T14871	Mrs R E Baldwin	MIScT RSciTech
T14882	Dr D Turland	MIScT RSci
T14768	Mr J S Screaton	MIScT RSciTech
T14890	Mrs D Jayesh	MIScT RSci
T14893	Ms Gregory	MIScT RSci
T14894	Mr M M Waserman	MIScT RSci
T9226	Mr S Moore	MIScT RSci
T14646	Mrs L Baxter	MIScT RSci
T14891	Mr M D Wyles	MIScT RSci
T14888	Mr G MacLeod	MIScT RSci
T14675	Mr D Gill	MIScT RSci
T14847	Dr V L Talbot	MIScT RSci
T14800	Mr O A Odeyemi	FIScT Sci
T13859	Mrs R A Connett	MIScT RSciTech
T14861	Mrs J M Cooper	MIScT RSci
T14883	Mrs J Lovell	MIScT RSciTech
T14786	Mrs V Gordon	MIScT RSci
T14916	Ms S Holden	MIScT RSci
T14938	Ms N Fox	MIScT RSci
T14866	Mrs K Vere	MIScT RSci
T14912	Mr R Bottomley	MIScT RSci
T14921	Dr L J Hollands	MIScT RSci
T14936	Ms H Norbertczak	MIScT RSci

Total 27

IST Organisation

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Terry Croft *MBE, FIScT*

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Mandy Taylor *MIScT*

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Philippa Nobbs *FIScT*

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Fellowship & Overseas Secretary
Derek Sayers *FIScT*

Co-opted member & Registrar
Michelle Jackson *PhD, FIScT*

Co-opted member
Chris Smith MIScT, RSci

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Ian Gray *MIScT*
Jacky Holt *MIScT*
Michelle Jackson *PhD, FIScT*
Philippa Nobbs *FIScT*

Chair & Education Officer
Philippa Nobbs *FIScT*

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Journal editorial team
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Chair & Journal Editor
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Deputy Marketing Officer
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Robert Hardwick *FIScT*
Dr L J F Youlten *FRCP, MRCS*
Prof. N-S Zhong

The Journal

Our next Journal edition will include a section focusing on Media and Arts, and we welcome article submissions from members and non-members from these areas.

Deadline is 30th November 2013

Back issues of the IST Journal are now available on-line

Copies of the Journal, including back issues to 2006 are now available on-line. Details on how to view them are on our web pages at istonline.org.uk

Please contact the IST Office at email: office@istonline.org.uk if you are unable to log on as it could be because we haven't got your current email address.

Article submissions

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

Contact the editor: i.moulson@shef.ac.uk

Or the IST office: office@istonline.org.uk

The guidelines for article submissions to the IST Journal:

1. Article submission deadlines;
   - **Summer edition is 31st May.**
   - **Winter edition is 30th November.**
2. Articles should be submitted electronically in Microsoft Word .doc format with images sent separately as JPEG files (in the highest resolution possible please). Please cross reference to images and captions in your article text.

   This is our preferred option but other formats can sometimes be accommodated; please contact the Editor.
3. **Short articles:** these can be submitted in any length up to roughly 1500 words.
4. **Major articles:** these are normally no longer than roughly 4000 words per edition, but please contact the Editor for longer submissions as they can usually be accommodated across two or more editions.
5. All accepted articles will be edited into the IST Journal's house-style.
6. All articles must be written in UK English. *(If English is not your first language, you should ask an English-speaking colleague to proofread your article.)* Poorly translated articles that fail to meet basic standards of literacy may be declined by the editors.
7. Article submissions should be submitted via email to office@istonline.org.uk. Your email should clearly state "Journal Article Submission" and the article and images sent with it as separate email file attachments.

The IST CPD Award

The IST Continuing Professional Development Award

The **IST CPD Award** has been developed specifically for technicians to ensure that you have a clear route to professional and personal development and recognition for the work you do. The award means that you will be able to demonstrate to a current or future employer your professionalism and competence.

As a CPD candidate you can plan and undertake activities based on competencies associated with your professional role over a period of up to 2 years. The award provides a framework within which you can identify your development needs and demonstrate that you are actively keeping abreast of new technologies, processes, and developments in your area of work.

The award is designed to be flexible in application and content, covering the needs of the more 'traditional' skills groups as well as those related to new and developmental aspects of the role and also easily tailored to meet any 'specialist' nature of a technician's role.

Key features

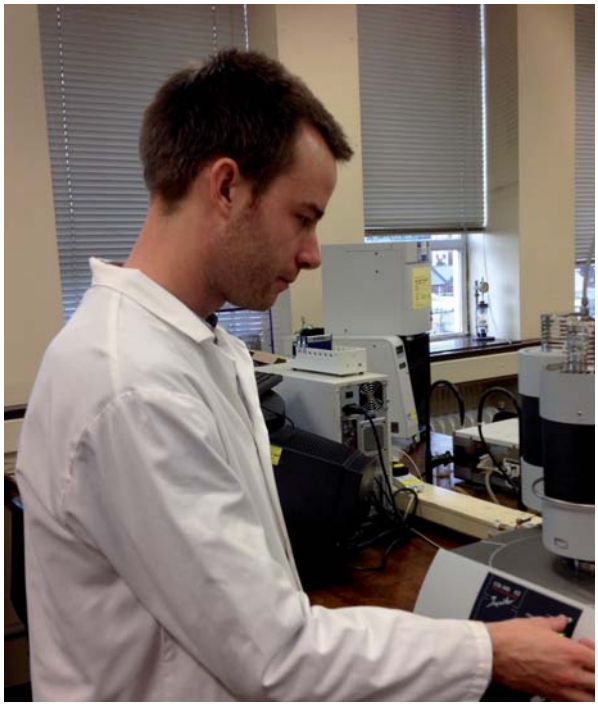
- On-line induction
- Development of a Personal Development Plan
- 16 generic role profiles to work from
- Evidence based competencies
- Personalised development activities
- Work based project OR dissertation
- Use of a reflective CPD log
- Underpinned by extensive learning resources

Candidates will have the support of a dedicated team of mentors, professional assessors, and access to a wide range of resources through both the IST and the heated website. In addition the communities of technicians undertaking the award share best practice and network with each other to aid their journey through the award.

On completion technicians can retain professional status by joining one of the registration schemes (see 'The IST CPD Award and the Registered Scientist, Registered Science Technician and Registered Practitioner' on our web site).

Ben Palmer, a technician working in the Department of Materials Science & Engineering at the University of Sheffield completed the IST CPD award earlier this year, explains why he undertook the award.

"I enrolled on the CPD Award as I wanted to complete a qualification that was, specific to technical staff, tailored around my role and flexible in its approach. The scheme looked a good way of documenting all of my CPD, developing my skills and driving my career forward. "



Ben Palmer

Want to find out more?

Visit http://istonline.org.uk/cpd/

The case for professional technicians[1]

In the UK, as in the rest of the world we live in an increasingly technological society. Daily life is enriched through digital communications and the flow of information. Our jobs increasingly demand more technical expertise. The world is a small place and other nations are following these trends – often missing out intermediate technological steps or entire stages as they race to catch us up.

The extent and pervasive nature of technology in our society today is such that it is creating an urgent and growing demand for many more technically able people to fill existing and newly created jobs which often demand a high level of skill and knowledge. Up to two million people are earning good wages from keeping technological Britain running smoothly. These are the nation's technicians and skilled operatives, although they may use a variety of different job titles to describe themselves. They are united by a shared identity having mastered the physical and material nature of technology.

Given the growing technological element inherent in modern workplaces, the changing context of our educational system and increasing globalisation, the need and case for technicians has now been elevated to a greater level than ever before. There is sharp focus on the critical role technicians play not just in engineering, advanced manufacturing and science industries, but now increasingly in traditionally more people-led sectors such as health, media and publishing, public administration, service industries and defence.

Expansion of science, engineering and technology (SET) jobs through advancing workplace technologies and replacement demand due to changing demographics, indicate that 1.5 million SET job opportunities will be created by 2020, with nearly a third of these in higher skilled technician roles. So, to increase and strengthen the UK's technician workforce is an important and valuable ambition.

In addition, technician occupations offer interesting and worthwhile career opportunities for many more practically minded individuals, they play an important part in running the day-to-day operations of the UK and from a social perspective, make a valuable contribution to all aspects of society. However, greater showcasing and investment in supportive and practical career routes is required, so that young people are fully aware of the choices and life benefits available to them.

Furthermore, although the demand for technical skills is rapidly increasing, the development of technicians is failing to keep pace. There is a lack of professional status afforded to technicians compared to other occupations and up-skilling opportunities and routes to progress are poorly signposted and confusing. In addition, technicians are drawn from a relatively narrow section of society, missing prime recruits and lacking in diversity.

Technicians are highly productive people, technically qualified to a minimum of Level 3, committed to continuous professional development and found in just about every area and walk of life. Yet, as the Skills Commission so clearly articulated in their recent report:

"Often neglected by policymakers and left on the educational side-lines, technicians are the unsung heroes of some of the UK's leading industries. For too long they have been undervalued, undernourished, and relegated to an occupational division considered less important than their professional counterparts."

The work and findings of the Technician Council have identified the need to update the image of technicians, to unite them under a common brand, encourage greater professionalism through registration with the appropriate sector body and above all support their quest for professional and personal development and passion for their chosen field. These are the highly skilled technicians who offer exceptional levels of creative as well as practical skills and are actively sought after by employers. From here on in, these are the professional technicians. These are the technicians that will help build our economy and society of tomorrow.

The attributes of the *professional technician* are clearly distinguishable:

- They develop valuable skills through their careers, many of which are transferable across employment sectors
- They take pride in their work and take continuous professional development seriously
- They have interesting, rewarding and worthwhile careers offering a gateway to the highest levels of education and training
- They are diverse individuals coming from a range of backgrounds
- They are proud to be recognised as professional technicians through a national registration process and common brand.

[1] Abstracted from Technician Council report: *Professional technician:* The future

Not working in science or science technology?

IST Registered Practitioners

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

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

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

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

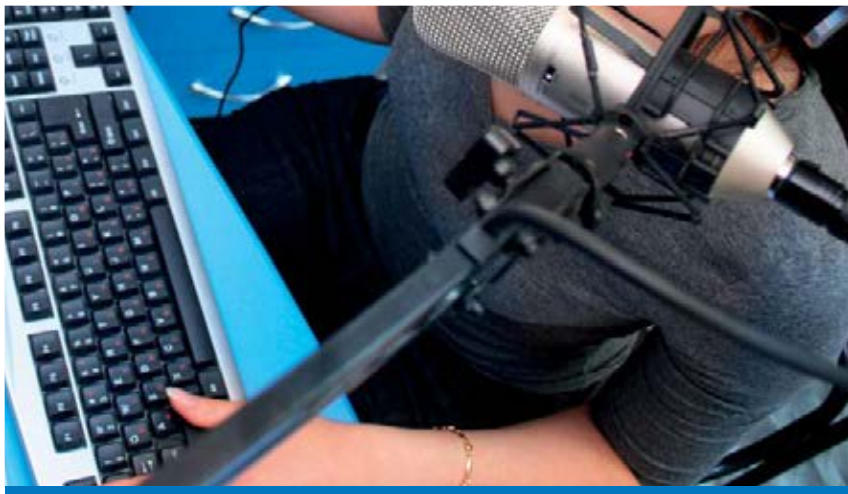
Criteria for Registration include:

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

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

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

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



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

The Institute of Science & Technology

IST CPD Award
Registered Practitioner

Registered Science Technician
Registered Scientist

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

Communications and the IST

At The IST we are working hard to ensure that we provide the best service to our members and one of the areas that we have been updated recently is communications. We now have a number of ways in which we contact and provide information for our members and we thought it might be useful at this stage to bring all those channels to your attention.

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

office@istonline.org.uk – general enquiries

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

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

It is important that we have up-to-date email addresses for all our members so if yours changes please let us know.

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

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

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

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

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

Leading Your Technical Team

Inspiring Leadership | Leadership Foundation for Higher Education

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

The nature of technical support in many universities and higher education colleges is changing. For many universities one of the key challenges is how to effectively channel, develop and manage their scarce but highly valuable technical resource. Increasingly, what has been highlighted when realigning and grouping technical support is the need to prepare and train technicians to manage, and above all, lead technical teams. Recent surveys have shown that high quality technical support is now seen as essential in delivering a high value student experience and quality research.

How the programme set works: 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. There is no role playing.

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. For example recent delegates were from institutions such as Glasgow Caledonian University, University of Leeds, University of Oxford, Canterbury College and Norwich University College of Arts. They also had a wide variety of job roles ranging from Technician, Senior Technician, Laboratory Manager, IT Network Team Leader, Workshop Manager, Geological Facilities Manager, Textile Workshop Manager and Bio-repository Manager.

Leading Your Technical Team

This first two day programme 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.

Content

- **Key issues for managers/supervisors and their teams -** roles and responsibilities.
- **Management v leadership**.
- **Motivation and delegation -** individuals and team.
- **Communication skills & team briefing -** influencing skills and analysing your network.
- **Managing change -** leading your team through change in an university environment.
- **People management issues & case studies.**
- **Teams and team roles -** team working.
- **Developing yourself and your team.**

Who is it for?

This programme is intended for anyone from UK universities and colleges, who might now or in the future, have technical management or supervisory responsibilities and is interested in developing their fundamental management/ leadership skills. The programme content is applicable to support staff from academic and service areas.

Building on Your Leadership Skills

This second two day 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.

Content

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

Who is it for?

This programme is particularly suited to people who have completed Leading Your Technical Team or those who have previously attended similar programmes and have a few years' experience in a technical managerial or supervisory role and want to further develop their management/ leadership skills. The programme is applicable to support staff from academic and service areas.

For more details please contact:

Baljit Sandhu
Marketing and Administration Officer
Leadership Foundation for Higher Education
Peer House, 8-14 Verulam Street
London WC1X 8LZ

T: 020 3468 4819
F: 020 3468 4811

www.lfhe.ac.uk

The Institute of Science & Technology

Application for membership

Before completing this form please read the Notes for Guidance for Applying, available at www.istonline.org.uk. All relevant sections of the following form must be completed, even when additional information is provided on a separate sheet. New members apply to join on the basis that the appropriate grade of membership will be awarded by the Institute on acceptance, and that the level will be determined by the details supplied on this form.

When the applicant is notified of the grade of membership offered by the Institute a request for the appropriate membership fee will be made. Personal details collected in respect of applications will be treated in the strictest confidence and every effort is made to ensure that data is held securely.

I agree to my details being passed onto individuals involved in the application review process.

Please accept my application for membership. If accepted I agree to abide with the by-laws of the Institute.

Signed: ..... **Date:** .....

PERSONAL DETAILS

Title (Dr/Mr/Mrs/Miss/Ms): .....

Surname: .....

Other Names: .....

Date of Birth: .....

Home Email address: .....

Telephone: .....

Address for correspondence: .....

.....

.....

A. DETAILS OF PRESENT POST

Job Title: .....

Date of Appointment: .....

Employer Name: .....

Employer Address: .....

.....

Email: .....

Type of work or discipline: .....

.....

Brief details of practical work undertaken in the year prior to application:

.....

.....

.....

B. PREVIOUS EMPLOYMENT HISTORY

Date	Employer	Type of Work/ Status/Title/Discipline
.....	.....	.....
.....	.....	.....
.....	.....	.....

C. QUALIFICATIONS

Give details below of any examinations passed, prizes or scholarships awarded etc. (Documentary evidence must be forwarded with this form, scanned images in jpg format are acceptable)

Date	Examinations/Prizes/ Scholarships etc	Institution
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

Continued overleaf

The Institute of Science & Technology

D. COURSES & OTHER RELEVANT DETAILS

Give details below of any courses you have, or are attending, membership of other professional bodies, published work etc.

Date	Courses/Professional Bodies/Publications etc
.....	.....
.....	.....
.....	.....
.....	.....

E. REFEREE

Give name, qualifications and full address of your manager or Head of Department/Supervisor, who need not be a member of the Institute, who knows you personally and who would confirm the particulars on this form and who would support your application for membership of the Institute.

Name: .....

Position:.....

Organisation: .....

Qualification(s):.....

Email:.....

Address:.....

.....

.....

Send to: Institute of Science Technology
Kingfisher House
90 Rockingham Street
Sheffield SE1 4EB

Email: office@istonline.org.uk

FOR OFFICE USE ONLY

Application received: .....

Registration fee received: .....

Referee form sent: .....

Applicant notified: .....

Grade awarded:.....

Membership fee received:.....

Membership No:.....

Membership card & Diploma sent:

.....

Direct debit instruction received:

.....

IST Registered Practitioners

Since 1987, the Institute of Science & Technology has operated a Register of competent and qualified technical practitioners. As the professional body for specialist, technical and managerial staff, we are actively involved in improving the status of, and the services offered by, technical staff in education, research, government and industry and it is our view that the Registration Scheme for laboratory and other technical practitioners is essential if their status, career prospects and expertise are to be recognised and enhanced, or indeed maintained.

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

Criteria for Registration include:

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

There is also a route for mature applicants who have achieved a high standard of professional competence but who may not have appropriate formal academic qualifications.

Registered Practitioners are permitted to use the post-nominal, designatory letters **MIScT(Reg)** or **FIScT(Reg)**.

Registration must be renewed each year and the renewal application should be accompanied by evidence of Professional and Personal Development. Registered practitioners may be removed from the Register if:

i) they fail to undertake any PPD in a 4-year period, or

ii) there is evidence that their professional conduct falls below the standard expected, or

iii) they cease to be a technical practitioner.

There is a fee for admission to the Register and a nominal annual renewal fee.

For further information, and an application form, contact the IST office or visit our website.

www.istonline.org.uk

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